A STUDY ON THE PERSPECTIVE OF PERSONAL WEALTH CREATION IN A CRISIS SITUATION

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ABSTRACT

"Personal finance is the process of budgeting, saving, and spending monetary capital over time while taking into account different financial risks and potential life events. When it comes to personal finances, an investor should think about the suitability of a variety of financial products, private equity investments, and insurance products, as well as participation and tracking of and/or employer-sponsored retirement plans, social security benefits, and tax management and many more. We have seen a number of countries face a lot of unpredictable problems during this period, such as the covid -19 pandemic, Myanmar's military coup against the government, wildfires in North America and Australia, and many more. These events have had a huge effect on the country's economy, and this burden has eventually fallen on the taxpayers. It is important to know how to handle one's finances in such a situation. As an investor, you must also understand when and how much to invest, as well as where to invest their money in such situations. The aim of this paper is to show how to manage personal finances in the face of a country's uncertainty, whether caused by man or nature, and also analyze the market prices of their investments as they drop and rise in response to the crisis

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Keywords: *personalfinancial, decision making, risk tolerance, crisis management*

Introduction

A recession is an era of economic contraction during which unemployment increases and trade and manufacturing production declines. Although the definition of a recession varies, it usually applies to six or more months of economic downturn. This indicates that a country's gross domestic product (GDP) has fallen for two consecutive years, indicating sluggish or negative economic growth. Natural or man-made events can trigger a recession; for example, the COVID-19 pandemic recently triggered a slowdown, raising concerns about a recession. The GDP of several countries was affected, Whether or not a recession is approaching, there are steps you should take to prepare the budget for any economic adjustments.

The idea of being prepared for unfavorable circumstances will still make you have the upper hand over your country's economic situation, making it better to be financially prepared during a crisis, whether caused by man or nature. The effect on the economy, whether man-made or natural, is devastating to the world and its economic condition, and this also would take a toll on taxpayers. The US unemployment rate rose to 14.7 percent in April, the highest amount since the Great Depression, according to the Bureau of Labor Statistics. Market instability has reached heights last seen during the financial crisis of 2007-2008. Many of us have never seen an economic situation like this before. But now that so many people are unemployed and in economic difficulties, we can see the value and rationality behind the theory. It is important to be financially able at times like this.

Literature Review

An Analysis of the Factors Affecting Investors' Financial Goals in Today's Scenario

Sidhanth et al [1] discuss the probable factors that lead to a person's decision in investing in a particular scheme. A quantitative study has been conducted using empirical data collected using electronic methods and a rough line is drawn to study the relationship between these various factors. Statistical analysis has been performed, using RStudio, on the dataset, which consists of information from 92 different individuals, while keeping intact the integrity and the trustworthiness of the dataset by ensuring a dispersed circulation of the data collection form, while also cleaning the dataset using secondary information found on the

Internet. The study concludes, with statistical proof, that there exists a relationship between the investor and some attributes like individual's income, gender, age, retirement age, and the number of children. It also shows proof as to the irrelevance of the marital status to a person's income statement.

An Empirical Analysis of Impact of Macroeconomic Variables on Indian Stock Market

P.Radha et al. [2] discuss the effect of c certain economic variables on the stock market, while also putting together a rather political review of the effect of the Modi Government(Prime minister, India, 2014- present) on the stock market. The study provides insight for the investors that are looking to know about the stock market in India. The stock market studies here because it runs parallel with the economic health of a country, which is evidently proved in this study. The implementation of policies and their impact on stock prices has also been conducted using "Granger's causality test", hence finding if there is a correlation between the government policies and stock market prices. Data used for the study is the stock market data in India, between 2009 to 2018, but has been divided into two parts - pre-Modi leadership and during the Modi government. The macroeconomic variables under consideration are the Bank rate, Repo rate, and Reverse repo rate. Nifty has been used as a representative of the Indian stock market. The main focus being banking sector stocks, this paper focuses on the private sector banks, which satisfy the criteria of resemblance to corporate banks (stock split, mergers, etc.). The Augmented Dickey-Fuller test was applied to test the fluctuations in the stock data. The study provides conclusive evidence suggesting that the Bank rate, repo rate, and the reverse repo rate have a positive correlation with the Nifty Indian stock prices and also the banks. Also, it is concluded that the results of correlation during and before the Modi government are similar.

Personal Finance Planning with respect to person with disability: Scale Development.

Saroj Kumar et al [3] put light on a rather untapped field of research - investment options and financial planning assistance for those who are specially-abled. The dataset consists of 181 responses collected strictly within the city of Lucknow, India, by means of interviews and pilot studies. The data was then categorized into various demographic profiles accordingly. The confirmatory factor analysis method was employed to develop a four-factor planning metric. The research is exploratory, cross-sectional,and descriptive. The four determinants of the personal financial planning scale - Finance planning, managing investment, managing retirement, and managing insurance were statistically significant at 0.001 level, among which the loadings of managing insurance is 0.69, as opposed to the other three, who have factor loadings greater than 0.7.

Prediction of project cash flow using time-depended evolutionary LS-SVM inference model

Min-Yuan Cheng et al [4] propose a novel machine learning methodology to predict the cash flow for a very specific use-case - construction business. In construction businesses, cash flow and its availability play a significant role in the profitability of the project. Predictions for the cash flow puts out a major stress from the minds of the construction project manager's mind, and he can focus on increasing the profits generated and formulating new strategies. This study hybridizes WLS-SVM (weighted least square support vector machine) a - supervised learning ML algorithm, MLIE (Machine-learning Based Interval Estimation), APLF (adaptive piecewise linear function) to correctly assign the weight values to the old and new values in the time series data and DE (Differential Evolution) as the search engine. The database is collected from a construction contractor from Taipei, consisting of information on several high-rise building projects between 1996 and 2006. The SVM model used 8 of the projects as training data to achieve reasonable accuracy, 2 for validation, and 2 for testing purposes. The study resulted in the model showing PCIP (Prediction Interval Coverage Probability) and MPI (Mean Width of Prediction Interval) values were calculated and found to be 96% and 0.13 respectively, for a 95% LOC, and 90% and 0.09 respectively, for a 90% LOC. These were acceptable values to rule that the model has turned out to be quite effective. However, the only limitation is the lack of

variety of data in this specific domain, for this specific use case.

Effects of Income Tax Changes on Economic Growth

William G. Gale et al [5], proposes A tax change's composition and funding are crucial to achieving economic development. Tax cuts will allow people to work, save, and save, but if they are not accompanied by immediate spending cuts, they would almost certainly result in a larger federal budget deficit, which will limit national saving and lift interest rates in the long run. The net effect on growth is unknown, although several forecasts indicate that it would be slight or negative. Base-broadening policies will minimize the effects of tax rate cuts on budget deficits while also reducing the impact on the labor market, saving, and consumption, reducing the direct impact on productivity. They do, however, reallocate capital across industries to their highest-value economic uses, resulting in greater productivity and possibly increasing the economy's total scale. According to the findings, not all tax reforms would have the same effect on progress. Reforms that boost benefits, reduce current subsidies, prevent windfall profits, and avoid deficit financing would have a more favorable impact on the economy's long-term scale, but they can result in trade-offs between equity and productivity.

Economic Impact of A Crisis

An economic crisis impacts not just organizations and businesses, but also the general public's level of living. Many nations are still in the midst of a crisis, and the effects may be quantified using several metrics that estimate the people's level of life, such as the active population. The economic crisis may come in different forms, but the most generic way of categorizing this crisis could be in form of natural and man-made disasters. In the face of such a crisis, the government responds in a variety of ways, for example, following the sudden crash in the economy of India, the Reserve Bank of India has taken a few steps at the micro and macro level. In order to support the economy despite weak activity, the central bank unveiled a host of monetary measures, including an out-of-turn repo rate drop and the ability to delay loan repayments. Steps to

strengthen the functioning of the market, promote exports and imports, relieve debt servicing, and relieving the financial limitations of state governments were also on the Reserve Bank's cards. Along with a 40 basis point drop in the repo rate and a three-month extension to the moratorium period. India's Covid-19 stimulus program is now approximately 10% of GDP, which is much lower than some other big countries. In comparison, the US is spending around 27% of its GDP on economic relief, and in Japan, the stimulus is now at 55% of the country's GDP. In May 2020, the Indian government launched a stimulus package worth Rs20 lakh crore. Farmers, women, and construction workers were explicitly targeted for Rs1.7 lakh crore. Furthermore, the funds that the government promised to transfer directly to the poor were just a reallocation of monies from regular yearly cash-benefit systems. This being targeted to certain people, it's not applicable to the entire population and they cannot benefit from it.

Ecnomic impact of natural disasters

Natural disasters, ranging from hurricanes and earthquakes to droughts and floods to pandemics and bushfires, have the potential to disrupt not only the lives of local communities, but also to cost governments, industries, and individual residents a significant amount of money. Larger disasters, such as pandemics and bushfires and many more disasters that are happening, have wreaked havoc worth tens of billions of dollars to the government and also to a lot of private-sector industries. While we may believe that the economy and natural disasters are two separate entities, all-natural disasters have and will continue to have an impact on the economy.

For research purposes, we're looking at the latest pandemic, COVID-19, as well as the recent bushfires in Australia caused by dry fuel moisture and the ongoing droughts. India has faced the most economic damage than the other countries during this pandemic, according to data released by the Government of India's Ministry of Statistics and Programme Implementation on August 31, 2020, real quarterly GDP contracted by a whopping 23.9 percent between April and June 2019. Since the country began publishing quarterly GDP

estimates in 1996, this level of real GDP decline has never been seen before. Even so, the estimated contraction of the Indian economy is almost certainly understated due to statistical omissions and the implementation of covert policies. China was the only nation to rise at a rate of 3.2 percent during that period because of exports that increased more than anticipated in December, as global coronavirus outbreaks fueled demand for Chinese products,

exports were made more expensive for international buyers. Exports increased by 38.7% in the third quarter, while the overall volume of commercial building transactions increased by 88.5 percent year over year, according to official reports. Both the manufacturing and service industries recovered well.
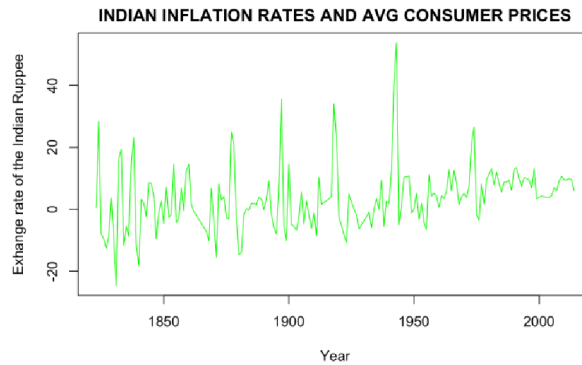
Graph 3.1.1: Indian inflation rates and average consumer prices

Also, the latest Australian bushfires, which lasted from June 2019 to May 2020, had a significant effect on the economy. This has cost the insurance companies a loss of 1.8 billion dollars on this particular bush fire and also the tourism industry which had a loss of

4.5 billion dollars these have hit the economy very hard, After last year's stagnation in inflation, continued low wage growth, and high underemployment, Australians were still wary of the economic outlook.
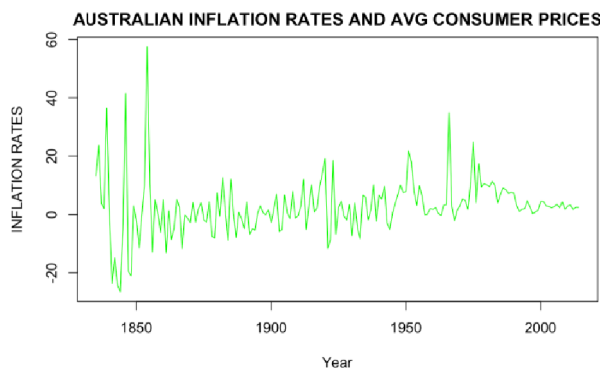
Graph 3.1.2: Australian inflation rates and average consumer prices

Economic impact of man-made disasters
There are many man-made disasters that are happening regularly and there are few that have a greater impact on the country's economy. Disasters like the Chernobyl power plant accident, the dust bowl, the oil spill by Exxon Valdez, Death in Bhopal due to the leakage of chemicals, and many devastating disasters caused by us humans. Human-caused disasters have a much bigger impact on the economy

than natural disasters, whether they are done deliberately or not.
For research purposes, we should look at the economic effects of the Chernobyl power plant accident and Exxon oil spills on their respective countries. In 1986-1989, direct losses of capital assets and other material commodities, as well as spending on actions to deal with the disaster's effects, totaled 9.2 billion rubles (Russian currency). The

agriculture industry was the one that took the brunt of the accident's consequences. Furthermore, the great global crisis of the 1990s had a negative impact on it. Looking at the situation individually, People from the impacted areas have it especially poor, with lower incomes, less private spending, and higher unemployment than people from other parts of the country. The proportion of small and medium-sized enterprises is also significantly smaller than in other countries, owing to the exodus of many professional and trained employees.

"The most expensive oil leak in history is the EXXON VALDEZ," according to the International Tanker Owners Pollution Federation Limited (Alaska, 1989). The cleanup alone cost about $2.5 billion, though gross expenses (including fines, damages, and claim settlements) have been reported to be as high as $7 billion at times." According to Oceana, the spill cost more than $300 million to more than 32,000 people whose livelihoods relied on commercial fishing. In the year after the leak, tourist spending fell by 8% in south-central Alaska and by 35% in southwest Alaska. The economic damages to commercial fisheries are projected to be 31 billion dollars two years after the Exxon Valdez leak. This has a great impact on the fishermen and the small industries that depend on them. Not just economically but and ecological also they get affected due to this.
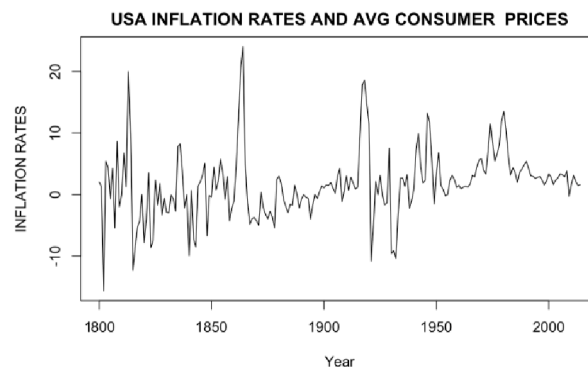
Graph 3.2.1: USA inflation rates and average consumer prices

Impact on an individual's financial state.
Aside from the physical destruction and instability, the country's financial situation has a significant impact on its people. Each individual is impacted financially in some way; the difference is the magnitude of the effect. The amount of money received per person in a country or area is referred to as per capita income. Per capita income can be used to calculate an area's total per-person income and to assess the population's standard of living and quality of life. A country's per capita income is determined by dividing its national income by its population. For example, COVID-19 has cost the world both financially and in terms of health. India, as one of the worst-affected countries, was estimated to have lost 8.7% of its per capita income, according to a few reports.

This was mostly due to the strict lockdown procedures that resulted in many residents losing their jobs and struggling to make ends meet. India has never seen such a severe economic downturn. Taking a closer look at the extent of the destruction, another study claims that 7.35 million people lost their employment as a result of the pandemic, equating to roughly 5% of Indians losing their jobs.

Impact of taxon economic growth.
To rectify the dips in the country's economy tax reforming comes into play. Although there is no question that tax policy will affect economic decisions, it is far from certain that tax rate cuts would result in a larger economy ex-ante. Whereas the rate cuts would increase the after-tax return on working, saving, and investing, they would also increase the after-tax income people get from their current level of activities, reducing their need to work, save, and invest. Economic activity is usually increased by the substitution effect, whereas it

is normally decreased by the income effect. Furthermore, if tax increases are not accompanied by budget cuts, they will result in a rise in federal borrowing, which will limit long-term growth even more. The historical evidence and simulation analysis support the notion that tax cuts that aren't accompanied by immediate budget cuts have little effect on growth. Tax cuts funded by immediate reductions in unproductive spending, on the other hand, would boost productivity

Aim and Objective.

1. To prepare yourself financially for unpredictable situations.
2. To determine what significant efforts one can take to prevent getting ensnared in a country's crisis.
3. Visualizing and aggregating data from past years, to support our research.

Data Analysis on Global Crisis.

The data used for this visualization and the aggregation was taken from Stanford Business school's official website. The dataset contains 8098 rows (after cleaning the data from inconsistencies) of information about the defaulted domestic debts, systemic crises, currency crises, banking crises, and the inflation crises of 68 countries, from the year 1800 to 2016. Further, the inflation rates and average consumer prices information for all the countries have been provided.
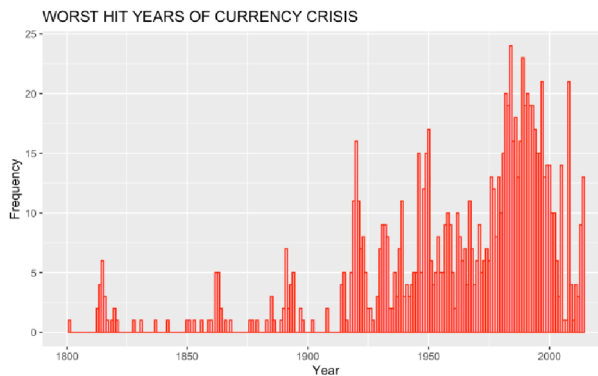
Graph 5.1: Worst hit years of Currency Crisis

Currency crises are the situation wherein there is a country's reserve bank is capable of holding foreign funds to keep the exchange rate afloat.
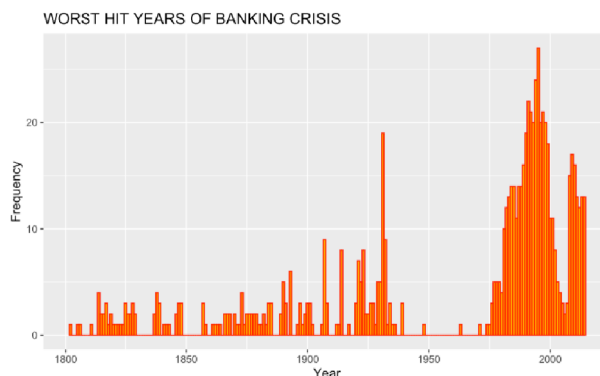
**Graph 5.2**: Worst hit years of Banking Crisis

Banking crises occur when a large number of customers withdraw the deposited amount, for any reason - the most common ones being the loss of confidence or trust in that bank

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WORST HIT YEARS OF INFLATION CRISIS
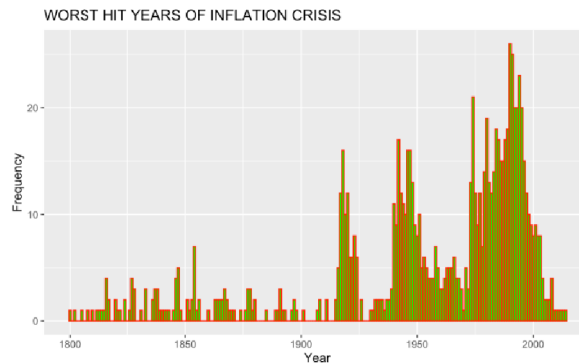
Graph 5.3: Worst hit years of Currency Crisis

From Graph 5.3, Inflation crises refer to the abnormal rise in prices. The plot shows average inflation in consumer prices throughout the years. Inflation is a measure that is used to directly measure the effectiveness of certain policies on the general public.

YEARS VS COUNT OF DOMESTIC DEBTS DEFAULTED
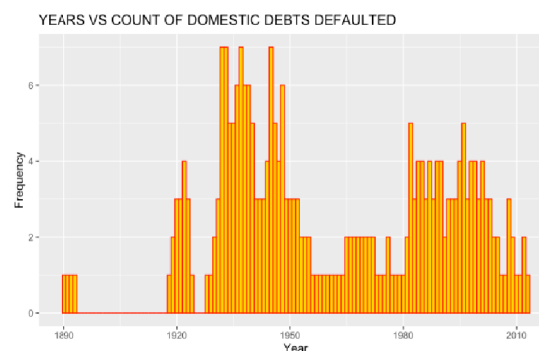
Graph 5.4: Years vs Count of domestic debts defaulted

From Graph 5.4, The peak of defaulted debts comes in the years 1930 - 1950, probably because of World Wars I and II, arguably a few of the worst man-made disasters.

WORST HIT YEARS OF SYSTEMIC CRISIS
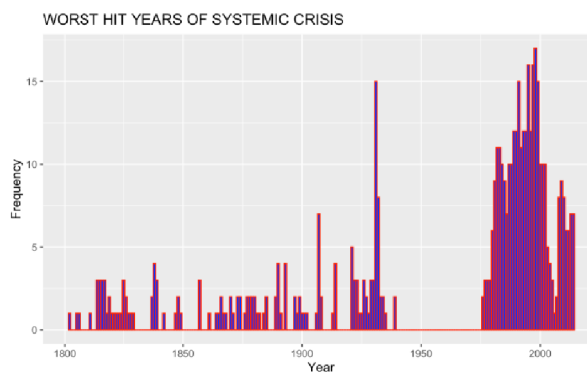
Graph 5.5: Worst hit of Systemic Crisis

From Graph 5.5, we see that the worst hit of systemic crisis has increased in the past few years gradually. The inflation rates of Australia, India, Russia, and the USA throughout the years. The Inflation rates and the average consumer prices can be used to directly measure the impact of events on the general public.
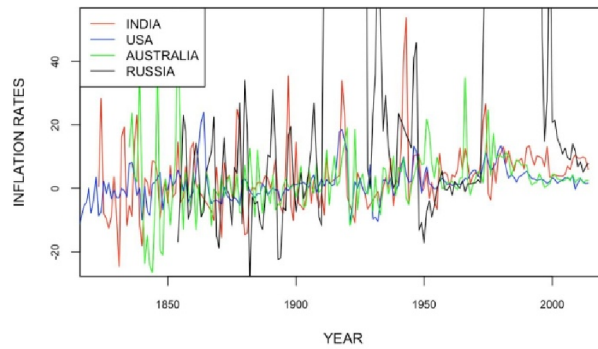
Graph 5.6: Inflation of countries India, USA, Australia, and Russia

A time series plot showing the steady decline in the number of commercial banks in the world, since 1990.

Graph 5.7: Number of commercial banks worldwide Vs Time

A time series plot showing the variation of the GDP for the bank sectors throughout the world.
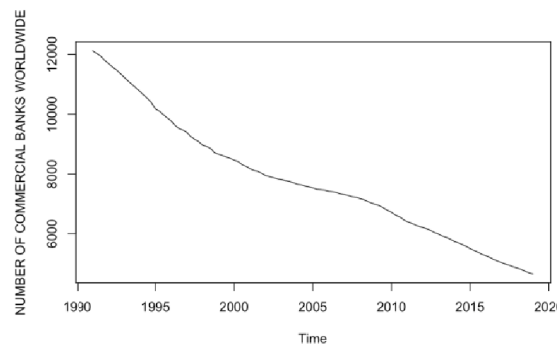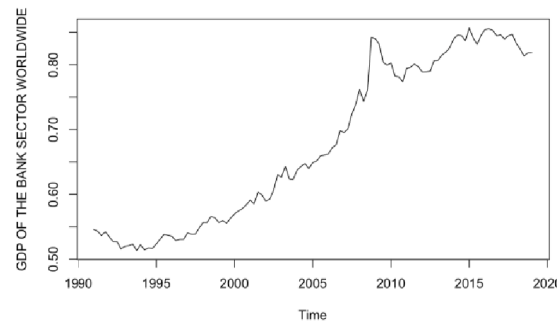

Discussion and Conclusion

The best solution in any financial state is to identify the problem, address it and set a budget that incorporates your priorities at first. However, not all problems can be solved in the same way. It's critical to understand what has to be done in your present circumstance in order to go forward with resolving it.

Building an emergency fund is one of the keys to sustaining in such given situations. It is essential to set one up. Consider it a life's shock absorber, one that will prevent you from adding to the debt burden you're already carrying. The coronavirus outbreak in recent times has highlighted the importance of maintaining an emergency fund when a crisis strikes. As a result, understanding how emergency funds work is important. Aside from emergency reserves, it is also helpful to be aware of various ways to save money in case of a disaster.

While no one can anticipate when a recession will begin or end, you may prepare now to avoid much of the pain. The stock market rises and falls, then rises again. Job opportunities come and go. However, in the past, every downturn has been followed by an upturn. Preparing now can help you weather the storm and position yourself to benefit when the economy improves. Building your assets, re-

evaluating your finances, and handling your loans are all important ways to prepare for the unexpected crisis that can happen.

Few ways to handle your budget during a crisis:

1. Each month, review the budget and see what costs can be eliminated. to exclude it from the budget. To save a few rupees, only buy what you need and choose generic over name-brand items. Don't buy things you desire; instead, buy what you need in your day-to-day life. Make your purchases wisely.

2. Increase your savings budget as soon as you can by leaving out needless costs. Savings should account for 20% of your profits, while "extra" costs such as subscriptions and memberships should account for 30%.

3. Set up higher regular deductions to the emergency fund after you've reduced your additional expenses. The first step in developing a fully stocked (8-10 months expenses) emergency fund is to start a small emergency fund of one's monthly expenses. This modest objective is much easier to achieve, and it will make you feel successful after you reach the final goal which is your fully stocked emergency funds. This can help you set up a higher deduction rate from your emergency fund.

4. It is general advice to pay off the high-interest loans so that they come in handy during a crisis. pay off tax-deductible debt accounts, such as student loans, while you're at it, so you can get money back during tax season.

5. Consider if you need to have a small sum of cash (anywhere from 3 thousand to 5 thousand) on hand in case of an emergency. It cannot always be easy or possible to reach your bank account or use a credit card, for example when you need to make a curbside transaction or deal with a widespread power outage. You don't want to keep a lot of money at home; you just need enough for a week's worth of food.

6. Having an emergency fund not only reduces tension during a crisis but also protects you from going into debt or depleting your retirement savings. You will want to reevaluate those parts of your budget that you found important prior to the present crisis and searching for funds to go into the emergency fund.

7. It is possible to discourage one crisis from piling on top of another by providing adequate insurance coverage like property insurance, life insurance, medical insurance, and many more. It's also worth double-checking if you have the coverage you need, not just the bare minimum. This is true with policies you now have as well as those you will need to buy in the future. When you have a serious condition or accident that keeps you from living, a disability insurance package is a must, as is an umbrella policy.

8. You have to be in a situation to be prepared to give up some long-term benefits for the sake of the short-term. if you are facing a loss of income and need to access money from places which you intended to save, do so instead of borrowing, selling something for a low price, or allowing credit card debt to build up. Be willing to give up some of your objectives in exchange for others.

9. Cash accounts such as banking, investments, and money market accounts, as well as CDs and short-term government loans, will be more useful. The value of these commodities does not fluctuate with market fluctuations, unlike bonds, stocks, and other financial instruments in which you have saved. As a result, it's a good idea to save in cash accounts as well.

10. It is advised to avoid panicking and steer clear yourself away from fear. Consult a financial advisor if you're unsure about any economic changes.

The goal of this research is to determine the trend of consumer price fluctuations throughout a country's crisis. We investigated and demonstrated that previous data support our findings. When it comes to financial planning, we can never be certain about the future, therefore it's always better to be prepared. Though not everyone will have the same set of options, we've outlined a few approaches to avoid a financial disaster in such a situation. We have learned a lot throughout this research on how the idea of recursion works and how one can be though not prepared

be able to overcome it. Being financially prepared during a crisis, whether triggered by man or nature, would give you the upper hand over your country's economic condition. The impact on the economy, whether man-made or natural, is devastating to the world and the economy, and it will also cost taxpayers money.

Life is unpredictably volatile, but being prepared and vigilant will help you avoid catastrophe and keep you away from disastrous situations. You can transform a possible financial disaster into a minor disappointment if you plan ahead.

References

1. Ganti, A., Shenoy, S., & Gopinathan, D. N. (2020). An Analysis of the Factors Affecting Investors' Financial Goals in Today's Scenario. International Journal of Advanced Research in Engineering and Technology, 11(9).
2. Radha, P., & Gopinathan, N. An Empirical Analysis of Impact of Macroeconomic Variables on Indian Stock Market.
3. Kumar, S., & Singh, S. K. Personal Financial Planning With Respect To Person With Disability: Scale Development.
4. Cheng, M. Y., Hoang, N. D., & Wu, Y. W. (2012). Prediction of project cash flow using time-depended evolutionary LS-SVM inference model. In ISARC. Proceedings of the International Symposium on Automation and Robotics in Construction (Vol.29,p.1). IAARC Publications.
5. Gale, W. G., & Samwick, A. A. (2014). Effects of income tax changes on economic growth. Economic Studies, https://www.brookings. edu/wpcontent/uploads/2016/06/09_Effects _Income_Tax_Changes_Economic_Growt h_Gale_Sa mwick. pdf.
6. Iqbal, J., Strobl, S., & Vähämaa, S. (2015). Corporate governance and the systemic risk of financial institutions. Journal of Economics and Business, 82, 42-61.
7. al-Hakim, M. H. (2020). Capturing the Performance of Indonesian Sharia Stock Index (ISSI) and Composite Share Price Index (IHSG) Jakarta Period 2016-2019. Falah: Jurnal Ekonomi Syariah, 5(2), 84-98.
8. Acharya, V.V., & Schnabl, P. (2009). Securitization without risk transfer: The anatomy of hidden bank debt. Work in progress, New York University Stern School of Business.
9. Bernanke, B. S. (2009). The crisis and the policy response: a speech at the Stamp Lecture, London School of Economics, London, England, January 13, 2009 (No. 442).
10. Blundell-Wignall, A., Atkinson, P., & Lee, S. H. (2009). The current financial crisis: Causes and policy issues. OECD Journal: Financial market trends, 2008(2), 1-21.
11. Borio, C. E., & Shim, I. (2007). What can (macro-) prudential policy do to support monetary policy?.
12. Smith, D., & Elliott, D. (2006). Crisis management.
13. Congdon, T. (2009). Central banking in a free society. Institute of Economic Affairs Monographs, No. HP, 166.
14. Ranjeeth, S., & Latchoumi, T. P. (2020). Predicting Kids Malnutrition Using Multilayer Perceptron with Stochastic Gradient Descent. Rev. d'Intelligence Artif., 34(5), 631-636.
15. Prasath, D. S., & Selvakumar, A. (2015). A Novel Iris Image Retrieval with Boundary Based Feature Using Manhattan Distance Classifier. International Journal Of Innovative Technology And Creative Engineering (Issn: 2045-8711) Vol, 5.
16. Balamurugan, K. (2021). Fracture analysis of fuselage wing joint developed by aerodynamic structural materials. Materials Today: Proceedings, 38, 2555-2562.
17. Party, C. (2009). From crisis to confidence: Plan for sound banking. Policy White Paper, 20.
18. Murugesan, Tk, And M. Krishnamoorthi. "Drivers And Obstacles Toward Becoming Entrepreneurs–A Study From The Perspective Of Rural People."International Journal of Mechanical and Production

Engineering Research and Development (IJMPERD) 8.3, Dec 2018, 907-915

19. Al-Omari, A., & Alganbousi, S. (2020). The entrepreneurial intentions among undergraduate students of Sultan Qaboos University and its relationship with their proactive personality. International Journal of Educational Science and Research, 10(3), 37-48.

20. Moses, C. (2014). Entrepreneurship Education and Student's Life Challenging Situations: An Empirical Study of Covenant University, Ota, Ogun State, Nigeria. International Journal of Business and General Management (IJBGM), 3(4), 1-10.

21. Moses, C., Akinbode, M., & Onochie, P. (2015). Strategies for Financing Small and Medium Enterprises in Nigeria: Concepts and Issues. International Journal of Business and General Management, 4(5), 25-38

AN ECONOMICS ANALAYSIS OF CUT FLOWER CULTIVATION IN TAMILNADU

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ABSTRACT

Cut flowers are harvested with stalk especially for arrangement in Vases, and are the lasting. These constitute a major share of the total world trade in floricultural products, important cut flower crops are rose, carnation, chrysanthemum, orchid, gerbera, lilium, anthurium, gladiolus, narcissus, bird of paradise, helicoma, anemone, ranunculus, tulip, calla, lily etc., Cur flowers are used in the preparation of bouquets and floral baskets as Corsages, flower arrangements and for decoration purposes

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Keywords: Rose Chrysanthemum, Orchid, Anthurium

Introduction

Cut flower cultivation is taking place in 145 countries of the world. In fact, flowers constitute one of the largest trading commodities in the agricultural sector, commanding a bigger market share than that of food grains. Floriculture-produces institute a larger market than that of rice and wheat. Global trade Cut flowers has been on the increase with the additional global input of floriculture products including cut--flowers, cut foliage and live plants, fetching an amount of not less than $3,000 million. Cut flowers account for more than half of this sum. Carnation, Rose, Chrysanthemum, Orchid, Anthurium, Aster, Gladiolus, etc., are the highly valued cut flowers in the international market. The largest exporters of cut flowers include the Netherlands, Columbia, Israel, Italy, Sri Lanka, Thailand and Kenya. The developing countries, which supply cut flowers are Taiwan, Singapore, Peru, Mexico, Costa Rica, Brazil, Ethiopia, Zimbabwe, Mauritius and Malaysia. Besides this, the world imports of foliage and live plants are also on the increase. But India's share in this venture is quite negligible. Recognizing the prospects of exporting floriculture-products, Government of India has accorded high priority to their export and has identified them as a thrust area for export. The Government has already initiated steps to enable the country to grab its due share in the global floriculture market. The Commerce Ministry has identified floriculture as an "extreme focus segment" and a Committee has already been put on the job of preparing a plan of action. The National Commission on Agriculture has set up a target of 5, 00,000 hectares for cultivation by the year 2002 A.D. Four States, namely, Tamilnadu for Orchids, Maharashtra for Carnations and Roses, Karnataka, for Chrysanthemums, and Andhra Pradesh, for Roses, have been identified for organised and co-ordinate flower production. That objective is to generate foreign exchange worth Rs. 200 crore annually by exporting flowers from the fifth year of floriculture-operations Some floral varieties having great demand all over the world are Roses, Chrysanthemums, Carnations, Lilies and Orchids and Anthuriums. Orchids have been occupying a pride of place in horticulture and floriculture not only for their aesthetic value but also for their therapeutic value right from the Vedic Age. Proportionately Orchids take 80 per cent of the total flower market in the world with Thailand contributing 85 per cent. Sri Lanka and Malaysia are the other major contributors. Cymbidium has the highest demand, followed by Dendrobium, Phalaenopsis, Oncidium, Vanda, Mokara and so forth. Though lndia is blessed with all varied climatic conditions of the world, it has not made any headway in cut flower production for both the international and the national markets. Flowers artist priced beyond the reach of common man for want of competition in production and marketing. Since production has remained stagnant, the prospects of export draw a blank

Importance of the Study

Tamilnadu is one of the few places in the world where the Orchids, of which about 200 varielies flourish in Nature. Tamilnadu's floriculture business is mostly concentrated on the Orchids. The cultivation has become a popular project with the involvement of both the public and private sectors and the readiness of some banks to advance financial aid. But production centres are scattered widely apart from one to the other with an assorted group of planters cultivating only a small 30 . Number of plants. The first Floriculture Development Centre in the country is in Tamilnadu An It is launched by the State Horticultural Department. Development programmes, which are implemented by the Government and the new venture, are expected to generate both direct and indirect employment to thousands of people in the State. The agro-climatic conditions of the Static are ideal for growing many dollar minting cut flowers such as Orchlds, Anthuriums, Roses and a host of other ornamental flowering plants. There is also a good potential for the setting up of Orchidariums and Anthurium nurseries. krishnagiri being declared as a biotechnology district, cultivation of Orchids and Anthuriums calls for special consideration. The National Bank has already sanctioned a scheme to krishnagiri District Co-operative Bank involving a financial outlay of Rs:20.80 lakhs for assisting 60 farmers for Orchid and Anthurium cultivation. It is understood that two schemes for Orchid and Anthurium cultivation involving loan assistarice to the tune of Rs. 60 lakhs have already been sanctioned by a commercial bank.

Scope of the Study

Even though the study can be made from the stand point of cultivators, traders, consumers, the Government or at the initiative of an institution, the present study is intended to throw light on the mechanics of in vitro propagation and assessment of co:;t and profitability of Orchid and Anthurium cultivation in Tamilnadu from the point of view of the producers of seedlings, cultivators and traders only. For a detailed analytical study of Orchid and Anthurium growers in the State, a sample survey has been conducted covering both the Orchid and Anthuriurn cultivators. An earnest attempt is also made to identify the production and marketing problems of Orchid and Anthurium growers in Tamilnadu State.

Objectives of the Study

- 1.The cultivation of Orchids and Anthodium's in a historical perspective.
- 2. To make an overview of the world production, consumption and trade in floriculture.
- 3. The analysis of the socio-economic conditions of the cut flower 60 growers of Tamilnadu

Methodology

The study is an empirical one, which is based mainly on primary and Secondary data required for the study have been collected from various books, and journals wherever it is found necessary. The study is an empirical one based on primary data. The data required for the study have been collected from both primary and secondary sources. Secondary data required for the study have been collected from books, and journals related to the topic. Primary data required for the study have been collected by means of structured schedules Administered among cultivators of cut flowers. Other information related to the marketing aspects of cut flowers have been collected by means of interviews arid discussions with traders, office bearers of cut flower societies.

Collection of Data
A. Primary Data

The primary data required for the study have been collected from the cut flower growers in the State of Tamilnadu by means of structured schedules, discussions, observations and interviews with expert persons and the information elicited from the results of experiments carried out in Bio-technology lab with their assistance. Experienced persons such as Professors of Tamilnadu Agricultural University,

Field Work and Data Collection Tools

Structured schedules were used to collect primary data required for the study by conducting a field survey in all the 38 Districts

in the State of Tamilnadu. Before the actual field survey, a pilot study was carried out 60 include only the appropriate questionate to necessary ones.

Sample Design

Since the population to be covered spreads over a wide geographical area of the State, a census method is found to be quite impractical. Hence a stratified random sampling technique is used for the purpose of the present study. The State of Tamilnadu for the purpose of the study is divided into Seven Zones via North eastern, North Western, Cauvery Delta, Southern, High Rain fall, Hilly Zones, Seven zones, six respondents (three Orchid cultivators and three Anthurium cultivators) have been contacted for the purpose of administering the schedules. Cultivators have also been categorised into three main groups for the purpose of eliciting information. They are Small-scale cultivators, Medium-scale cultivators and Large-scale cultivators. Persons having less than 2,000 plants are categorized as Small-scale cultivators. Those who are having more than 2,000 and less than 5,000 plants are included in Medium-scale cultivators and

persons having more than 5,000 plants are taken as Large-scale cultivators. Thus altogether 84 respondents (3 X 2 X "4) three respondents each from two categories of cut flower producers in all the 38 Districts of the State have been selected for the purpose of field survey.

B. Secondary Data

The relevant secondary data for the study have been collected mainly from various Books, Thesis, Reports, Journals and Periodicals relating to the subject.

Data Analysis

Statistical techniques such as scaling and scoring techniques are used for the analysis of data. Scoring technique is used for identifying the cultivation and marketing problems of Orchid and Anthurium growers and also for the interpretation of information elicited from the sample respondents. Scaling technique is used to analyses the opinion of respondents regarding various aspects of cultivation and marketing.

Table 1

S.NO	Sources of Training	Low	Medium	High	Total	Percentage
1	Cut Flower Societies	3	--	--	3	16
2	Agricultural Universities	2	3	6	11	58
3	Federation of Indian floriculturists	--	1	--	1	5
4	Tropical Botanical Garden and Research Centre	--	--	1	1	5
5	Private Agencies	1	--	2	3	16
6	Other	--	--	--	--	--
	Total	6	4	9	19	100

Table No. 1 indicates that 58 per cent of the Orchid cultivators, who have undergone various training programmes, have got the training regarding the cut flower production from Agricultural Universities. Those who have undergone training programmes or~ganised by the cut flower societies and private agencies constitutes 16 per cent each

and those who have the opportunities to participate in the training programmes conducted by the Federation of Indian Floriculturists and the Tropical Botanical Garden and Research Centre account for 5 per cent each Classifications of Orchid cultivators who have obtained a number of Technical guidance's are depicted in Table No. 1

Table 2

S.NO	Sources of Technical Guidance	Low	Medium	High	Total	Percentage
1	Self	10	12	7	29	69
2	Government dept / agency	--	1	--	1	3
3	Agricultural university	2	1	5	8	19
4	Private professionals	2	--	2	4	9
	Total	14		14	42	100

From Table No.2 it is observed that majority (69 per cent) of the Orchid cultivators have not obtained any technical guidance. Those who have obtained the technical guidance from Agricultural Universities and Private professionals constitute 19 per cent and 9 per cent respectively. Only 3 per cent of the cultivators have relieved technical aid from the Government Sector / agencies Classification of Orchid Cultivators on the basis of their membership in various cut flower societies is presented in Table No. 2 Classification of Orchid Cultivators on the basis of Membership in Cut Flower Societies

Table 3

S.NO	Category	Low	Medium	High	Total	Percentage
1	Cultivators who have membership in cut flower societies	9	5	6	20	48
2	Cultivators who have mo membership in cut flower societies	5	9	8	22	52
	Total	14	14	14	42	100

Majority (5% per cent) of the producers of Orchids have no membership in any c:ut flower societies, while 48 per cent of them have membership in cut flower societies. Field investigation reveals that the cultivators get motivation from various sources such as friends and relatives, journals and periodicals, Agricultural Universities, etc., Details regarding the source of getting motivation for the commercial cultivation of Orchids are shown in Table No. 3

Conclusions

Most of the primary data required for the study have been collected from sample respondents based on sample survey method. As such, it is subject to the normal errors inherent in such social surveys due to the natural bias in the reporting of data by respondents Even though utmost care has been taken in verifying the reliability of data, possibility of such errors cannot completely be ruled out. Although there arc: several types of cut flowers grown on a commercial basis, the present study is limited to the analysis of two commercially important cut flowers, viz.. Orchids and Anthuriums that have gained wide popularity in Tamilnadu. The protocol in case of in vitro propagation of Orchids and Anthuriums are different and this will also vary frorn variety to variety, resulting in variations in the elements of cost at each stage. The present study is limited to the analysis on the basis of the laboratory results obtained in case of in vitro propagation of the dendrobium variety of Orchid and the andreanum variety of Anthurium plants only. The study is also limited to the analysis from the points of view of the biotechnology labs, cut flower growers and traders only and as such the generalization of the findings is also limited to that extent.

References

1. Reddy et al. (1992). "Prospects of Commercial Cultivation of Orchids in India", Journal of Orchid Society of India, Vol. 6(1-2), pp. 15-20.

2. Chakrabarti, K. (1995). Indian Orchid Trade-A Critical Review. Indian Forester, 121(12), 1095-1101.

3. Pal, S., & Sarkar, I. (2020). Worldwide Pests of Important Commercial Flowers. In Advances in Pest Management in

Commercial Flowers (pp. 3-28). Apple Academic Press.

4. J. Kaur (1!399), "Valentine Day; Providing Impetus to Domestic Floral Trade", F/oriculture Today, Vo1.3 (IO), pp. 6 -12.

5. Fuchs, M. (2020). Going Where No White Man Has Gone Before. AAA, Arbeiten aus Anglistik und Amerikanistik, 45(2), 197.

6. Rajeevan, et al. (1997), 'Orchids, Anthuriums and Indoor Plants, the Natural Resources of Tamilnadu', K.B. Tampi, N.M. Nayar, and C.S.

7. Nair, (ed.), Worldwide Fund for Nature .- India, Tamilnadu State Office, Thiruvananthapuram.

8. M.N Shegade, and S.G Borude (1992), "Economic Analysis of Flower Production in Thane District of Maharastra", South lndian Horticulture,

9. Vol. 40(4), KIP. 21 8-233.

10. Shukla and N. Jain (1996), "A Long Wait to Full Bloom", The Economic 7i'mes, March 1 1, 1996.

11. 9Sudha and K.V. Subramanyam (1992), "Flower Based Mixed Cropping System in Coconut Gardens - An Economic Analysis', Journal of 111d1an Coconut, Vol. 23(1), pp. 2-4.

REVIEW OF RESEARCH ON EFFECT OF VIBRATIONS ON SLEEP OF HUMAN BEINGS

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ABSTRACT

Sleep is necessary to every human being. There are many people who are facing problems of insufficient sleep. There are many reasons for this. Few people suffer from this for few days to few weeks & even few months. Generally the treatment given is medicines which lead to short span relief. Researchers have studied relationship between fatigue, vibrations & sleep, specifically in case of drivers. Many researchers have performed experiments for this study. In this paper, review of the research work done by the researcher in this area is taken. The finding of the literature review will be used to further research work.

Introduction

Fatigue in human being is extreme tiredness resulting from mental or physical exertion or illness. Chronic tiredness or sleepiness, headache, dizziness, sore or aching muscles, muscle weakness, slowed reflexes and responses, impaired decision-making and judgments are some of the symptoms of human fatigue. Fatigue is different from drowsiness, where a patient feels that sleep is required.

Sleep: Sleep is one of important functions in physiological function of human body. Some people lose touch with what it feels like to be sleepy. Sleepiness or drowsiness is the extreme desire to fall asleep.

Insomnia: Insomnia is a sleep disorder in which you have trouble falling and/or staying asleep, despite the opportunity to do so (e.g. being in bed), and experiencing decreased daytime function because of this. The condition can be short-term (acute) or can last a long time (chronic). It may also come and go. Acute insomnia lasts from 1 night to a few weeks. Insomnia is chronic when it happens at least 3 nights a week for 3 months or more.

About 40% of people with disabilities report long-term difficulties with sleep. Sleep problems are almost 3 times more common in people with chronic conditions such as traumatic brain injury, spinal cord injury, multiple sclerosis, post-traumatic stress disorder and Parkinson's disease than in the general population

Literature Review

Bronson Du et al. (2018) performed research on the effects of Whole Body Vibrations (WBV). The base considered for research was an exposure to whole-body vibration (WBV) increases physical and mental fatigue & professional drivers face these common issues. The objective of this research was to determine whether altering WBV exposures had any effect on driver vigilance and discomfort. A repeated measures crossover design of five truck drivers with regular 10-h routes was used. Active and passive suspension truck seats were evaluated. For each seat, WBV exposures were measured. Participants completed a discomfort questionnaire and a reaction time task before and after their shift for two weeks, one week per seat. Compared with the passive seat, the active seat significantly reduced WBV exposures, decrements in the optimal and mean reaction times ($p = 0.02$, 0.047, respectively), and discomfort in the lower back and wrist(s)/forearm(s) ($p < 0.01$, 0.01, respectively). Study results indicated that reducing WBV helps reduce discomfort and maintain vigilance, which may improve drivers' health and reduce the risk of truck collisions..

N. Zhang et al. (2018) investigated the effects of low frequency whole body vibration on heart rate variability (HRV), a measure of autonomic nervous system activation that differentiates between stress and drowsiness. During this research work, fifteen participants underwent two simulated driving tasks for 60

minutes each: one involved whole-body 4-7 Hz vibration delivered through the car seat, and one involved no vibration. The Karolinska Sleepiness Scale, a subjective measure of drowsiness, demonstrated a significant increase in drowsiness during the task. It was found that within 15-30 minutes of exposure to vibration, autonomic (sympathetic) activity increased ($p < 0.01$) in response to the stress of maintaining alertness and performance when drowsy, and peaked at 60 minutes ($p < 0.001$). Changes in three other HRV domains (higher LF/HF ratios, lower RMSSD (ms), and pNN50 (%) values) were consistent with increased sympathetic activation.

Wu Ren et al. (2018) studied Vibration Characteristics and Human Riding Comfort of a Special Equipment Cab. As special equipment drivers often suffer from vibration which threatened their physical and mental health, this was focused by authors. In order to study the riding comfort of a special equipment cab, a hammering experiment was carried out on it by acceleration sensors. According to the test results, the natural frequency was calculated which was compared with the result analysis by the finite element method. Next, the equipment operating condition test on a flat road was done. The vibration characteristics of the whole vehicle were obtained later. The results showed that the cab vibration and the finite element results agree well, but the natural frequency of the cab was close to the vibration frequency of the human body. And this was not conducive to long-term operation of the drivers. In order to improve the human operational comfort, it is necessary to reduce its natural frequency during the cab structure design process.

Hitoshi Kimura et al. (2017) focused on the physiological phenomenon of passengers often feeling sleepy in running cars or trains. It was thought that if a machine can reproduce this phenomenon, it is feasible to put a person, such as an insomnia patient or an infant, to sleep without any harmful effects. The results of their previous study suggested that low-frequency vibration induces sleep. In this research work, a new mechanical bed for inducing sleep was developed and the effects of different vibration conditions were studied. The new bed was having two active DOFs in the vertical and horizontal directions to examine the anisotropy of sensation. The bed included three main parts: a vertical driver unit, a horizontal driver unit, and a unique 2-DOF counterweight system to reduce driving force and noise. With regard to motion accuracy, the maximum motion error in the vertical direction lifting 75 kg load was only 0.06 mm with a 5.0 mm amplitude of a 0.5 Hz sinusoidal wave. The results of excitation experiments with 10 subjects showed a significant difference in sleep latency between the conditions with vibration and without vibration. The average latency with insensible vibration (amplitude = 2.4 mm) was shorter than that with sensible vibration (amplitude = 7.5 mm). These results suggested the ability of appropriate vibration to induce sleep.

Amzar Azizan et al. (2016) did research on the effects of vibration on vehicle occupant drowsiness. A laboratory experimental setup has been developed. Vibration was applied to the volunteers sitting on the vehicle sear mounted on the vibration platform. Seated volunteers were exposed to a Gaussian random vibration, with 1-15 Hz frequency bandwidth at 0.2 m/s2 r.m.s. for 20 minutes. Tow drowsiness measurement methods were used, Psychomotor Vigilance Test (PVT) and Karolinska Sleepiness Scale (KSS). Significant changes in PVT ($p < 0.05$) and KSS ($p < 0.05$) were detected in all eighteen volunteers. A moderate correlation ($r > 0.4$) was observed between objective measurement (PVT) and subjective measurement (KSS). The results suggested exposure to vibration for 20 minutes can cause significant drowsiness impairing psychomotor performance. The research outcome will be helpful for in study related to road safety.

Neil J. Mansfield et al. (2014) did research on Combined Effects of Long-Term Sitting and Whole-Body Vibration on Discomfort Onset for Vehicle Occupants. The fact considered for research was Occupants of automobiles experience discomfort after long drives, irrespective of how well designed a seat might be. They found in the literature that Previous studies of discomfort during driving were

focused either on the seat shape and materials ("static" properties), long-term discomfort ("fatigue" properties), or dynamics ("vibration" properties).These factors have previously not been considered together. The research was carried in the different phases. The objective of the research was to define and test a model for describing long-term discomfort from vibration. During first phase was an independent measures laboratory trial using an automobile seat, which lasted 80 minutes; Study in phase II was a repeated measures laboratory trial using a rail passenger seat, which lasted 60 minutes; Study in phase III was a repeated measures field trial in a people carrier automobile, which involved 70 minutes of travelling. The findings showed that discomfort accrues with time but that more discomfort is experienced when subjects are also exposed to whole-body vibration. Exposure to whole-body vibration accelerates development of discomfort. The relationship between the reported discomfort, the vibration magnitude, and the exposure time can be described using a multifactorial linear model. It was concluded that ignoring parts of the multi-factorial model (i.e., static, dynamic, or temporal factors) will compromise understanding of discomfort in context.

D Engen et al. (2012) investigated the effect of chair massage offered to nurses during working hours on stress related symptoms. A 15 minute chair massage once a week for 10 weeks was provided by one of three Certified Massage Therapists available 3 days a week. Instruments used included the Perceived Stress Scale (PSS-14), Smith Anxiety Scale (SAS), and Linear Analogue Scale Assessment (LASA) scale. Mean and standard deviations of PSS-14, SAS and LASA scores at baseline and at 10 weeks were calculated and analyzed with the paired t-test. Any p-value < 0.05 was considered statistically significant. It was found that offering chair massages for nurses in a psychiatric/pain rehabilitation unit during working hours was very difficult due to busy clinical schedules. But the results obtained were significantly reduction in stress related symptoms. The efforts were highly appreciated by the nurses.

H. Kimura et al. (2010) investigated the relationship between sleepiness and vibrations on several trains in the first stage of their research work. It elucidated the sleep inducing factors of running cars or trains. The sleepability of each train was discussed by the ratio of sleeping passengers (RSP). High RSP trains were recognized as comfortable to sleep. The acceleration profile of trains was analyzed by FFT and jerks. The results suggested that the comfortable train was having low frequency (under 2.0 HZ) vibrations with particular fluctuation. Small jerk also contributed the sleepability. A prototype sleep inducing machine was tested with several subjects. The questionnaire survey indicated that near 1.0 Hz excitation was the most comfortable vibration for sleep.

M. J. Griffin et al. (2007) conducted investigation on discomfort caused by translational vibration at the seat, feet and back of seated persons. At octave centre frequencies from 1 to 63 Hz, the first determined levels of fore-and-aft, lateral and vertical seat vibration which caused discomfort equivalent to 0.5 and 1.25 m/s^2 r.m.s. 10 Hz vertical seat vibration. In the second experiment, comfort contours equivalent to 0.8 m/s^2 r.m.s. 10 Hz vertical seat vibration and subject transmissibilities were determined from 18 males and 18 females at preferred third octave centre frequencies from 1 to 100 Hz. In both these studies the feet of subjects were not vibrated and there was no backrest.

It was found that the shapes of equivalent comfort counters need not normally depend on vibration level. Significant correlations were found between subject characteristics (size & transmissibility) and subject relative discomfort. The males & females produced similar equivalent comfort contours.

Kazuhide Yamazaki (1977) found that researchers have studied the effects of whole-body vibration on physiological function of human body, but there were no experimental studies on the effect on sleep. During this research, subjects were exposed to very low level of vibration (vertical direction) and the effects on sleep were studied. The subjects were 4 healthy male students and a vibration

exposure was done to the subject sleeping on a vibration table once per 30 min for 30 sec. Vibration levels measured on bedclothes were 60, 65, 69, 74, 79 dBVL. Effects of vibration on sleep were investigated by comparing sleep stages before and after the vibration exposure. The permissible maximum vibration level was considered to be 65 dB measured on the bedclothes as vibration level which scarcely disturbed the sleep of Stage 2 in 8 hr-sleep. Moreover, it was seen that the permissible value determined more strictly was 60 dB

Findings Of Literature Review

Camera was mounted on a tripod and kept in certain height. All the movement were captured in sagittal plane. Standard badminton court was used which is available at Lakshmibai national institute of physical education (M.P.). Standard badminton racket and shuttle were used. Video was analyzed through Kinovea 0.8.27 software. One way ANOVA was used as a statistical tool. SPSS software was used for statistical result.

- Insomnia is faced by large number of people some or the other time in their life.

- Exposure to whole body vibrations increases physical & mental fatigue.
- Vibrations with proper parameters may reduce insomnia to a large extent by inducing limited physical fatigue leading to sleep.
- Low frequency vibrations (0.5 Hz to 10 Hz) are suitable to induce sleep.
- Amplitude of vibrations used to induce the sleep was in the range of 2.4 mm to 7.5 mm
- The timings for vibrations were ranging from 20 minutes to 60 minutes.
- The vibrations produced to induce sleep are in horizontal & vertical directions.
- Research has been done on the persons using actual vehicles (trucks), cabs running on roads, laboratory set up like simulated car seats, Mechanical beds, vibration tables
- There is a need of a vibrating device which can be used to treat insomnia patient to sleep without any harmful effects.

Conclusions

There is need of a device which can induce limited fatigue through vibrations leading to better sleep of human beings

References

1. Du, B. B., Bigelow, P. L., Wells, R. P., Davies, H. W., Hall, P., & Johnson, P. W. (2018). The impact of different seats and whole-body vibration exposures on truck driver vigilance and discomfort. Ergonomics, 61(4), 528-537.
2. Zhang, N., Fard, M., Bhuiyan, M. H. U., Verhagen, D., Azari, M. F., & Robinson, S. R. (2018). The effects of physical vibration on heart rate variability as a measure of drowsiness. Ergonomics, 61(9), 1259-1272.
3. Ren, W., Peng, B., Shen, J., Li, Y., & Yu, Y. (2018). Study on vibration characteristics and human riding comfort of a special equipment cab. Journal of Sensors, 2018.
4. Kimura, H., Kuramoto, A., Inui, Y., & Inou, N. (2017). Mechanical bed for investigating sleep-inducing vibration. Journal of healthcare engineering, 2017.
5. Zhang, N., Fard, M., Bhuiyan, M. H. U., Verhagen, D., Azari, M. F., & Robinson, S. R. (2018). The effects of physical vibration on heart rate variability as a measure of drowsiness. Ergonomics, 61(9), 1259-1272.
6. Mansfield, N. J., Mackrill, J., Rimell, A. N., & MacMull, S. J. (2014). Combined effects of long-term sitting and whole-body vibration on discomfort onset for vehicle occupants. International Scholarly Research Notices, 2014.
7. Ranjeeth, S., & Latchoumi, T. P. (2020). Predicting Kids Malnutrition Using Multilayer Perceptron with Stochastic Gradient Descent. Rev. d'Intelligence Artif., 34(5), 631-636.
8. Prasath, D. S., & Selvakumar, A. (2015). A Novel Iris Image Retrieval with Boundary Based Feature Using Manhattan Distance Classifier. International Journal Of Innovative Technology And Creative Engineering (Issn: 2045-8711) Vol, 5.

9. Balamurugan, K. (2021). Fracture analysis of fuselage wing joint developed by aerodynamic structural materials. Materials Today: Proceedings, 38, 2555-2562.

10. Engen, D. J., Wahner-Roedler, D. L., Vincent, A., Chon, T. Y., Cha, S. S., Luedtke, C. A., ... & Bauer, B. A. (2012). Feasibility and effect of chair massage offered to nurses during work hours on stress-related symptoms: a pilot study. Complementary therapies in clinical practice, 18(4), 212-215.

11. Kimura, H., Endo, M., Koseki, M., & Inou, N. (2010). Sleep-inducing factors in mechanical environments. Journal of Environment and Engineering, 5(2), 275-286.

12. Rakheja, S., Dewangan, K. N., Dong, R. G., & Marcotte, P. (2020). Whole-body vibration biodynamics-a critical review: I. Experimental biodynamics. International journal of vehicle performance, 6(1), 1-51. YAMAZAKI, K. (1977).

13. The Effect Of Whole-Body Vibration On Human Performance And Physiological Functions Part 1. Experimental Study Of The Effect Of Vertical Vibration On Human Sleep. Industrial health, 15(1-2), 13-21..

CASE STUDY ON E-WASTE MANAGEMENT IN BANGALORE

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ABSTRACT

Electronic waste is one of the major obstacles to the environment as it contains life threatening materials to the mankind. Computers, television, bulbs, batteries etc. which are disposed illegally may release many hazardous toxic substances to the land which leads to loss of soil efficacy and underground water. This arises due to poor knowledge regarding appropriate disposal and recycling methods which can be done by advancing technology and modern science. In spite of policy laid by government in controlling pollution under critical observations related to global prospective as the policy level are not implemented appropriately. Hence these papers include few industries involved in recycling e- waste in Bangalore and methods of handling e- waste. This recycling waste is handled by informal sector which are not acknowledged about the after effects and ill conditions that occur to the nature and mankind. This paper put forth this issue and creates adequate awareness among the disposal handlers in an effective way and implements the policy level initiatives in an appropriate way

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Keywords: Biomechanics, long service, flick service, short service, ANOVA.

Introduction

Industrial revolution has marked its significance in the field of science and technology during 18th century in human civilization. The information and communication has advanced to its best during 20th century and it organizes our way of life in many aspects. This improved the quality of living; this also have adverse effects through its bulky produced electric waste which is hazardous to environment and mankind. E-waste can be defined as the discarded electronic items from houses, offices etc. Some are really life threatening due to poisonous metals in it. The E- waste are the ones which are recycled in many was even the metals are been separated, for example plastic content which is present in the device can be separated and reused. The E-waste is enormously growing throughout the world due to lots obvious advantages in time saving and making life easier through gadgets like mobile, laptops, mixer grinders etc. Every year 20- 50metric tons of E-waste is being produced world- wide, whereas United States alone 14-20million personal computers are thrown out each year, with an annual increase of 3-5%. However only 13- 18% is recycled. These are ending up in landfills which cause health hazards. Few are incinerated and through fumes which causes environmental pollution. These are carelessly handled and finding routes into developing countries. India is aiming to join the famed league of developed nations by year 2020. It is undergoing accelerated industrial growth and rise in 85 of GDP. There is phenomenal increase in waste production. India produces 12.5lakh million tons of E-waste per annum. India ranks 5 in producing E-waste in the year 2016 across the globe. In these areas management of E-waste will also improve in ranking of India.

Literature review

Electronic waste is drawing attention globally as there is constant rise in the production of e-waste. This paper facilitates the information about the increasing and its effects in the communities of Bangalore, Karnataka and socioeconomic factors and consumer's choice. It also mentions about vivid issues of e-waste management such as impact, status and management strategies used in reduction of e-waste. It also provides awareness about informal recycling effects on human health. There are suggestions for the manufacturing companies about how to handle the e-waste disposal and recycling techniques. The necessity of this document is to emphasize the need for proper treatment of e-waste to deal with the ill effects on mankind. The electronic industry is the world's largest and rapidly growing manufacturing industry in the world. Those equipment's obtained at the least use of those electronic devices to be discarded are

termed as e-waste. This e-waste contributes nearly 1% of solid waste in developed countries according to 2001 and expected to be four times greater by 2021 and it's one of the fastest growing waste streams.

E-waste consists of ferrous and non-ferrous metals, plastic, glass, ceramics, rubber etc. This e- waste is very much reusable as the secondary raw material but it can be hazardous if this waste is not disposed appropriately. It can be life threatening to mankind and environment, as it consists of toxic materials like lead, cadmium, mercury, polychlorinated biphenyls etc. The presence of these elements more than required in e-waste that are inflammable can be dangerous to environment and mankind. According to the current affairs the developed nations are finding a new way instead of treating e-waste appropriately, it is exported to the developing countries. This leading to environmental issues as recycling is done in a crude manner. A review study conducted on uncontrolled dumping and crude recycling of e- waste provides the importance of best treatment of e-waste and impact of negligence of e-waste on mankind and environment. As there is rapid growth in production of e-waste worldwide it is wise and necessary to develop the appropriate methods to dispose and practice the reusable processes. Legislation is the need of the hour for enforcing environmentally sound management of e-waste. "Today gadgets are tomorrow's e-waste". 95% of e-waste is recyclable. However continuous recycling causes more harm to the environment than landfilling. While many companies have effective management of e-waste and recycling programs, the majority of companies export some percentage of their electronic waste to China or poor countries in Africa, where the waste is recycled or destroyed and stripped of its valuable metals. Though these looks fair on surface but unregulated recycling centres burn or dissolve the plastic components to release the precious metals: a process that releases environmental contaminants into the air, land, and water that would otherwise that would remain trapped and inert in landfills. The major portion of the e-waste generated domestically as well as illegally imported are recycled in crude manner leading to pollution of the environment. Lack of legislation in our country at present is aiding this threatening form of recycling. Hence this is highest need to form appropriate rules and strict regulation on developing appropriate methods of recycling and dismantling and diffusing of electronic waste. The necessity of environmentally sound management of e-waste is brought out with the help of a case study on uncontrolled dumping of e-waste. We have collected data of disposed materials percentage in Bangalore and which is causing harm to environment and for reducing this we have explained some techniques from which it can be controlled without causing any effects to the environment.

Methods and Methodology
Study area

Bangalore is the capital of Karnataka state which is also known as 'Silicon Valley' of India is the second fastest growing and developing city. It is located on the Deccan Plateau in the south-eastern part of Karnataka, located at an altitude of 920m above sea level. This city is located at 12.9716° N, 77.5946° E. The area of Bangalore is about 709 km^2 and the metropolitan area is about 8005 km^2. According to 2011 census, the population of this city is approx. 84.3 lakhs. The average temperature lies between 26.1℃ and 15.1℃. Bangalore is the nation's leading IT&BT Park, commercial and industrial centre of Karnataka. It is famous for its pleasant weather throughout the year, a blend of cultures and its diversity.

Both primary and secondary data collected from key informants and Karnataka state pollution control board, NGO'S, Formal units, processing units respectively. The information is gathered on December 2016 about generation of e-waste by many interviews and group discussions from the visited companies. Through pilot studies conducted at core e-waste recycling areas like Peenya, Nayandahalli and BTM layout, the information obtained from informal recyclers through questionnaires. These questionnaires are designed based on the specialization of recycling segregation, dismantling, collecting, extraction of the appropriate metals like silver gold copper plastic etc. The visit is made to analyse the dismantling document the analysis and precautions taken to improve by the

recyclers and trainees. This analysis comprised by the observations like situation number of workers, space organization, installation, sites etc. Material recycling/ dismantling process input the e-waste materials functions. Dismantling process methods and tools, continuous safety and working conditions.

This was conducted in March 2009 at Bangalore city of India. Apart from surveys and data collection, out reaches the Bangalore rural district and Dobbaspet industrial area were taken to know the existing practices in e-waste management. Bangalore has more than 1700 IT Companies producing 8000 tons of e-waste annually. For this study the chosen trace items are personal computers. A tracer item in this context means an electronic or electrical item which is surveyed along the complete life span which gives information of all or represents all sorts of PC's. Reliable statistics of measurable recycling practices and high dynamics is the information technology sectors were reason for the decision to use PC as tracer.

The assessment strategy followed a certain order:

Players and stakeholders of the E-waste recycling stream were identified including consumers, traders, repair shops, dissemblers, scrap dealers and dismantlers. Qualitative research involved semi-structured in-depth interviews with the formal E-waste recyclers present in Bangalore: (a) Ash recyclers (b) E-Parisara. One-to-one interviews were conducted to gather information with respect to following areas:

1. Detailed understanding of each stage: Sourcing, Logistics, Processing of E-waste
2. Current handling capacities
3. Status of technology being used currently and challenges faced

E-Waste Composition And Recycle Potential

The composition of e-waste and its recyclable potential is specific for each appliance. In order to handle this complexity, the parts/materials found in e-waste may be divided broadly into six categories as follows: Iron and steel, used for casings and frames Non-ferrous metals, especially copper used in cables, and aluminium Glass used for screens, windows Plastic used as casing, in cables and for circuit boards Electronic components Others (rubber, wood, ceramic etc.) Overview of the composition of the appliances in the three categories mentioned earlier is given in table:

Apparatus	Ordinary weight (kg)	Iron % weight	Non- Iron metal % weight	Glaze % weight	Plastic % weight	Electric parts % weight	Further % weight
Refrigeration appliances	47.1	65.3	7.0	2.3	14.2	0.3	16.10

Home computer	28.63	21.05	25.50	15.02	23.01	17.31	0.71
TV sets	36.22	5.37	5.8	62.8	22.5	0.91	3.56

The typical values of items of commercial value from refrigerator, home computer and television set aregiven in tables

Reparable number of Materials in a Refrigerator

physical Type	Weight %
CFCs	1.21
Grease	1.36
Iron scrap	47.63
Non-Iron scrap	5.96
Synthetics	14.88
Compactor	24.83
Cables/Plugs	1.50
Consumed Foam	8.66
Crystal	1.85
Varied Waste	0.34
Over-all	101.01

Recoverable Amount of Resources in a Individual Computer

Fundamentals	Contented (% of total weight)	Contented (Kg)	Reprocessing efficiency (%)	Recoverable mass of element(kg)
Plastics	24	6.27	21%	1.255
Lead	7	1.72	6%	0.089
Aluminium	15	3.84	81%	3.083
Ge	1.0015	0.01	0.01%	0.0
Ga	1.0014	0.01	0.1%	0.0
Fe	21	4.55	82%	5.454
Tin	1	0.28	75%	1.135
Cu	7	1.87	94%	1.698
Barium	1.0314	0.010	0.0%	0.0
Nickel	0.8504	0.230	0.0%	0.0
Zn	3	0.61	68%	1.362
Tanialum	0.0154	0.0044	0%	0
In	0.0015	0.00046	59%	0.00025
Vanadium	0.0020	0.010	0%	0
Be	0.0158	0.0046	0.0%	0
Gold	0.0016	0.00044	98%	0.00046
Europium	0.0002	0.01	0.0%	0
Tritium	0.0156	0.01	0.0%	0
Ru	0.0016	0.00045	81%	0.00034
Co	0.158	0.0048	84%	0.0035
Pd	0.003	0.000076	94%	0.000076
Manganese	0.0314	0.01	0.0%	0
Ag	0.0186	0.0155	97%	0.00505

Antimony	0.0095	0.01	0.0%	0
Bismuth	0.0062	0.01	0.0%	0
Chromium	0.0064	0.01	0.0%	0
Cd	0.0095	0.01	0.0%	0
Se	0.0015	1.00046	69%	0.0003
Nb	0.0001	0.00046	0.0%	0
Y	0.0002	0.01	0.0%	0
Hg	0.0032	0.01	0.0%	0
As	0.0023	0.01	0.0%	0
Silica	24.8403	6.78	0.0%	0

Recoverable Amount of Resources in a TV:-

Fundamentals	% by mass Recoverable	Mass of component (Kg)
Aluminium	2.1	0.4354
Cu	2.40	1.2208
Lead	1.20	0.0734
Zn	1.30	0.1186
Nickel	0.037	0.0038
Fe	13.1	4.354
Plastic	25.2	9.422
Glass	54.2	19.176
Ag	0	0.000734
Gold	0	0.000352

Results

Generation of E-waste is increasing at a fast pace. Hence, managing the E-waste is a greater challenge for developing countries like India. Therefore a proper disposal method has to be adopted to overcome the harmful effects of E-waste to the environment and also human health.

As per the recent study Bangalore ranks third in India after Mumbai and Delhi, and produces nearly 92,000 metric tonnes of E-waste annually. Based on survey made on different recycling industries in Bangalore, E-Parisara Pvt.Ltd produces about 12000 tons of E-waste annually and 1250000 tons annually in India about 50000 tons are imported illegally. About 1800 tons of electronic scraps are being generated by Manufacturers and Assemblers every year. As per the estimation nearly 1000 tons of plastic which is equivalent to Iron, 300 tons of lead, 43 tons of nickel and 350 tons of cu is generated in Bangalore as Electronic waste.

More than 2,700 programming organizations produce electronic types of gear, about 35 fabricating equipment units and about 70,000 specialists are availed by the BPO business in Bangalore. BPO and other programming organizations contribute Electronic waste to a higher extent. In last 10 years there is lots of interests in key elements like PC's, TV's and cell phones which are viewed as expansion of E-waste in the whole Nation. As a result, the biosphere products as abundant as 50 million tonnes of automated and electrical excess a year where only 20% of this is recycled correctly. The Electronic waste generated yearly is value finished $62.5 billion, which is in excess of the GDP of most countries.

Suggestions

Options for improved management: We have seen many methods and reports related to e-waste disposal recycling management etc. And reports related to estimation of e-waste

generated by the cities and how it is disposed by companies and how it causes harm to the environment and mankind when it's not appropriately treated. With these studies it shows how it is disposed.

Governance: Managing e-waste should be held as a responsibility and to be handled it carefully. Many institutions came forward to work with the e-waste management. There should be an authority to authorize a proper and harmless disposal and treatment of e-waste and management. Any institutions that involve in the e-waste management must be organized with specified objectives which consist of safe methodologies. The NGO'S that collect domestic waste need to be stream lined. The program should be made with certification for students like any of the skill training or courses. Research and development should be carried out for the improvement of the appropriate treatment and periodic audits to be conducted.

Creation of awareness: Awareness to be created through the participatory governance model. This awareness to be created among children and public on the impact of E-waste to be appropriate. The products to be labelled with hazardous materials it contains on electronic devices.

Formulizing the informal sector: E-waste waste collection and management is livelihood of many poor families. This people should be taught appropriately about its management and its impact. They should be trained adequately in short duration in a simple way. This should be monitored by government.

Reuse: This is in action by increasing the lifespan with precautions and measures. The reuse of e- waste reduces the harm on the environment and promotes to process the products that consumers buy at the state of collection events. There should be a separate formal system to promote the reuse of e-waste.

Recycle: Recycling has advantages of reusing the products instead of manufacturing the whole of a product. The harmful material when recycled can cause a dangerous effect on the environment. According to this context it can be more relevant in redesigning the product in orderly encouraging sustainable products design using non-hazardous materials.

Conclusion

During the initial years of economic liberalization and IT regulation in India, E-waste is recognised as a significant growth. However electronic apparatuses cannot be circumvented in today's world. So, also is the case of left-over management is a challenging task especially in the largest IT hub. Bangalore is one of it, where E- waste generation is considered s huge from IT and electronic companies, banking sectors and educational institutions present in the city.

The advance technology is leading and old ones are discarded because of new versions are in existence and rapid inventions led to more for producing E-waste and are less conscious about the hazardous effects causing to the environment.

Outdated knowledge, Pyro metallurgy has been used for recovery of precious metals from waste electronic equipment's. However the computers, mobile phones, household products etc. usage is increased in Bangalore city.

It is our responsibility to keep the atmosphere from dangerous substances by recycling the E-waste products for the better life of future.

References

1. Alastair, I. (2004). Mapping Environmental Justice in Technology Flows: Computer Waste Impacts in Asia Global Environmental Politics 4: 4. Massachusetts Institute of Technology.

2. Cui, J., & Forssberg, E. (2003). Mechanical recycling of waste electric and electronic equipment: a review. Journal of hazardous materials, 99(3), 243-263.

3. Babyrani Devi, S., Shobha, S. V., & Kamble, R. K. (2004). E-Waste: The Hidden Harm of Technology Revoluation. Journal of Indian Association for Environmental Management, 31, 196-205.

4. Hagelüken, C., & Art, S. (2006). Recycling of e-scrap in a global environment-chances and challenges: Umicore precious metals refining. In Indo-European Training Workshop. Bangalore and New Dehli.

5. Ranjeeth, S., & Latchoumi, T. P. (2020). Predicting Kids Malnutrition Using Multilayer Perceptron with Stochastic Gradient Descent. Rev. d'Intelligence Artif., 34(5), 631-636.

6. Prasath, D. S., & Selvakumar, A. (2015). A Novel Iris Image Retrieval with Boundary Based Feature Using Manhattan Distance Classifier. International Journal Of Innovative Technology And Creative Engineering (Issn: 2045-8711) Vol, 5.

7. Balamurugan, K. (2021). Fracture analysis of fuselage wing joint developed by aerodynamic structural materials. Materials Today: Proceedings, 38, 2555-2562.

8. Niu, X., & Li, Y. (2007). Treatment of waste printed wire boards in electronic waste for safe disposal. Journal of Hazardous Materials, 145(3), 410-416.

9. Ramachandra, T. V., & Saira, V. K. (2004). Environmentally sound options for e-wastes management. Envis Journal of Human Settlements, 5.

COMPARATIVE STUDY OF ANXIETY IN ELEMENTARY SCHOOL STUDENTS IN TIMES OF PANDEMIC

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ABSTRACT

The objective of the article is to compare the levels of anxiety in elementary school students of two private and public educational institutions in times of pandemic. Due to the fact that the adolescence stage is full of turbulences and abrupt physical, behavioral and socio-affective changes, characterized by great reactivity of emotions and even more within a pandemic context produced by COVID-19. The methodology was quantitative, non-experimental, comparative, descriptive and cross-sectional; population conformed by 104 students of the sixth grade of primary education, the instrument was the questionnaire (IAES), Inventory of School Anxiety, (Spielberger, Gorshuch and Lushene, 2015), to measure Anxiety-State and Anxiety-Trait. The results evidenced that 84.3% and 82.9%, of the students of the educational institutions, public and private, present a medium level in Anxiety-State respectively; while for Anxiety-State presents the same values with a moderate level; on the other hand, it is evidenced that there are minimal differences in terms of gender in both educational institutions, with U-Mann-Whitney: 25,000 and z= -,361, with $\rho > 0.05$ for Anxiety-State, and with U-Mann-Whitney: 27,000 and z= -,233, with $\rho > 0.05$ for Anxiety-Trait. It is concluded that the average mean and moderate level of Anxiety-State and Anxiety-Trait, propitiate anxious behavior on the part of the students, with minimal differences in terms of gender.

Keywords: *Anxiety, intrinsic restlessness, elementary school students, confinement times.*

Introduction

In this context of the new present, primary educational institutions show anxiety events that affect their self-esteem and are uncertain by their own parents and educators. The change from a familiar social reality to that of ignorance and not knowing what will happen the next day coexists with pressure at school, where they only worry about increasing the skills of the student body and have even labeled them as bad compared to their peers, triggering states of deep stress and anxiety, due to the fact that the whole world is going through a pandemic caused by COVID-19 (Ozamiz-Etxebarria et al., 2020). In this context, children need to reinforce their self-concept, which is related to the development of self-control (Acosta & Clavero, 2018; Alemany-Arrebola et al., 2020) this condition has different factors, as well as academic compliance, interaction with other colleagues, direct contact with educators, etc. the same one that can give you the socio-emotional support in order to cope with this process of school assimilation in which you are.

In the same sense, (Campo, 2015) the individual will show his role of self-concept through his emotions, thoughts, feelings and the value of his being, as well as the skill he has to be able to relate to the individuals of his context; Likewise (Palacios-Garay & Coveñas-Lalupú, 2019) the appreciation that the individual has of himself, is a basic element of the development of the individual's character and is correlated with general comfort and psychosocial normality.

For the present investigation, it is linked to the management and educational quality; In this sense, the formulation of the problem was the following: What level of anxiety exists among elementary school students, in times of pandemic, of two private and public educational institutions, in a district of Lima? And the objective was to compare the anxiety levels in elementary school students in times of pandemic in two private and public educational institutions, in a district of Lima.

Anxiety as an aspect of unity without understanding the various contexts and response situations that make up this construct (Vázquez, 2020) considered anxiety in

schoolchildren as a multidimensional phenomenon and the purpose was to distinguish the relationships and the ability to predict the contexts and anxiety response in schoolchildren about trait anxiety, state anxiety and depression. The School Anxiety Inventory (IAES), the State Trait Anxiety Inventory (STAI and STAIC) and the Childhood Depression Inventory (CDI) these instruments were applied to a sample of 1409 schoolchildren in Spain, from twelve to eighteen years of age. The findings show significantly positive relationships towards the contexts and anxiety response of schoolchildren with trait anxiety, state anxiety and depression. Likewise, most of the contextual elements and response systems of schoolchildren anxiety are significantly and positive predictors of trait anxiety, state anxiety and depression. The repercussions of the praxis of these findings are replicated.

Anxiety is a normal individual reaction; however, it becomes abnormal when it persists and manifests itself at all times (Stephens et al., 2016), the purpose of this study being to establish the correlation between types of educational institution and anxiety ranges as well as finding diversity or equalities regarding gender and level of education, according to the type of educational institution with a sample of Colombian students. The methodology used was quantitative type, transactional cut and descriptive follow-up in comparison of groups. With a sample of 658 students from state and private schools in the third grade to the seventh grade of high school; using the state-trait anxiety inventory in children (STAIC), the interpretation validated for the Colombian country was used. Whose findings were very statistically significant differences in terms of the ratings of the worry factor, showing higher ratings in samples of schoolchildren from private educational institutions, quiet ratings, high scores in the male gender and concern for the female gender. In addition, there is no differentiation in the ranges and classes of anxiety for the grade level studied. It was concluded that there are high levels of anxiety in schoolchildren from private educational institutions and higher levels of concern in female students.

Motivation and anxiety present essential psychological elements within a sports context, due to the close link with sports productivity (Castro-Sánchez et. Al., 2019) in order to explain the ranges of anxiety and motivation observed in athletes, and describe the Diversities found between the motivation observed and ranges of anxiety in soccer players of lower categories, with a total of 154 soccer players registered in the federation from sixteen to eighteen years of age. Individuals were given a questionnaire "Motivational Climate" (PMCQS-2) and Anxiety Inventory "(STAI). The findings showed that soccer players in lower categories have high ranges of trait-anxiety and state-anxiety; Regarding motivational climate, the majority of the subjects analyzed have a motivational climate of commitment to activities. Soccer players with a motivational appreciation of commitment to activity show medium levels of state anxiety, while subjects with a lower motivational appreciation with commitment to activity show high anxiety ranges. Anxiety towards qualified practices in primary school students (Anxiety, 2019) presented two purposes to establish the courses that caused the greatest anxiety compared to qualified practices; and to determine differences in levels of anxiety before the graded practices in relation to the school subject and the sex of the students, evidencing greatly that the ladies show higher levels of anxiety before the practices.

This research was carried out with the purpose of determining the anxiety of schoolchildren, self-esteem and perfectionism that students of regular basic education have and to determine differences between gender and academic level (Gómez-Nuñez & García-Fernández, 2014). The sample consisted of 498 schoolchildren in the fifth and sixth grade of primary education. The anxiety of the schoolchildren was estimated with VAAR, (Visual Analogue Scale for Anxiety Revised) and self-esteem was estimated with AE-P, (Self-esteem Questionnaire for Primary Education and Perfectionism), with respect to the level of the schoolchildren, differences are evident in performance anxiety, whose grades in fifth-grade schoolchildren are higher regarding factor III of self-esteem, than sixth-grade

children; and in perfectionism, the final grade of sixth grade children also shows high marks. Likewise, the findings in relation to gender show that in Self-Criticism-Oriented Perfectionism in terms of the final grade, males reveal significantly higher scores than females. These findings show the great difficulty of variables, which indicates providing projections of psychoeducational intervention.

Anxiety as an element that emotionally causes displeasure and is caused on several occasions by fear, this is shown as a risk of which the cause is recognized (Méndez et al., 2009). It is the experience of fear in uncertain circumstances, originated by unpleasant events, it is the indefinite fear due to external stimuli, which incites distortion in the qualities of the individual (Ríos et al., 2014).

The description as a fundamental psychological variation, is accommodated through the risks or challenges that arise at the moment or in the future (Pilarska, 2018), its purpose being to provoke appropriate behaviors and face realities, its permanence is subject to the magnitude and to the result of the difficulty that originated it. Anxiety is attributed to psychological, behavioral and physical signs, which traditionally referred to anguish (Martinez Otero Pérez & Gaeta González, 2014). At present, both definitions are divided through psychological indications, in this sense anxiety is used by specialists in scientific psychology and the term 'anguish' is used by professionals in humanistic psychology.

Between anxiety and stress, there are common factors, their differences being complicated, in this sense the expression 'anxiety' refers to the emotion of worry and restlessness. Fear manifests itself in an imprecise way, on the other hand, stress exposes emotional excesses originated by external features that are prolonged putting the individual on the edge of collapse. At the same time, anxiety affects the mental and physical experiences of the person, in this sense, they do not acquire the subjective as the first possibility, but on the contrary by physical discomforts. One of the elements of anxiety is to teach avoidance behavior, stating that the human being by panic avoids some circumstances.

Anxiety manifests itself in non-detailed stages, often being only a few months and at other times spanning several years, it always occurs in various contexts of life, the individuals involved will only feel free for short periods of time.

Among the symptoms of this disorder is evidence of muscle stiffness, tremors, intense emotions of anguish, extreme sweating, dry mouth and dizziness, in this sense, individuals will live permanently in a state of pressure, showing emotions of tension, excessive nervousness, insomnia and being irritable. In accordance with the theory of psychoanalysis, internal alterations produce anxiety, while the affected individual does not have the skill to manage it. In these conflictive contexts, the individual overcomes by creating fears, which originate from the fear of losing a loved one or losing socioeconomic recognition.

The categories about anxiety (Spielberger, 2015; Brailovskaia et al., 2018) must specify between AE (state anxiety) and RA (trait anxiety), to differentiate them, in this sense the ER Anxiety theory (Castro, 2018), defines AE, equal to "emotional state", which is provided immediately and is changeable over time, determined by mixing stressful feelings, which cause discomfort and uneasiness, increasing alterations originated at a physical level, however , AE is linked to personal differences, with firm characteristics, responding to conditions observed as challenging. whereas the A-R is not evidenced directly, through behavior, but is derived by the repetition of the increased state of anxiety that the individual receives.

Due to the aforementioned, individuals who present a high degree of Trait Anxiety are those who face the greatest conditions as threatening and are the most likely to suffer from State Anxiety frequently and intensely

Method

The study is circumscribed in a positivist paradigm, quantitative approach, due to the measurement of the variables (Sanchez, 2015); the method is hypothetical deductive, due to the statement of the hypotheses and their testing. The design was non-experimental, cross-sectional and descriptive comparative level (Hernández & Mendoza, 2018). The population consisted of 104 elementary school students from two educational institutions, I. E.

Fermín Tangüis (private) and I. E. Abraham Valdelomar N ° 116 (public) and thus carry out the comparative study.

In the inclusion of the research, students who were in the sixth grade of primary education, whose parents gave their informed consent, were considered; on the other hand, the exclusion criteria were those students whose parents decided not to participate in the research.

The research was carried out using the survey as a technique and the School Anxiety Inventory (IAES) questionnaire (2015), as an instrument. The content validity of the instrument was given by expert judgment and the construct validity of the instrument, with KMO = 0.000, being significant; Likewise, reliability was performed through Cronbach's Alpha and obtained a value of 0.966 indicating high reliability of the instrument (Bernal, 2018).

The questionnaire (IAES), Inventory of School Anxiety, (Spielberger, Gorshuch & Lushene, 2015), consists of 2 dimensions: anxiety-state and anxiety-trait, each one with 20 items, giving a total of 40 items, whose answers correspond on the ordinal scale nothing = 0, somewhat = 1, quite a bit = 2, a lot = 3.

The instrument was applied through emails obtained from the database of students enrolled in the 2021 school year, from both educational institutions. For the results, Excel and SPSS version 26 were used and a descriptive analysis with tables for frequencies and percentages was carried out, an inferential analysis was also carried out, for which the Kolmogorov Smirnov normality test was carried out and the results were p <0.05 establishing that the non-parametric Mann Whitney U test be performed, which is a test for 2 independent samples.

Results

Descriptive analysis

Table 1. State anxiety in elementary school students of I.E. Abraham Valdelomar (public) and I.E. Fermín Tangüis (private)

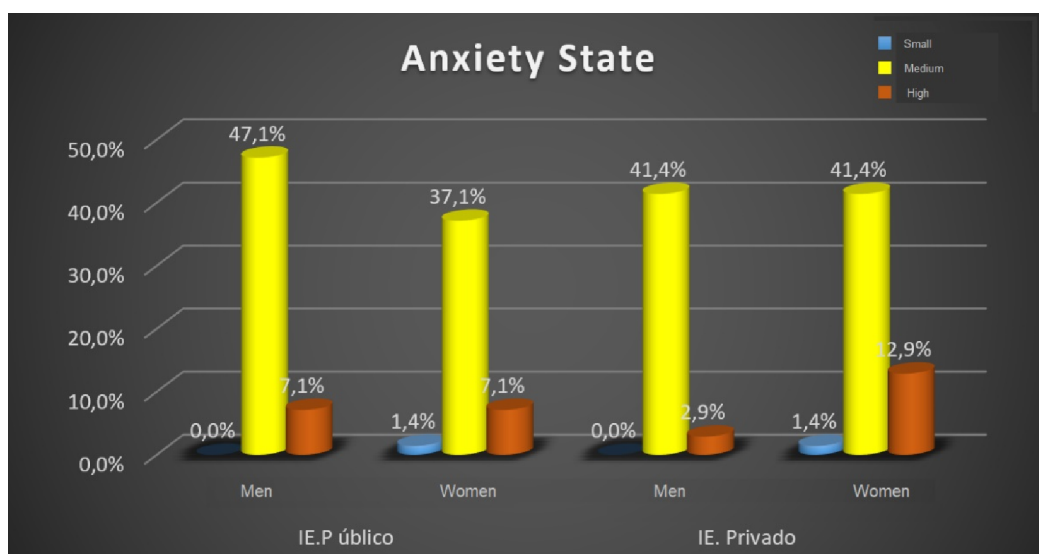| Anxiety State	I.E. Público		I.E. Privado	
	Men	Women	Men	Women
Small	0.0%	1.4%	0.0%	1.4%
Medium	47.1%	37.1%	41.4%	41.4%
High	7.1%	7.1%	2.9%	12.9%
Total	54.3%	45.7%	54.3%	45.7%

Figure 1. Anxiety-State in elementary school students of I.E. Abraham Valdelomar (public) and I.E. Fermín Tangüis (private)

It is observed that the Anxiety-State of the students of the elementary level of the I.E. Abraham Valdelomar, according to the results, are at a moderate level in both men and women with 47.1% and 37.1% respectively. As for the I.E. Fermín Tangüis, the findings are at a moderate level in both men and women with 41.4% in both.

Therefore, it is affirmed that in times of pandemic and the new teaching-learning modalities have caused anxiety in these students, in this sense the anxiety in primary students of educational institutions of both public and private management, it is observed that Anxiety -State is present at a moderate level, as well as the percentage of male students from the public institution is similar to the female students from the private institution.

Table 2. Trait-anxiety in elementary school students of I.E. Abraham Valdelomar (public) and I.E. Fermín Tangüis (private)

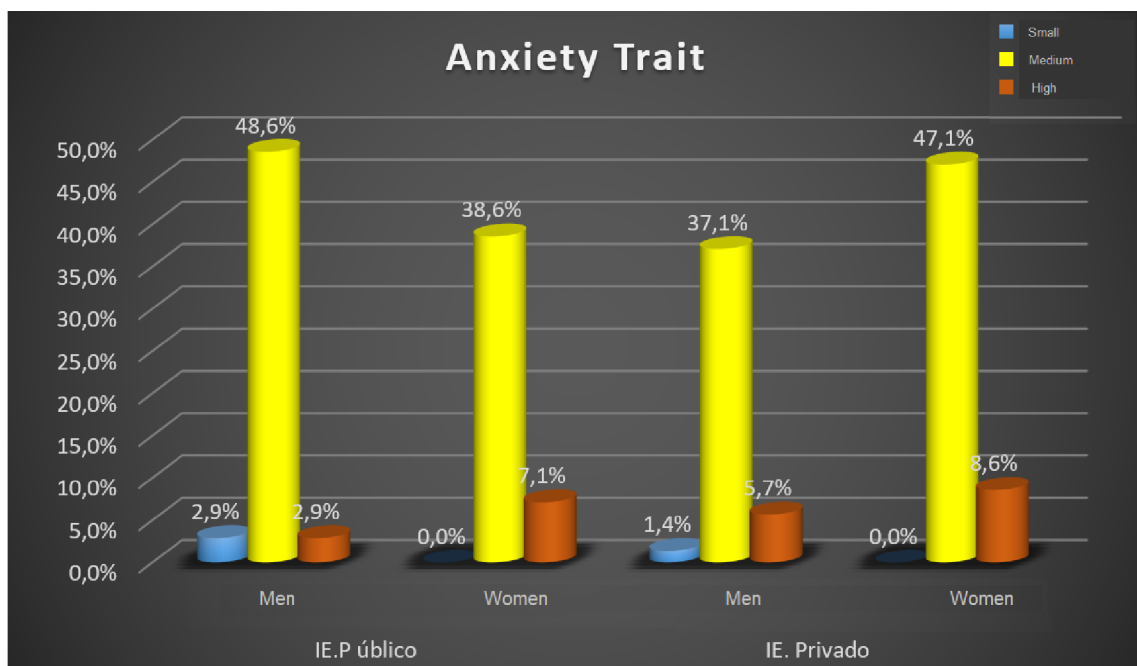| Anxiety Trait	I.E. Público		I.E. Privado	
	Men	Women	Men	Women
Bajo	2.9%	0.0%	1.4%	0.0%
Medio	48.6%	38.6%	37.1%	47.1%
Alto	2.9%	7.1%	5.7%	8.6%
Total	54.3%	45.7%	54.3%	45.7%

Figure 2. Anxiety-Trait in elementary school students of I.E. Abraham Valdelomar (public) and I.E. Fermín Tangüis (private)

It is observed that the Anxiety-Trait of the students of the elementary level of the I.E. Abraham Valdelomar, according to the results, are at a medium level in both men and women with 48.6% and 38.6% respectively. As for the I.E. Fermín Tangüis, the findings are at a medium level in both men and women with 37.1% and 47.1% respectively.

Therefore, it is affirmed that, in this new normality, and virtual education have caused anxiety in the student body, of both educational institutions Abraham Valdelomar and Fermín Tianguis of public and private management respectively, it is observed that Trait-Anxiety is present in A medium level in both groups of students, as well as the percentage of male students from the public institution, is similar to the female students from the private institution.

Inferential analysis

Ha: There are significant differences in the levels of State Anxiety in the students of the I.E. Abraham Valdelomar (public) and the I.E. Fermín Tangüis (private).

Ho: There are no significant differences in the levels of State Anxiety in the students of the I.E. Abraham Valdelomar (public) and the I.E. Fermín Tangüis (private)

Table 3. Contrast statistic of State Anxiety levels in elementary school students of I.E. Abraham Valdelomar (public) and I.E. Fermín Tangüis (private)

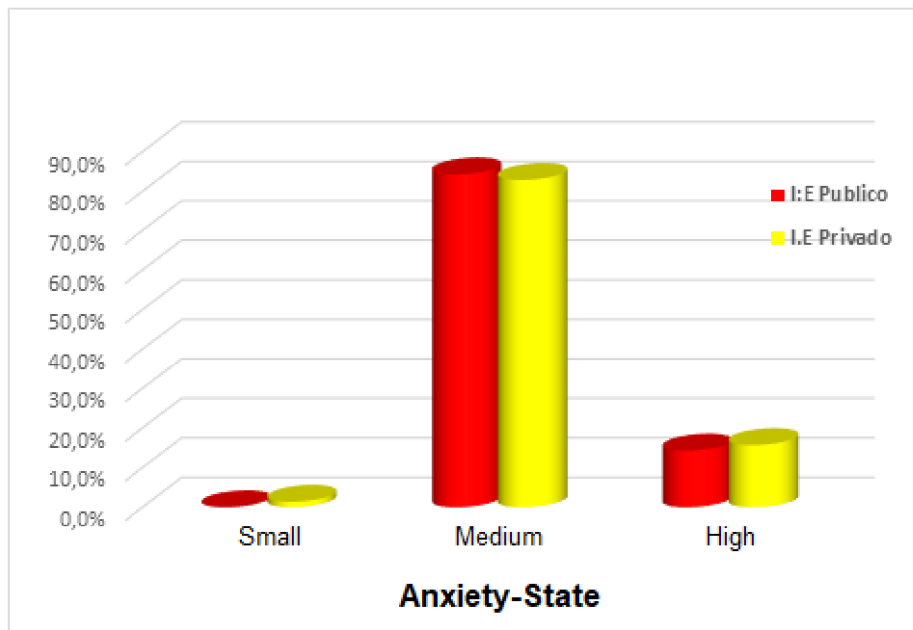| Group	Anxiety-State			Test U Mann-Whitney
	Small	Medium	High	U= 25,000
I.E. Abraham Valdelomar	0.0%	84.3%	14.3%	Z= -,361
I.E. Fermín Tangüis	1.4%	82.9%	15.7%	p= ,718

Figure 3. Levels of Anxiety-State in elementary school students of I.E. Abraham Valdelomar (public) and I.E. Fermín Tangüis (private)

It is evidenced according to the findings shown in table 3 and figure 3 on State Anxiety of the students of the educational institutions Abraham Valdelomar and Fermín Tangüis of public and private management respectively, it is observed that according to the statistic of the U of Mann -Whitney, there are no statistically significant differences between both groups, because the p value is> 0.05, accepting the null hypothesis, which reaffirms that the state of anxiety is present at a moderate level in both groups of students.

Therefore, it is affirmed that this pandemic has generated anxiety in a general way for all students equally, affecting the teaching-learning process, students have abrupt adaptation behaviors to a virtual world.

Ha: There are significant differences in the levels of Trait-Anxiety in the students of the I.E. Abraham Valdelomar (public) and the I.E. Fermín Tangüis (private).

H0: There are no significant differences in the Trait Anxiety levels in the students of the I.E. Abraham Valdelomar (public) and the I.E. Fermín Tangüis (private).

Table 4. Contrast statistic of Trait-Anxiety levels in elementary school students of I.E. Abraham Valdelomar (public) and I.E. Fermín Tangüis (private)

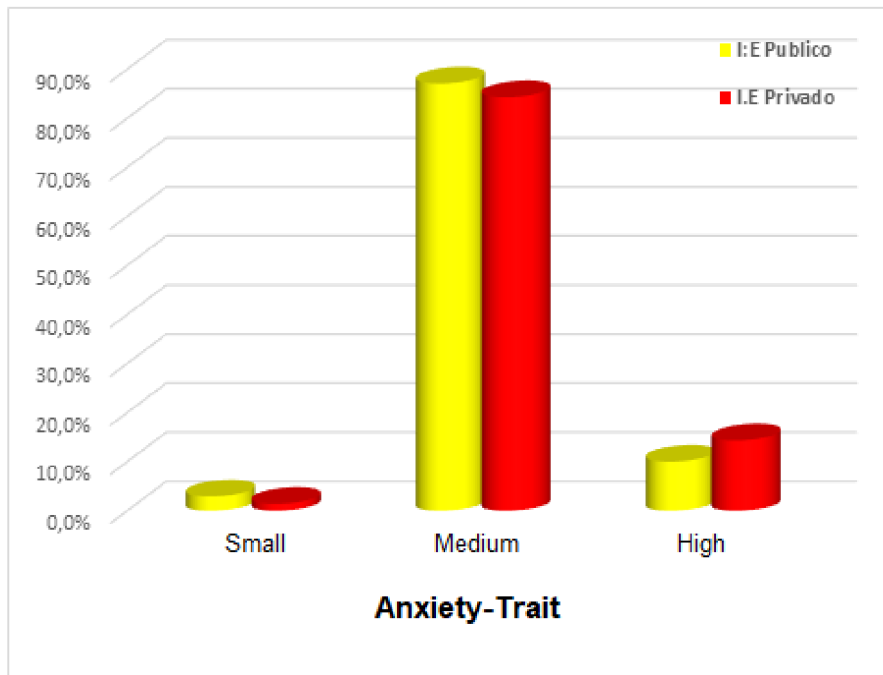| Group	Anxiety			Test U Mann-Whitney
	Low	Medium	High	U= 27,000
I.E. Abraham Valdelomar	0.0%	84.3%	14.3%	Z= -,233
I.E. Fermín Tangüis	1.4%	82.9%	15.7%	p= ,816

Figure 4. Anxiety-Trait Levels in Elementary School Students of I.E. Abraham Valdelomar (public) and I.E. Fermín Tangüis (private)

It is evidenced according to the findings shown in the table and figure 4 on Trait-Anxiety of the students of the educational institutions Abraham Valdelomar and Fermín Tianguis of public and private management respectively, it is observed that according to the statistic of the U of Mann- Whitney, there are no statistically significant differences between both groups, because the p value is> 0.05, accepting the null hypothesis, which reaffirms that Trait-Anxiety is present at a medium level in both groups of students.

Discussion

As a product of the forced confinement, due to the measures provided by the government, to avoid the massive contagion of COVID-19, social isolation occurred, causing anxiety to all individuals of various ages. Above all, to individuals of school age, limiting them not to communicate in person with their teachers and peers, which affected their emotional health, causing anxiety before virtual classes.

In the research carried out (Castro, Zurita, Chacón & Lozano, 2019), they show that the results are significantly positively related to the anxiety contexts of schoolchildren regarding Trait Anxiety and State Anxiety while the results found with the U-Mann-Whitney: 27,000 and z = -, 233, are contrary, since no significant differences are appreciated in Trait-Anxiety, this characteristic being the same for both boys and girls.

Both states of anxiety rose in sixth grade students, due to the disruptive situation caused by confinement and to this add the lack of technological devices, although if they had it it was already out of date, and it was not very useful for students (Pedró, 2020).

In the same line, students from both educational institutions increased Trait-Anxiety at a medium level, without significant differences due to the educational modality, attributing this to the scarce connectivity to the

network on the part of the student body (Rivera, et. Al., 2020).

According to the results found, with the U-Mann-Whitney: 25,000 and z = -, 361, students from both educational institutions show greater State Anxiety at the moderate level, in this sense Vázquez, et. to the. (2020) considered school anxiety as a multidimensional construct, which shows greater anxiety in the face of situations, examination and response systems.

Anxiety is a normal human response, but it becomes pathological when it persists and is maintained over time (Stephens, et. Al., 2016). On the other hand, the results found, there are significant differences in anxiety levels according to the educational institution, whether private or public, with greater concern in primary school children referring to the female sex.

Likewise, in the research carried out by Anxiety, (2019) stated that greater anxiety is evidenced when the qualified practices are carried out; and determined that the levels of anxiety before these practices with notes, is related to the subject or course and the gender of the schoolchildren, greatly evidencing that the ladies show higher levels of anxiety before the practices. While in the results of the present investigation, women show a higher degree of anxiety about the private educational institution than men.

On the other hand, it was observed that there is no significant association between State Anxiety and stress for carrying out activities; Among the results of the primary school students, Trujillo (2020) highlighting that during the time of health emergency children were involved on an emotional level, increasing anxiety and stress. In the same line, the present research shows that there are also minimal differences between the State Anxiety of both institutions in the development of activities, it is also shown that, as individuals, they are more exposed to an alteration of the mental system, due to confinement due to the spread of COVID-19.

The anxiety of schoolchildren was estimated without significant changes, showing a slight increase in anxiety in girls compared to grades in fifth-grade schoolchildren, (Lagos, Mart, & Luengo, 2018), in the same way, in terms of Anxiety -Trait, a minimal ascendancy in the percentage is appreciated, in what refers to the public educational institution, in which girls have a sharp increase compared to boys, in a state of confinement.

Conclusions

In this new pandemic reality, the daily life of families has suffered abrupt alterations due to health measures issued by the government worldwide, in all contexts of the individual's work, as well as in the economic, social, labor, educational, among others, as a result of the confinement due to COVID-19. In this sense, this new virtual reality scenario has profoundly disrupted the standard of living of individuals, causing uncertainty in all the families involved due to the sudden death of relatives, loss of work, and the most important thing, feeling separated from their loved ones. and other friendships, all these chaotic events have determined in individuals higher levels of anxiety.

Primary education students, both from public and private educational institutions, have minimal differences in the level of anxiety, showing a slight growth in the female gender compared to the male students.

Primary students from the private educational institution have a slight degree of anxiety in relation to students from the public educational institution, State Anxiety at the moderate level and Trait-Anxiety at the medium level, of primary school students. of both institutions have a minimal difference.

Anxiety is considered as a feeling of fear, fear and restlessness. It usually shows itself as a behavior inclined towards stress, with individuals presenting sweating, tension and even palpitations. Anxiety disorder becomes pathological, when it does not fade and worsens over time, interfering with the performance of daily tasks, in attending virtual classes and social interrelationships and especially in this new normal of life. pandemic. It is recommended that both public and private educational institutions have a psychology department, in order to generate intervention and emotional support programs in order to generate the development of skills and abilities to face stressful events such as anxiety and first-year students. can make proactive decisions in a pandemic reality..

References

1. Alemany-Arrebola, I., Rojas-Ruiz, G., Granda-Vera, J., & Mingorance-Estrada, Á. C. (2020). Influence of COVID-19 on the perception of academic self-efficacy, state anxiety, and trait anxiety in college students. Frontiers in psychology, 11.

2. Freire, C., del Mar Ferradás, M., & Suárez, M. (2021). Diferencias en ansiedad ante los exámenes en función de los niveles de autoestima en estudiantes de Educación Primaria. European Journal of Child Development, Education and Psychopathology, 9(1), 4.

3. Azorín Abellán, C. M., Arnaiz Sánchez, P., & Maquilón Sánchez, J. J. (2017). Revisión de instrumentos sobre atención a la diversidad para una educación inclusiva de calidad. Revista mexicana de investigación educativa, 22(75), 1021-1045.

4. Bernal Torrez, C. A. (2010). Metodología de la investigación, administración, economía, humanidades y ciencias sociales.

5. PULIDO ACOSTA, F. E. D. E. R. I. C. O., & HERRERA CLAVERO, F. R. A. N. C. I. S. C. O. (2018). Predictors of Happiness and Emotional Intelligence in Secondary Education. Revista Colombiana de Psicología, 27(1), 71-84.

6. Anxiety, T. (2019). Ansiedad ante los exámenes en estudiantes de educación primaria : diferencias en función del curso y del género Text Anxiety in Elementary School Students : Differences by School Year and Gender. 49(2), 151–168. https://doi.org/10.30827/publicaciones.v49i2.8087.

7. Bernal Pablo, P. (2018). La Investigación en Ciencias Sociales: Técnicas de recolección de la información. Universidad Piloto de Colombia.

8. Brailovskaia, J., Schönfeld, P., Zhang, X. C., Bieda, A., Kochetkov, Y., & Margraf, J. (2018). A Cross-Cultural Study in Germany, Russia, and China: Are Resilient and Social Supported Students Protected Against Depression, Anxiety, and Stress? Psychological Reports, 121(2), 265–281. https://doi.org/10.1177/0033294117727745.

9. Campo, L. A. (2015). Development of Boys and Girls Self Concept Related To Social Interaction in Childhood. Psicogente, 17(31), 67–79. https://doi.org/10.17081/psico.17.31.422.

10. Castro-Sánchez, M., Zurita-Ortega, F., Chacón-Cuberos, R., & Lozano-Sánchez, A. M. (2019). Motivational climate and levels of anxiety in soccer players of lower divisions. Retos, 2041(35), 164–169.

11. Castro Magan, I. M. (2018). Propiedades psicométricas del inventario de andisedad: Rasgo-Estado. Paian, 7(1). http://revistas.uss.edu.pe/index.php/PAIAN/article/view/312.

12. Gómez-Nuñez, M. I., García-Fernández, J. M., Inglés, C. J., Sanmartín, N. L., & Barrancos, M. L. (2014). ¿ Existen diferencias en rechazo escolar según los niveles de ansiedad escolar?. International Journal of Developmental and Educational Psychology, 4(1), 501-502.

13. Martinez Otero Pérez, V., & Gaeta González, L. (2014). Entornos Escolares Saludables: Prevención De Riesgos Psíquicos Y Promoción De La Salud Mental. Revista Iberoamericana de Educación, 66, 45–58.

14. Méndez, J. M., Altare, A. E., Maldonado, A. V., Saavedra, D. B., & Maldonado, I. C. (2009). Asociación entre ansiedad y rendimiento académico en un grupo de escolares. Psychologia. Avances de la disciplina, 3(2), 109-130.

15. Ranjeeth, S., & Latchoumi, T. P. (2020). Predicting Kids Malnutrition Using Multilayer Perceptron with Stochastic Gradient Descent. Rev. d'Intelligence Artif., 34(5), 631-636.

16. Prasath, D. S., & Selvakumar, A. (2015). A Novel Iris Image Retrieval with Boundary Based Feature Using Manhattan Distance Classifier. International Journal Of Innovative Technology And Creative Engineering (Issn: 2045-8711) Vol, 5.

17. Balamurugan, K. (2021). Fracture analysis of fuselage wing joint developed by aerodynamic structural materials. Materials Today: Proceedings, 38, 2555-2562.

18. Ozamiz-Etxebarria, N., Idoiaga Mondragon, N., Dosil Santamaría, M., & Picaza Gorrotxategi, M. (2020). Psychological symptoms during the two stages of lockdown in response to the COVID-19 outbreak: an investigation in a sample of citizens in Northern Spain. Frontiers in psychology, 11, 1491.

19. Palacios-Garay, J., & Coveñas-Lalupú, J. (2019). Predominancia del autoconcepto en estudiantes con conductas antisociales del Callao. Propósitos y Representaciones, 7(2), 325–338. https://doi.org/10.20511/pyr2019.v7n2.278

20. Pilarska, A. (2018). Big-Five personality and aspects of the self-concept: Variable- and person-centered approaches. Personality and Individual Differences, 127, 107–113. https://doi.org/10.1016/j.paid.2018.01.049

21. Ríos, E. M., Ronda Herrera, R., & Rojas, A. G. (2014). Ansiedad dental: Evaluación y tratamiento. Avances En Odontoestomatologia, 30(1), 39–46. https://doi.org/10.4321/S0213-12852014000100005

22. PULIDO ACOSTA, F. E. D. E. R. I. C. O., & HERRERA CLAVERO, F. R. A. N. C. I. S. C. O. (2018). Predictors of Happiness and Emotional Intelligence in Secondary Education. Revista Colombiana de Psicología, 27(1), 71-84.https://doi.org/10.1371/journal.pntd.0005004

23. Spielberger, C. D., Gorsuch, R. L., & Lushene, R. E. (1982). Cuestionario de ansiedad estado-rasgo. Madrid: Tea, 1.

24. Taylor, R. F. (2019). La teoría científica. Scientia et Technica 13 (35) pp. 311- 318. https://www.redalyc.org/pdf/849/84903554.pdf

25. Reyes, N., & Trujillo, P. (2020). Ansiedad, estrés e ira: el impacto del COVID-19 en la salud mental de estudiantes universitarios. Investigación & Desarrollo, 13(1), 3-14.

26. Sánchez-de-la-Torre, M., Sánchez-de-la-Torre, A., Bertran, S., Abad, J., Duran-Cantolla, J., Cabriada, V., ... & Vázquez, M. J. (2020). Effect of obstructive sleep apnoea and its treatment with continuous positive airway pressure on the prevalence of cardiovascular events in patients with acute coronary syndrome (ISAACC study): a randomised controlled trial. The Lancet Respiratory Medicine, 8(4), 359-367..

COMPARATIVE STUDY OF DIGITAL COMPETENCE OF PRIMARY AND SECONDARY SCHOOL TEACHERS IN TIMES OF PANDEMIC

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ABSTRACT

The study of digital skills in teachers is established as a government policy; However, teachers have been developing digital skills as they have needed it and as part of their ongoing training as part of a personal decision. In these times of pandemic, the Peruvian Ministry of Education has carried out some training in digital skills that have had teaching access at the levels, primary and secondary; being used by secondary level teachers. This research article aims to compare the levels of digital competence of primary and secondary teachers in times of pandemic. Regarding the methodology, the approach was quantitative, the type of research was basic, the method used for the present research work is hypothetical deductive and the design used is non-experimental cross-sectional and was established with a sample of 80 primary level teachers and 80 secondary level teachers. The research concluded that there are significant differences in the digital competence of primary and secondary teachers in times of pandemic, due to the fact that in the comparison of primary and secondary level teachers that the U-Mann-Whitney: 1364,000 and z = -6,267, with ρ = 0.000 and ρ <0.05. Secondary level teachers presented better average range levels of 103.45, unlike primary teachers who present an average range of 57.55

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1. Introduction

At a global level, the importance of digital technology and teaching-learning techniques is established (Unesco, 2016). The development of the teacher's competence is an academic objective that has been diagnosed within the discipline of educational coverage based on international frameworks and models (Padilla-Hernández et al., 2019). Taking into consideration that digital competence considers the technological aspects related to the control of computer systems and programs, the informative or communicative aspect referred to the search for statistics, verbal exchange and collaboration (Pozos et al., 2018; Prendes et al., 2018). The management of ICT technology is vital within the context that has been developing within the contemporary 12 months of the COVID-19 pandemic and determining the virtual capacities of teachers is a point of interest currently seeking innovation and good performance in academic spaces that are carried out at a distance.

The growing expansion of insurance for the possession of portable devices in Western societies, and specifically among participants in educational communities, has led to the availability of voice and information at any time and area, which suggests that these devices have a greater presence within academic activities they carry out. Therefore, it is unknown, and in the case, little thought is given, how they learn to use said devices and to what extent they expand virtual capacities for the control of computer assets with access to facts, communication, organization, to name a few (Organista et al., 2017).

Teachers, with their know-how, experiences, observation, decision-making approximately as a way to take advantage of possibilities and face the restrictions of virtual practices and sources and thus help the student to know and their own professional development. In fact, in the last two decades, one of the topics of interest has been educational technology (Prendes, 2018). Therefore, in the current scenario, teachers are expected to take advantage of a wide variety of virtual teams for the purposes of innovation and academic improvement (Adams-Becker et al., 2017). On the other hand, the awareness that digital skills are important is from this era, in addition to the mobilized skills and the reflective choices that

teachers make to contain virtual technology in a strategic and pedagogical way (Pozos, 2013) and that they have an effect on students' digital skills (Redecker, 2017).

However, they present various problems and, in this regard, (Castañeda et al., 2018) regarding the lack of expertise of the teacher's function from a holistic angle, it has gone from being developed within the school classroom, leaving aside the sociocultural context in which competence is brought into play, and the instrumental view of the era as an unbiased space or one in an effort to inevitably convey benefits in education.

At the national level, the results of digital competences indicate that 88.7% of the Peruvian population has access to at least some ICT device, one in three people has a computer at home, and the level of internet access has increased by 40.7%. (Guizado, Menacho & Salvatierra, 2020). Secondary level teachers obtained 78% of regular level, 22% of good level of digital skills, establishing that, at a better level of digital skills, teachers achieve better levels of professional development. However, ICT accesses in educational institutions are more heterogeneous: only one in four is connected, with 86% of the connections in operational states. The institutions that have internet access at secondary level is 52%, while the ratio between the number of students per computer is six and seven (Mateus & Muro-Ampuero, 2016). It is necessary to establish that digital skills in teachers are very complex and show difficulties unlike other areas of society (From, 2017). The teacher must make every effort to achieve digital skills and be in connection with the digital knowledge society (Hatlevik & Christophersen, 2013).

Therefore, the research presented the general objective of comparing the digital competence of primary and secondary teachers in times of pandemic and in the same way. He proposed the following specific objectives for primary and secondary school teachers in times of pandemic: 1) Determine the level of search and treatment of information, 2) Determine the level of technological literacy, 3) determine the level of critical thinking, solution of problems and decision making, 4) determine the level of communication and collaboration, 5) determine

the level of digital citizenship and finally, 6) determine the level of creativity and innovation. Regarding the general research hypothesis, it was raised whether there are significant differences in the digital competence of primary and secondary education teachers in times of pandemic, and for the specific hypotheses raised in primary and secondary education teachers in times of pandemic on whether there are differences in: 1) the level of information search and processing, 2) the level of technological literacy, 3) the level of critical thinking, problem solving and decision-making, 4) the level of communication and collaboration , 5) the level of digital citizenship and finally, 6) the level of creativity and innovation.

Theoretical approach: Connectivism

The theoretical approach of digital competences is connectivism, this allows the access and analysis of large-scale data that are generated from the interactions of teachers online; enabling the analysis of learning in open, flexible and distance environments, which in turn improves the learning process considering social and cultural challenges (Siemens, 2019). The synergistic evolution of the fields of connectivism and learning design gain relevance by leading the birth of a relevant area of study in the field of learning in modern contexts of interconnectivity (Mangaroska & Giannakos, 2019).

Digital skills

Digital competences are defined as the use of technological equipment for the development of tasks, problem solving, access to sources, exploration, identification and evaluation of information in an appropriate way to study content and behave effectively in digital communities (Gutiérrez, Cabero & Estrada, 2017). Likewise, digital skills are considered essential knowledge, skills and attitudes while ICTs are used to perform tasks; solve difficulties; communicate; deal with statistics; to collaborate; create and share content material; and increase knowledge in a powerful, appropriate, vital, innovative, self-sufficient, flexible, ethical and thoughtful way for work, entertainment time, engagements, learning, socialization, acquisitions and

improvement (Ferrari, 2012). In general, the trainer's digital competence refers to the expert competence that educators want to take advantage of from the digital technologies of their practice (Padilla-Hernández et al., 2019). From the broadest perspectives, skills and knowledge of characteristics in virtual contexts are a demand of all citizens and, consequently, one of the challenges lies within the training of educators to promote information and knowledge of this line in formal schooling (Atchoarena et al., 2017). It is true that the curricula in primary education in various parts of the world include the integration of ICT as relevant elements for the good education of students.

Consequently, the advertising and marketing of a teacher profile for the use of digital resources has been included in the educational coverage. Proof of this are the international frameworks and models that have addressed the digital competence or ICT competence of teachers. One of these frameworks is that of the competence and needs of ICTs of the United Nations Educational, Scientific and Cultural Organization (Unesco, 2011).

Dimensions of digital competences

Information search and treatment

Through which teachers and / or students use digital environments in communication and work collaboratively, including remotely, to support individual / collective learning (Gutiérrez et al., 2017). Likewise, to search for information, it is recommended to use bookmarks, the use of historical address retrieval, among other knowledge that must be developed to guarantee a good treatment of the information (Cabanillas, Luengo and Torres, 2020).

Technological literacy

In technological literacy, teachers and / or students show innovative ideas, construct information and develop innovative procedures and approach the use of ICT (Gutiérrez et al., 2017). Likewise, digital literacy is the set of skills used to efficiently locate, manipulate and interpret information through internet resources, knowing the ICT environments. People with virtual capacities can function effectively within the multimedia environment, speak satisfactorily on these platforms and

work more effectively thanks to the perfect use of the possibilities of computing (Escandell, 2017).

Critical thinking, problem solving and decision making

Process by which teachers and / or students use digital tools to acquire, examine and use communications (Gutiérrez et al., 2017). It is highlighted (Dewey, 1989) that for each of these forms of questioning it is not uncommon for them to be thoughts and, at times, it is very complicated and difficult to differentiate them. Each of them has its specific personal traits and even unique methods and products. Whoever knows what the satisfactory approaches are to thinking and why they are better can, if he wishes, adjust his own way of wondering to enhance their effectiveness, that is, make the process higher.

Communication and collaboration

Process by which teachers and / or students use critical thinking skills and thus design and increase investigations, control tasks, clarify problems and make informed selections, using appropriate equipment and digital resources (Gutiérrez et al., 2017).

Digital Citizenship

Process through which teachers and / or students worry about human, cultural and social problems correlated with ICTs and carry out criminal and moral behaviors (Gutiérrez et al., 2017). Likewise, it is proposed that, although the technology of records and communications offers interesting mechanisms for the session and generation of records for the development of virtual citizenship, there are elements that must be taken into consideration, since they are related to excellence and truthfulness. of the records. Information used by virtual citizens to worry about the future of public affairs (Ramos, 2019). It is important to bear in mind that trends in internet use were analyzed, highlighting the way in which residents are using it to learn about current problems in political, social and economic terms (Marcos et al., 2018).

Creativity and innovation

Process by which teachers and / or students demonstrate an adequate understanding of the concepts, systems and operations of ICTs (Gutiérrez et al., 2017). Creativity and technological innovation represent key elements for the development of various areas of society (Córdova et al., 2018).

2. Methodology

The study is circumscribed in a positivist paradigm, quantitative approach, due to the measurement of the variables; the method is hypothetical deductive, due to the statement of the hypotheses and their testing. The design was non-experimental, cross-sectional and comparative (Hernández & Mendoza, 2018). The population consisted of 160 educators at the primary and secondary levels and thus carry out the comparative study.

The research was carried out with the survey technique and the instrument was the Gutiérrez questionnaire, Cabero and Estrada (2017) performed the content validity through expert judgment and the construct validity of the instrument, with KMO = 0.000, being significant; Likewise, they carried out the reliability of Cronbach's Alpha and obtained a value of 0.966 indicating high reliability of the variable.

Excel and SPSS version 26 were used for the results and descriptive analysis of frequencies and percentages was performed and for the inferential analysis the Kolmogorov Smirnov normality test was performed and the findings were $p < 0.05$ establishing that the non-parametric test be performed Mann Whitney's U which is a test for 2 different samples.

3. Results

After applying the instruments, we reached the following results, responding to the objective presented, as well as the testing of the hypothesis

Table 1. Levels of digital skills in primary and secondary school teachers

			Level of digital skills			
			Inadequate	Regular	Adequate	Total
Educational institutions	Primary	fi	33	45	2	80
		% fi	41.3%	56.3%	2.5%	100
	High school	fi	4	68	8	80
		% fi	5%	85%	10%	100

In table 1, primary level teachers presented 41.3% of inadequate level, 56.3% of regular level and 2.5% of adequate level of digital skills and secondary level teachers presented 5% of inadequate level, 85% of regular level and 10% presented an adequate level of digital skills

Table 2. Levels of information search and treatment in primary and secondary school teachers

			Information search and treatment level			
			Inadequate	Regular	Adequate	Total
Educational institutions	Primary	fi	40	32	8	80
		% fi	50%	40%	10%	100
	High school	fi	15	42	23	80
		% fi	18.8%	52.5%	28.8%	100

In table 2, the primary level teachers presented 50% of inadequate level, 40% of regular level and 10% of adequate level of search and treatment of information and the secondary level teachers presented 18% of inadequate level. 52.5% of regular level and 28.8% presented adequate level of search and treatment of information.

Table 3. Levels of technological literacy in primary and secondary teachers

			Technological literacy levels			
			Inadequate	Regular	Adequate	Total
Educational institutions	Primary	fi	44	27	9	80
		% fi	55%	33.8%	11.3%	100
	High school	fi	14	43	23	80
		% fi	17.5%	53.8%	28.7%	100

In table 3, primary level teachers presented 55% of inadequate level, 33.8% of regular level and 11.3% of adequate level of technological literacy and secondary level teachers presented 17.5% of inadequate level, 53.8% of regular level and 28.7% presented an adequate level of technological literacy.

Table 4. Levels of critical thinking, problem solving and decision making

			Levels of critical thinking, problem solving and decision making			
			Inadequate	Regular	Adequate	Total
Educational institutions	Primary	fi	35	33	12	80
		% fi	43.8%	41.3%	15%	100
	High school	fi	27	33	20	80
		% fi	33.8%	41.3%	25%	100

In table 4, the primary level teachers presented 43.8% of inadequate level, 41.3% of regular level and 15% of adequate level of critical thinking, problem solving and decision making and the secondary level teachers presented 33.8% of inadequate level, 41.3% of regular level and 25% presented adequate level of critical thinking, problem solving and decision making

Table 5. Levels of communication and collaboration

			Level of communication and collaboration			
			Inadequate	Regular	Adequate	Total
Educational institutions	Primary	fi	44	31	5	80
		% fi	55%	38.8%	6.3%	100
	High school	fi	14	46	20	80
		% fi	17.5%	57.5%	25%	100

In Table 5, primary level teachers presented 55% of inadequate level, 38.8% of regular level and 6.3% of adequate level of communication and collaboration and secondary level teachers presented 17.5% of inadequate level, 57.5% of regular level and 25% presented an adequate level of communication and collaboration.

Table 6. Levels of digital citizenship

			Levels of digital citizenship			
			Inadequate	Regular	Adequate	Total
Educational institutions	Primary	fi	45	23	12	80
		% fi	56.3%	28.7%	15%	100
	High school	fi	20	28	32	80
		% fi	25%	35%	40%	100

In table 6, primary level teachers presented 56.3% of inadequate level, 28.7% of regular level and 15% of adequate level of digital citizenship and secondary level teachers presented 25% of inadequate level, 35% of regular level and 40% presented an adequate level of digital citizenship.

Table 7. Levels of creativity and innovation

			Levels of creativity and innovation			
			Inadequate	Regular	Adequate	Total
Educational institutions	Primary	fi	38	34	8	80
		% fi	47.5%	42.5%	10%	100
	High school	fi	29	40	11	80
		% fi	36.3%	50%	13.8%	100

In table 7, the primary level teachers presented 47.5% of inadequate level, 42.5% of regular level and 10% of adequate level of creativity and innovation and the secondary level teachers presented 36.3% of inadequate level, 50% of regular level and 13.8% presented an adequate level of creativity and innovation of digital competences.

Hypothesis testing
Table 8. Significance of the digital competence variable and its dimensions in comparison with primary and secondary level teachers

	Group	N	Range average	Sum of ranges	Test statistics	
Digital skills	Primary	80	57,55	4604,00	U Mann Whitney	1364,000
	High school	80	103,45	8276,00	Z	-6,267
	Total	160			Sig. (bi)	0.000
Information search and treatment	Primary	80	62,95	5036,00	U Mann Whitney	1796,000
	High school	80	98,05	7844,00	Z	-4,800
	Total	160			Sig. (bi)	0.000
Technological literacy	Primary	80	61,61	4928,50	U Mann Whitney	1688,500
	High school	80	99,39	7951,50	Z	-5,172
	Total	160			Sig. (bi)	0.000
Critical thinking, problem solving and decision making	Primary	80	74,22	5938,00	U Mann Whitney	2698,000
	High school	80	86,78	6942,00	Z	-1,724
	Total	160			Sig. (bi)	0.049
Communication and collaboration	Primary	80	57,73	4618,50	U Mann Whitney	1378,500
	High school	80	103,27	8261,50	Z	-6,228
	Total	160			Sig. (bi)	0.000
Digital citizenship	Primary	80	64,57	51,65,50	U Mann Whitney	1925,500
	High school	80	96,43	7714,50	Z	-4,390
	Total	160			Sig. (bi)	0.000
Creativity and innovation	Primary	80	73,55	5884,00	U Mann Whitney	2644,000
	High school	80	87,55	6996,00	Z	-1,903
	Total	160			Sig. (bi)	0.048

Table 8 shows the variable digital competence in the comparison of teachers at the primary and secondary level that the U-Mann-Whitney: 1364,000 and z = -6,267, with ρ = 0.000 and ρ <0.05; Therefore, it is established to reject the null hypothesis and it is established that there are significant differences in the digital competence of primary and secondary teachers in times of pandemic.

In the same way, we analyze the results for the dimensions of the study such as: information search and treatment, technological literacy, critical thinking, problem solving and decision making, communication and collaboration, digital citizenship and finally creativity and innovation meeting , according to the level of significance when developing the U-Mann-Whitney test, that the p-value is less than 0.05, which is why it is established that there are significant differences in the dimensions indicated for primary and secondary school teachers in times pandemic.

Teachers at the secondary level presented better levels with an average range of 103.45, unlike primary teachers who presented an average range of 57.55. Likewise, significant differences were found among primary and secondary teachers for the dimensions, search and treatment of digital information, technological literacy, critical thinking, problem solving and decision-making, communication and collaboration, digital citizenship, and creativity and innovation. ρ <0.05; rejecting the null hypothesis and it is established that there is a significant difference in each of the established dimensions, due to the fact that secondary level teachers present higher average ranges than primary level teachers.

4. Discussion

The research found that the variable digital competence in the comparison of teachers at the primary and secondary level than the U-Mann-Whitney: 1364,000 and z = -6,267, with ρ = 0.000 and ρ <0.05; Therefore, the null hypothesis must be rejected and it is established that there are significant differences in the digital competence of primary and secondary teachers in times of pandemic. Teachers at the secondary level presented better levels with an average range of 103.45,

as opposed to primary teachers who presented an average range of 57.55. In this sense, the development of the teacher's digital skills is an educational purpose that has been recognized in the context of educational policy based on an international framework and model (Padilla-Hernández et al., 2019); However, teachers have been developing digital skills as they have needed and as part of their ongoing training and personal decision. In these times of pandemic, Minedu has carried out some training in digital skills that have had access to teachers at the initial, primary and secondary levels; being used by secondary level teachers.

Teachers, with their experiences, imagination and foresight, make decisions about how to take advantage of opportunities and deal with limitations of virtual practices and assets to help the student acquire knowledge and personal development. In fact, the role of the teacher is always one of the topics of interest in educational technology (Prendes, 2018). In these times, it is essential to manage ICT technologies in the context that has been working in this year of the COVID-19 pandemic and to establish the digital skills of teachers as a current point of interest in the search for innovations and efficiency of the distance educational activities they carry out.

In the present study, primary level teachers presented 41.3% of inadequate level, 56.3% of regular level and 2.5% of adequate level of digital skills and secondary level teachers presented 5% of inadequate level, 85% of regular level and 10% presented an adequate level of digital skills. Coinciding (Guizado, Menacho and Salvatierra, 2020) with secondary level teachers, they obtained 78% of regular level, 22% of good level of digital skills, establishing that, at a better level of digital skills, teachers achieve better levels professional development. In this regard, they raise the idea of the importance of developing digital skills with the perspective that professionals who acquire digital skills late come to benefit from their strengths and reverse the disadvantages presented by not having developed digital skills (Bokek -Cohen, 2018). So it is important to reflect and take action to carry out training.

Likewise, the dimensions of search and treatment of digital information, technological

literacy, critical thinking, problem solving and decision-making, communications and collaborations, digital citizenship, and creativity and innovation presented ρ <0.05, establishing that there are significant differences in the aforementioned dimensions, due to the fact that secondary level teachers present higher average ranks than primary level teachers. In this regard, from the development of the dimensions of digital competences with a holistic view (Ocaña, Valenzuela & Garro, 2019) it is important to demonstrate the domain of search and information processing.

5. Conclusions

According to the research objective, it is established that there are significant differences in the digital competence of primary and secondary teachers in times of pandemic, due to the fact that in the comparison of primary and secondary level teachers that the U-Mann-Whitney: 1364 .000 and z = -6.267, with ρ = 0.000 and ρ <0.05. Teachers at the secondary level presented better levels with an average range of 103.45, as opposed to primary teachers who presented an average range of 57.55.

Likewise, the dimensions of search and treatment of digital information, technological literacy, critical thinking, problem solving and decision making, communication and collaboration, digital citizenship and creativity and innovation presented ρ <0.05, establishing that there is a significant difference in each of dimensions, due to the fact that secondary level teachers present higher average ranks than primary level teachers.

References

1. Smyrnova-Trybulska, E. (2018). Smart university in smart society–some trends.
2. Atchoarena, D., Selwyn, N., Chakroun, B., Miao, F., West, M., & Coligny, C. D. Working Group on Education: digital skills for life and work.
3. Bokek-Cohen, Y. A. (2018). Conceptualizing employees' digital skills as signals delivered to employers. International Journal of Organization Theory & Behavior.
4. García, J. L. C., González, R. L., & Carvalho, J. L. T. (2020). La búsqueda de información, la selección y creación de contenidos y la comunicación docente. RIED. Revista Iberoamericana de Educación a Distancia, 23(1), 241-267.
5. Castaneda, L., Esteve, F., & Adell, J. (2018). Why rethinking teaching competence for the digital world? Red-Revista De Educacion A Distancia, (56).
6. Cordoba Zuniga, E., Castillo Toro, J. L., & Castillo Quesada, N. (2018). Creativity and innovation: As engines of business development. REVISTA DIGITAL LAMPSAKOS, (19), 55-65.Dewey. J. (1989). Cómo pensamos. Paidós: Barcelona Recuperado de https://scielo.conicyt.cl/scielo.php?script=sci_nlinks&pid=S0718-07052018000100008900012&lng=en
7. Escandell Montiel, D. (2017). Alfabetismo digital en la enseñanza de segundas lenguas: espacios para una educación adaptada a las necesidades comunicativas de nuestra época. Doblele: revista de lengua y literatura, 3, 0017-30.
8. Ferrari, A. (2012). Digital competence in practice: Analysis of frameworks. Institute for prospective technological studies. European Comission. Recuperado de https://ifap.ru/library/book522.pdf
9. From, J. (2017). Pedagogical digital competence—between values, knowledge and skills. Higher Education Studies, 7(2), 43–50. https://doi.org/10.5539%2Fhes.v7n2p43
10. Osco, F. G., Vargas, I. M., & Melgar, A. S. (2019). Competencia digital y desarrollo profesional de los docentes de dos instituciones de educación básica regular del distrito de Los Olivos, Lima-Perú. Hamut´ay, 6(1), 54-70.
11. Gutiérrez Castillo, J. J., Cabero Almenara, J., & Estrada Vidal, L. I. (2017). Diseño y validación de un instrumento de evaluación de la competencia digital del estudiante universitario. Revista Espacios, 38 (10).
12. Hatlevik, O. E., & Christophersen, K.-A. (2013). Digital competence at the beginning of upper secondary school: Identifying factors explaining digital inclusion.

Computers & Education, 63, 240–247. https://doi.org/10.1016%2Fj.compedu.2012.11.015

13. Hernández, R. y Mendoza, (2018). Metodología de la investigación. Las rutas cuantitativa, cualitativa y mixta, Ciudad de México, México: Editorial.

14. Mangaroska, K., & Giannakos, M. (2018). Learning analytics for learning design: A systematic literature review of analytics-driven design to enhance learning. IEEE Transactions on Learning Technologies, 12(4), 516-534.

15. Recio, J. C. M., Vigil, J. M. S., & Zaldúa, M. O. (2018). El consumo de información en las redes sociales: encrucijada de los medios digitales. In Conocimientos sin fronteras: Colaboración científica e institucional en Documentación e Información (pp. 718-741). Departamento de Biblioteconomía y Documentación.

16. Ranjeeth, S., & Latchoumi, T. P. (2020). Predicting Kids Malnutrition Using Multilayer Perceptron with Stochastic Gradient Descent. Rev. d'Intelligence Artif., 34(5), 631-636.

17. Prasath, D. S., & Selvakumar, A. (2015). A Novel Iris Image Retrieval with Boundary Based Feature Using Manhattan Distance Classifier. International Journal Of Innovative Technology And Creative Engineering (Issn: 2045-8711) Vol, 5.

18. Balamurugan, K. (2021). Fracture analysis of fuselage wing joint developed by aerodynamic structural materials. Materials Today: Proceedings, 38, 2555-2562.

19. Mateus, J. C., & Muro-Ampuero, E. (2016). Competencias TIC: una estrategia para invertir en tecnología educativa.

20. Ocaña-Fernández, Y., Valenzuela-Fernández, L. A., & Garro-Aburto, L. L. (2019). Artificial Intelligence and Its Implications in Higher Education. Journal of Educational Psychology-Propositos y Representaciones, 7(2), 553-568.

21. Organista-Sandoval, J.; Lavigne, G.; Serrano-Santoyo, A. y Sandoval-Silva, M. (2017). Desarrollo de un cuestionario para estimar las habilidades digitales de estudiantes universitarios. Revista Complutense de Educación, 28 (1), 325-343. Recovered from https://revistas.ucm.es/index.php/RCED/article/view/49802

22. Padilla-Hernández, A. L., Sánchez, V. M. G., & López, M. A. R. (2019). Niveles de desarrollo de la Competencia Digital Docente: una mirada a marcos recientes del ámbito internacional. Innoeduca: international journal of technology and educational innovation, 5(2), 140-150.

23. Pozos, k. & Tejada, J. (2018). Competencias Digitales en Docentes de Educación Superior: Niveles de Dominio y Necesidades Formativas. Revista Digital de Investigación en Docencia Universitaria, 12 (2), 59-87. ISNN 2223-2516. http://dx.doi.org/10.19083/ridu.2018.712

24. Prendes, M. P. (2018). La Tecnología Educativa en la Pedagogía del siglo XXI: una visión en 3D. RIITE Revista Interuniversitaria de Investigación en Tecnología Educativa, (4), 6–16. doi: 10.6018/riite/2018/335131

25. Prendes, M., Gutiérrez, I. & Martínez, F. (2018). Competencia digital: una necesidad del profesorado universitario en el siglo XXI. RED. Revista de Educación a Distancia, 1(56), 1-22, Artíc. 7. http://dx.doi.org/10.6018/red/56/7

26. Ramos, A. (2019). Ciudadanía e información en ambientes digitales. Investigación bibliotecológica, 33(78). https://doi.org/10.22201/iibi.24488321xe.2019.78.58045

27. Redecker, C. (2017). European framework for the digital competence of educators: DigCompEdu (No. JRC107466). Joint Research Centre (Seville site).

28. Siemens, G. (2019) Learning analytics and open, flexible, and distance learning. Distance Education 40 (3), 414-418. https://doi.org/10.1080/01587919.2019.1656153. Unesco, I. C. T. (2011). Competency framework for teachers. Paris: United Nations Educational, Scientific and Cultural Organization.

COMPARATIVE STUDY OF RESOURCE ALLOCATION USING MANAGEMENT SOFTWARES - PRIMAVERA P6 AND MICROSOFT PROJECT

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ABSTRACT

With the growing industrial civilization, the construction management system plays a predominant role in controlling and coordinating the whole project. This can only be achieved by using the best software tools available on the market. Software management tools opted must be robust, user-friendly, and must consume less time to navigate to corresponding tabs. When it comes to the construction management industry the software opted must give us the eagle-eye view of the entire project at any point in time. By using the best software tools, we can control many aspects, one that tops up all will stand by the financial aspects of all the stakeholders. This aspect may hamper the projects directly or indirectly if managed poorly, which results in a huge loss of time and amount, not just from a financial perspective but also psychologically and emotionally as well. In this project, a comparison of two-construction management software's Primavera P6 and Microsoft (MS) project software is been carried out, by considering a refurbishment of an existing retail unit as a case study model. The analysis is done based on the resource allocation navigations and capitalizing tasks based on the value and non-value added tasks, to identify and suggest additional best-supporting criteria for Primavera P6 software and Microsoft (MS) project software to develop 'What good likes' in construction resources management area.

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Keywords: Microsoft (MS) project, Primavera P6, Project management, Resource management, Task Capitalization

Introduction

Construction project management is an integrated process of proper planning and systematic scheduling of all the associated works related to the completion of the project considered. Every construction project work contains numerous factors; all these are inter-depended on each other at all the given intervals. Thus, it becomes one of the most responsible duties to create a support page where all the factors that play an important part of the project, to get a proper base tool to work with. In the current world, support project management works many software's. However, most of all it is important to know the importance and functions of the individual software we opt to implement on the project we work on. With the fast-growing environment and civilization, it becomes important we concentrate on the best tool to benefit the various accepts of the project in different situations

Resource management

 Resource management is the method of distributing all the resources in the best conceivable way. The principal aim is to maximize all resource efficiency by using the best software tool available. This will lead to successful completion of the project, which is set up to meet the organization goals. Resources are the things from people to machinery to end facilities. Resources used are the most important tools and values needed to complete any given activity. Construction of the project not only rely on the overall total quality and accurate quantity of the works involved in the projects but also the availability of the on-time resources involved in the works carried out. Resources in the total project budget plays a vital role and add up a huge total value to the cost plan estimated. That is why it becomes an important key area to manage and plan accordingly. The best process can be achieved through the proper selection of

the software used for the projects, which amplify the time of interest contributed.

Importance of Resource management

Some of the important key points in every resource management are pointed as below,

i. It provides the project with an overview of everyone and everything involved under every part of the works.
ii. It enables better planning and control over the entire project tasks.
iii. It makes the planning and management process more transparent clear to under every scope of work been carried.
iv. It helps you see problems before they start on site until the end date.
v. It gives you control over the entire project budget management.

Purpose of Resource management

i. Resource management is directly proportional to the actual planned cost.
ii. It quantifies the actual time, cost, and the whole sequence of a given operation in the construction project.
iii. The series of resource scheduling uncovers all the flaws in the planned budget, which leads to the easy revision of the plan budgets and thus reflect the better cost figures.

Benefits of Resource management

i. Maximizing resource efficiency and developing a better Resource Utilization system.
ii. Getting a bird's eye view of the project resources at any instant of time.
iii. Preventing miscommunication mishaps for having true transparency.
iv. Predicting the future of the resource by foreseeing and avoiding problems in advance.
v. Taking Control of the entire project to meet the targets.

Importance of software in Construction management

i. The software selected for the project much be user-friendly
ii. It should behave with high accuracy and should be integrated with many businesses implemented tools
iii. Budgeting the project on the software much be easy, and the time consumed much be minimal
iv. It should be easy to track at any given point of time by multiple users
v. It should be benefited on-site and off-site, i.e. people much have the visibility at every given place irrespective of the condition at a given instance with the same data populated.
vi. The visibility of the data should be distributed, and certain restrictions should be added to end-users
vii. All the navigations that will be used to create a project must be easily accessible and should not involve complex steps to add certain data.
viii. It should be robust and should provide support to complex solution breakdowns

Brief literature review

S. Ragavi & R. N. Uma (2017) [1], implemented a detail study on "Planning and scheduling of an apartment building by comparison of MS project and Primavera". This paper explains the basic general construction sequence of an apartment building using both the management software's MS Project and Primavera. The approach integrated was on the planning and scheduling of the two software's, to conclude operational characteristics, and its functionality, and technical implemented features. The paper concluded stating Primavera is better than MS Project, and Primavera supplies better security tools for accessing project files and Baseline plans.

Shruti Singh, Shweta Istape, Amruta Surve, Sahil Pandey, Avinash Singh & Sangram More (2018) [2], implemented a detail study on "Comparative study of planning and scheduling of a construction project using

Microsoft project". This paper details the planning and scheduling various activities that was involved in the construction project using MSP software. The works presented on the paper gave the difference between the actual works carried using MSP and the normal traditional planning techniques. The case study model was the residential building in Mumbai, which clearly defined the implementation of the MSP software makes up the construction works and the budgeted cost-effective. They have concluded the results by using the two additional supporting theories CPM and PERT for the analysis. Thus, the result concluded that the planning shows the estimated period of the project completion is 18 months only. While the actual was 20 months in principle. It highlights all the critical activities and the critical path periods. It has been showing that some activities and the tasks delayed by 4 months, using the best approach and it was scientific.

Rhuta J and Prof. V Z Patil (2015) [3], implemented a detail study on "Resource Scheduling of Construction Project: Case Study". The study stated that the project delays occurs only due to the inadequate and incomplete supply of the required resources on time. Preparation for an exact workable plan and detail analysis of the resources for all the large complex construction works leads to a better plan approach and solutions for the integrated ricks. Thus, using the Project management packages such as MSP (Microsoft Project) and Primavera P6 in any of the construction sector will helps in resolving the resource risks in the project at a given times. This paper stated that the work phase was carried out in two different phases. First phase, where in all the required data was collected from the planned sites, post which all the necessary quantities were estimated in-line with the drawing, these details acquired was later used to calculate the required work force. Second phase, involved the software analysis of the pre-estimated works from the first phase. The result was as resource decreases duration increased by 10.38% and cost by 0.94%.

Shubhashree P. Deshmukh, Akshay V. Sagale, Dr. Manish M. Bais (2019) [4], implemented a detail study on "Study of

Scheduling in Microsoft Project Software". The project work and all the relevant details was scheduled using MSP Microsoft Project software. The project model used to analyse the work was on an apartment building, which displayed how a detailed and proper planning, with all the accurate scheduling can be done by integrating the software MS project. It was concluded by stating that all the traditional way of analysis is uneconomical and in depth they consumes more time for the works with huge compatibilities, also the planning used will not subdivide the main task or the activities. Thus, they lead to hurdle of over-allocation of resources on a project, by giving improper judgment on the work details.

T.Subramani, T.M.Karthick (2018) [5], implemented a detail study on "Study on Time and Resource Management in Construction Projects Using MS Project". They have used a resource scheduling to easy and quick track project by integrating the constrained intervals. The project had two different stages. The first stage has been used to allocate the resource on MS Microsoft project software, by detailing all the task timetable for all the activities for the development of business construction works. Finally, Standard schedule rates (SOR) were used to estimate the resources allocated on the software. Thus, they concluded by using an effective method of time management tool perceived by the respondents was by using the Critical Path Method (CPM).

SK. Nagaraju, B, Sivakonda Reddy (2012) [6], implemented a detail study on "Resource Management in Construction Projects – a case study". Resource scheduling was done for a fast-track project with constrained durations using Primavera software. The project had two different phases. First phase, with the implementation of the primavera software the project works was schedule for various tasks and the related activities for the construction work model on a commercial building, based on Standard Schedule Rates (CPWD). Second phase, resource-constrained analysis for resource levelling the various activities and the tasks, by decreasing resources with increased duration to study the time-cost implications on the project model. The presented schedule work rates were linearly increasing day-by-day cost due to the sudden requirement of labour

and thus, the overall result had an impact on the overall cost tracking buget, and the cost achieved in the paper has a very steep curve. If the resource constraints were down decreased by 10% to 50%, this caused the total duration period of a project to up increase by 2% to 18.23 %. The over-all percentage increase in duration was about 18.23%, which was causing a percentage increase in project cost of about 1.684%.

Balraj G. Wajantri, Amey A. Kelkar (2018) [7], implemented a detail study on "Application of Microsoft project for resource optimization in multiple project management". Resource management technique, using MSP Microsoft Project software a detailed schedule developed for the execution of three residential buildings and the total time and cost required for each project completion, as well as total duration and cost for all the three projects, were obtained. Further, a single schedule was developed for all three projects, resources are simultaneously distributed, and project cost and time were obtained and are compared with the earlier ones. The main conclusion was to focus on the study that will help in developing a framework concerning resource management with special emphasis on labour management, which will supply a platform for labour management in a scenario of simultaneous execution of different projects. The application of MSP Microsoft Project software this project work helped in resource allocation because of which the total duration and cost of the project was been able to reduce.

Objective of the paper

The following are the objective of the paper-
  i.   To identify the resources allocation and scheduling technique using different tools opted.
  ii. To identify the value-added tasks in resource allocation, sequence a construction.
  iii. To calculate the actual allocation differences in using the different tools, that enables for a better approach.
  iv. To identify and suggest additional supporting criteria for Primavera project software and MS Project to develop 'What good likes' in resources.

About The Software Used

Primavera software - p6 professional 19(x64)

Primavera is generally termed as Enterprise project portfolio management (EPPM) Software. Primavera software has several benefits like it is one of the user-friendly software, all the resources can be optimized, it has enhanced visibility, forecasting the activities is simple, tracking the features added option benefit, it gives good collaboration, etc.

Figure 1 Logo of Oracle Primavera P6

Microsoft project software

Microsoft Project is a project management software product, developed and sold by Microsoft. It is designed to help all the project managers develop a plan, assign resources to tasks, track progress, budget management, and workload evaluation.

Figure 2 Logo of Microsoft project software

Microsoft visio

Microsoft Visio is used to create simple and complicated geometrical diagrams of different shapes. It offers a very wide range of built-in shapes, tools, objects, and stencils to work with a different project. It helps us to create 3D structures, a simple flow chart, etc., that are easy to understand and share information.
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Figure 3 Logo of Microsoft Visio

Bluebeam Revu

It is software that is used to take off the quantities by a PDF document, which helps us to estimate the cost by accurate measurements. It used vector data to mark up the measurements correctly. This software is easy

to use than AUTO CADD as all the tools required are readily available on the ribbon, thus omits the use of commands. All the mark-up measurements are down listed and can be imported back to other working tools.

Figure 4 Logo of Bluebeam REVU

Study Work Methodology Used For The Research

The methodology adopted in this project is designed by referring from various knowledge sources and Literature papers survey and thus it is framed as below.

The methodology adopted in this project is divided into three main phases. The entire project is integrated with Primavera and MS Project software, and the key reports will be generated. This generated report has been studied and populated to meet the scope and objective of the project, with a proper conclusion.

PHASE-1 Pre-Data collection

This is the initial phase of the project, where all the technical knowledge information has been collected and studied to set up the project. Works like collecting the project data as a reference model to the works. All the information has been searched through papers and the internet. A detailed study was conducted on the subjects and software skills were implemented.

PHASE-2 Data Analysis

The draft-estimated template was worked on MS-Excel to understand the rates and quantities part. All the rates used whereas per the companies' Standard schedule rates. The data gathered for the working model was inputted to Primavera P6 and Microsoft Project Software. Post which detailed data was analysed on the resource allocation navigation steps on both the tool, by implementing the lean principle tool methodology of classifying the value, non-value, and essentially non-value-added tasks.

PHASE-3 Result Analysis

The results were captured by working on a flowchart series through the MS-Visio tool, to implement the chart classification for the applied principle. Graphical representations have been worked out to justify the objective considered with proper conclusions
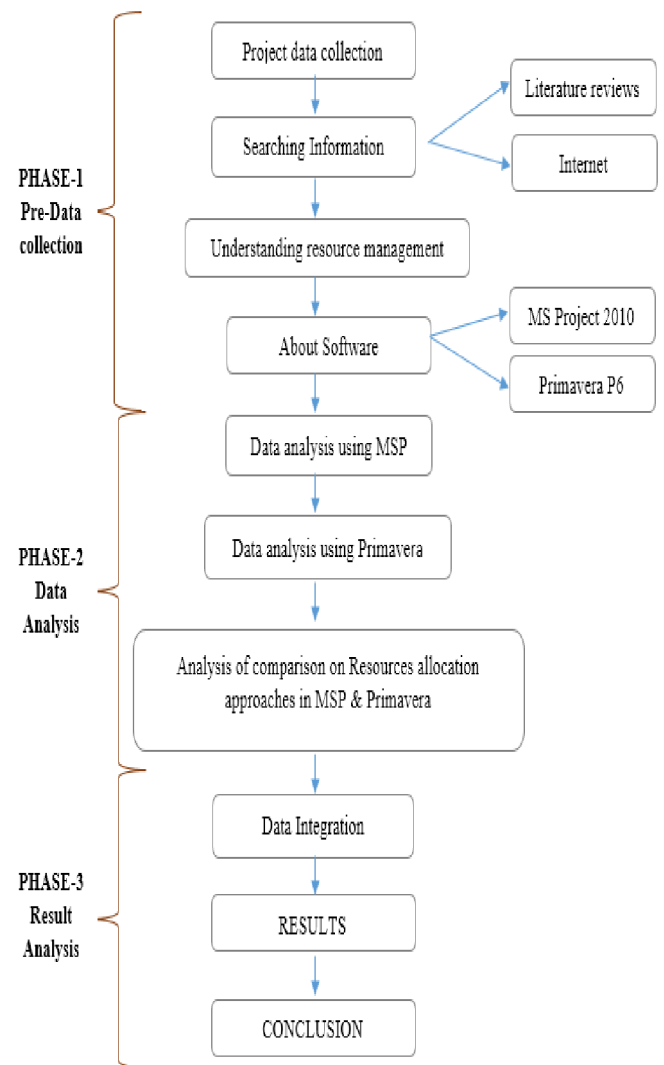
Flowchart 1 Methodology System framed for the project work

Analysis Using Microsoft Project Software
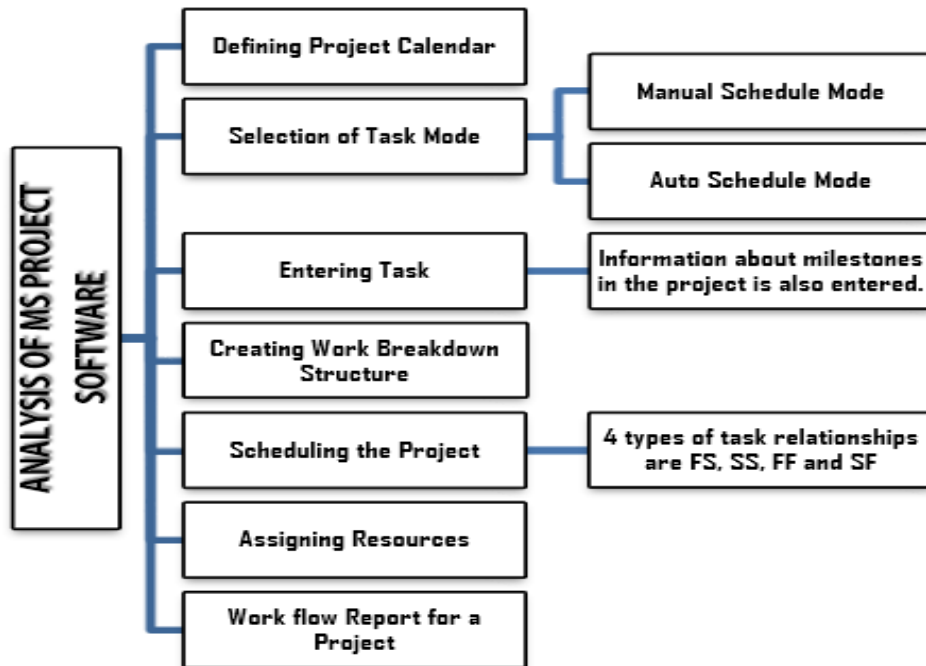
Flowchart 2 Analysis structure of MS Project software used for the project work

Analysis Using Primavera Software
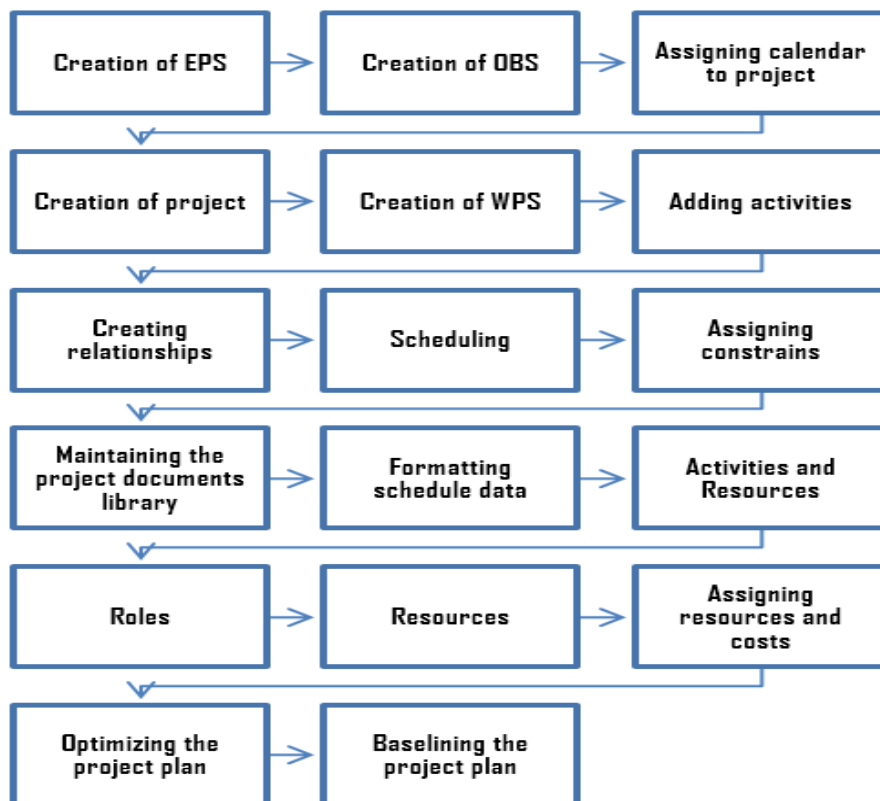
Flowchart 3 Analysis structure of Primavera Project software used for the project work

Data Integration

Lean Six Sigma

This principle was developed in 19th century, where in it is a method that is used to improve the performance of the system, by omitting or eliminating the waste system. Thus, the principle helps us to understand the framework for the overall organisation by classifying the best tasks only, which in turn add values. This principle has been developed by using six sigma and lean manufacturing principle integrated together.

One important principle of the lean six sigma is to *'understand what adds value'*

Understanding What Adds Value

All the operation steps or procedure, which are included in defining the work/project, must add value to the time used or implied. Thus, it is crucial to understand what the steps that add value to the project are. This principle not only identifies the waste but also helps us to find the errors and waste, which helps us to develop an additional supporting tool if necessary, by replacing the original. The waste in this principle refers to the defects, over production, waiting, extra processing, inventory steps, motions etc.

Therefore, based on the above theory principles this project has been developed to classify the value

added task, Non-value-added task and Essentially non-value-added task, at one point of the software used i.e. Resource allocation navigation steps in both the software's Primavera P6 and Microsoft project software.

Task Categorization

a. Value added task (VAT)

- These activities are those, which adds value to a process.
- Consumes less time for end results
- Helps in delivering the correct specified data on the results
- Represented in blue

b. Non-Value-added task (NVAT)

- These are those which do not add any value to the product
- They form a part of process, but benefits with zero results
- Represented in grey

c. Essential Non-Value-added task (ENVT)

- These are the tasks that partially add value to the tasks or end product
- They form a part of process, but benefits with minimum or zero results
- Represented in Amber

Thus, the above classification has been implemented to classify the navigation tasks on the project model and percentage have been given out.

Analysis Of Data Integration

Primavera Software

One the application of the lean six sigma principle it been analysed that it includes 42% of the value-added tasks when we work on the resource allocation using Primavera P6 software. This has been analysed in detail for every step of resource navigation to an individual task or the selected activity.

Table 1 Represents the detail of task categorization of Primavera software

	Value added task (VAT)	Essential Non-value added task (ENVT)	Non-Value added task (NVAT)
PRELIMINARIES	Project	Indent/Out dent	Based online resource
	Resource		
	Add		
	Data-Resource ID & Name		
GENERAL	Employee ID	Resource ID/name	Active status
	Title		
	E-Mail Address		
	Office Phone number		
CODES		Resource Code	
		Code Value	
		Code Description	
DETAILS	Resource Type	Profile	Create Personal Calendar
	Labour	Currency & Overtime	Default Units/Time
	Non-Labour		Auto Compute actuals
	Material		Calculate costs from units
	Unit of Measure		
	Calendar		
UNITS & PRICES	Shift Calendar		Add Shifts
	Effective date		Number of Shifts
	Max Units/Time		
	Standard rate		
ROLES		Role ID	
		Role Name	
		Proficiency	
		Primary Role	
NOTES		Resources Notes	
USER DEFINED FIELDS		Customize user defined fields	User defined field
			Data type
			Value
			Hide empty rows

Table 2 Represents the values of task categorization of Primavera software

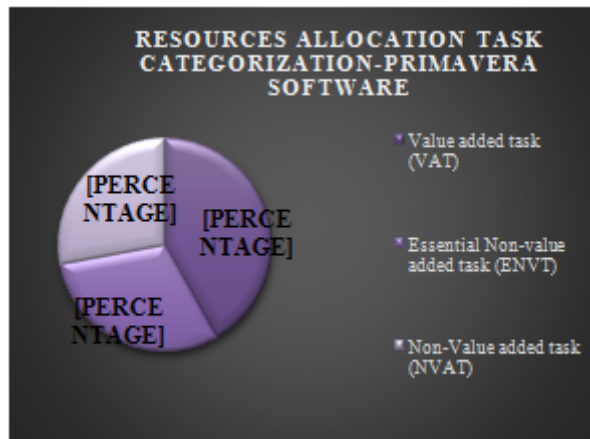|	
Value added task (VAT)	18
Essential Non-value-added task (ENVT)	13
Non-Value-added task (NVAT)	12

Figure 4 Integrated Data representation for Primavera software based on Lean six sigma

Microsoft Project (Msp) Software

One the application of the lean six sigma principle it been analysed that it includes 51% of the value-added tasks when we work on the resource allocation using Microsoft software. This has been analysed in detail for every step of resource navigation to an individual task or the selected activity.

Table 3 Represents the detail of task categorization of Microsoft project software

|	Value added task (VAT)	Essential Non-value added task (ENVT)	Non-Value added task (NVAT)
RESOURCE SHEET	Resource Name	Group	
	Initials	Additional columns	
	Type		
	Work, Material, Cost		
	Material		
	Maximum Units		
	Standard Rate		
	Overtime rate		
	Cost per Use		
	Accure At		
	Start, Prorated, End		
	Base Calendar		
RESOURCES INFORMATION	General	Material label	Resource name
	Email	Booking type	Initials
	Costs	Effective data	Group
	Cost rate tables	Notes	Code
	Generic, Budget, Inactive	Custom field	Type
	Committed, Proposed		Resource name
			Standard rate
			Overtime rate
			Per use cost
			Custom field name

Table 4 Represents the values of task categorization of Microsoft project software

Value added task (VAT)	18
Essential Non-value added task (ENVT)	7
Non-Value added task (NVAT)	10
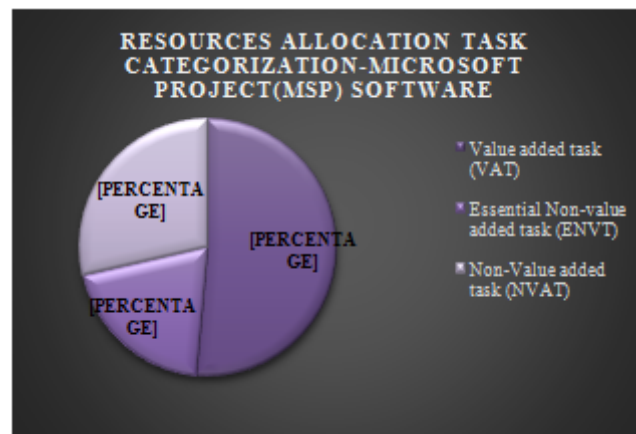
Figure 5 Integrated Data representation for Microsoft project software based on Lean six sigma

Conclusion And Further Scope
Conclusion

1. Microsoft project and Primavera P6 software are one of the leading management software tools in construction sector.
2. In MSP, there are only 11 baselines for creation of a project. The end user must use a complex formula and logics to set the functional performance. The addition column application is restricted to 40 only. Single relationship is allowed for allocation between two different task and activities.
3. In Primavera P6, we can create unlimited baselines. It is one of the best user-friendly tools with least complex set-ups involved. The additional column application is restricted to 200. It allows multiple relationship allocation between two different task and activities.
4. The paper mainly signifies the actual difference while navigating the resource allocation using the two best performance management tools.
5. The Value-added task (VAT) for resources allocation sequence in Microsoft project software was 51% and using Primavera P6

it was 42%, which was analysed at every step of the navigation.
6. Resource allocation in Primavera P6 is best suited when we have multiple projects with complex resource, and when the stakeholder asks for a line level detail of every work carried out with documentation.
7. In Microsoft project software, the resource allocation sequence is simple and minimal with some complex functional additions.

Furter Scope Of Work

1. Using Lean six sigma principle in different stages of planning and scheduling the project work, we can eliminate multiple or re-iterated navigation and allocation. This will help us enhance the time wisely and productively and should cut the complexity of the management software in principle.
2. With growing civilization and construction, it becomes a primary key factor to have the best support tools to manage the project wisely, not only on the project work budget or time, but also the amount of time invested by end users i.e. Project management human resources use their time to input the correct and precise details to the tools, to get the best results.

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References

1. S. Ragavi & r. N. Uma (2017), "Planning and scheduling of an apartment building by comparison of MS project and Primavera".
2. Shruti Singh, Shweta Istape, Amruta Surve, Sahil Pandey, Avinash Singh & Sangram More (2018), "Comparative study of planning and scheduling of a construction project using Microsoft project".
3. Joshi, R., & Patil, V. Z. (2013). Resource scheduling of construction project: Case

study. International Journal of Science and Research, 4(5), 563-568.

4. Deshmukh, S., Sagale, A., & Bais, M. (2019). Study of Scheduling In Microsoft Project Software. International Journal of Scientific Research & Engineering Trends, (5), 419-428.

5. Subramani, T., & Karthick, T. M. (2018). Study on time and resource management in construction projects using MS project. International Journal of Engineering & Technology, 7(3.10), 23-26.

6. Nagaraju, S. K., & Reddy, B. S. (2012). Resource Management in Construction Projects–a case study. Resource, 2(4).

7. Ranjeeth, S., & Latchoumi, T. P. (2020). Predicting Kids Malnutrition Using Multilayer Perceptron with Stochastic Gradient Descent. Rev. d'Intelligence Artif., 34(5), 631-636.

8. Prasath, D. S., & Selvakumar, A. (2015). A Novel Iris Image Retrieval with Boundary Based Feature Using Manhattan Distance Classifier. International Journal Of Innovative Technology And Creative Engineering (Issn: 2045-8711) Vol, 5.

9. Balamurugan, K. (2021). Fracture analysis of fuselage wing joint developed by aerodynamic structural materials. Materials Today: Proceedings, 38, 2555-2562.

10. Wajantri, B. G., & Kelkar, A. A. (2018). Application Of Microsoft Project For Resource Optimization In Multiple Project Management.

11. Pinha, D. C., & Ahluwalia, R. S. (2019). Flexible resource management and its effect on project cost and duration. Journal of Industrial Engineering International, 15(1), 119-133.

12. Patil C B, Arun Kumar C J (2019), "Planning, Scheduling, and Optimization of Labour Resources in the construction of Residential Apartment using Primavera P6 software".

CONSTRUCTION MANAGEMENT WITH FOCUS ON MAINTENANCE OF STRUCTURES

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ABSTRACT

The study aims to identify major factors affecting maintenance and problems occurring in the construction management and building maintenance and to identify the major factors affecting it.It is important to know about management in construction for any task to be finished on schedule while simultaneously yielding great quality and meeting the spending plan, a ton of preparation and the board should be carried out.The study focuses on the perpetuation issues faced by the cooperative apartment houses like repairs, plumbing, sanitation, flooring, painting etc. for this data is collected by questionnaire survey about the maintenance of structure from tenements. In this investigation after gathering set of data on maintenance problems and prime problems are identified by statistical Analysis using statistical package for social sciences software. The main objective of this study is to identify the problems being faced in a residential building and the analysing the major factors affecting the building maintenance. Analysis of factors was done using Relative Rank Index and Analytical Hierarchy process to identify the most affecting factor. All structures must be maintained throughout their lifespan. Less maintained building would have to compromise on its durability and reliability considerations, which are the most critical characteristics of a building. Thus, identification of major problems and factors are important to know the severity and then give suitable recommendations is the purpose

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Introduction

The term construction project is defined as a high-value, time bound, special construction mission with well-planned and performance objectives. Construction projects are not easy and time taking undertakings.Each structure is constructed in a unique way to suit its environment. Development of structures have gotten progressively difficult and tedious.Construction of buildings have become more tedious now. It is mainly for the construction line professionals in civil engineering where they apply their management skills and help in successful completion of project. Nobuilding or structure shall be without any maintenance but following few measures can help in keeping maintenance minimal and easy to fix. The buildings that cannot be maintained will be damaged and deteriorate further causing permanent damage. This damage is caused by human factors, such as lack of knowledge for workers on maintenance and repair work methods.

1.2. Maintenance management

Any building when constructed will certain objectives. During its economic life, the building or any structure has to be kept in good condition. Maintenance is a cyclic and continuous procedure which needs a lot of observation and coming up with a solution when in case of necessityAlmost any structure is prone to defects or damage though preventive measures are taken during the design and construction. All structures must be maintained throughout their lifespan. Less maintained building would have to compromise on its durability and reliability considerations, which are the most critical characteristics of a building. The building maintenance program should be systematic and proactive to prevent the need for regular repairs. It should have sufficient staff and budget for proper maintenance. When deterioration occurs due to various reasons then restoration it to its original state completely is impossible. An efficient team should see to that reliability and efficiency is

achieved. Repair can be defined as activity which is responsible for fixing broken damages, equipment repairs and failed devices. Some type of repairs are correcting defects like minor cracks and plaster flaking , repairing doors and windows , replacement of glass panels and electrical works.

1.3 Types of Maintenance

1. Major repair or restoration: Which includes re-roofing or rebuilding faulty walls and regularly incorporating detailing in improvement.
2. Periodic maintenance: Instances like annual contracts for decorations or repairs.
3. Regular or everyday maintenance: This is more of the preventive type, like checking rainwater gutters and servicing, mechanical and electric installations.

1.4 Causes of building maintenance problems

1. Low budget
2. Material specifications are not up to the requirement
3. When there is lack of supervision or checking during construction process.
4. Preventive maintenance is neglected
5. Faulty design and poor workmanship
6. Improper building maintenance policies and standards
7. Client's negligent attitude towards maintenance
8. Wrong selection of building material components and system.
9. Lack of understanding the importance of maintenance work.

1.5.About software

Statistical package for the social sciences (SPSS) is a software broadly used for analysing complicated statistical data. The data can be batched or non-batched type. This software can breakdown any complex data to its simplest form and analysis is done easily.it is also used to collect data from every file type and then utilize them to produce charts , tabulated reports , descriptive statistics , graphs and many more.

The advantages of analysing date with the help of SPSS software are:

1. Easy to understand
2. Time to require for data analysis is comparatively less and more accurate in SPSS
3. It is beneficial for analysing quantitative data as well as qualitative data.
4. Any graphs or charts can be generated based on the requirements of data distribution of the user
5. The possibility of the occurrence of errors is minimal.

2. Objectives

1. Identification of various factors that are affecting maintenance of building
2. Data collection and processing of the major factors by using Relative Rank Index method in SPSS software
3. Analysing and optimising the major factors using Analytic Hierarchy Process
4. Identification of major problems being faced in a residential building and giving recommendations for better maintenance in future.

3. Methodology

This research study mainly aimed to investigate the facilities provided in the given case study. It primarily focuses on the maintenance problems faced by the residents. It also aims in providing recommendations to reduce the maintenance problems and the maintenance costs. A questionnaire survey was taken through Google forms and collected data was analysed through software called SPSS.

Similarly another questionnaire survey was taken from the professionals like Academicians, Architects, and Engineers etc. to identify the major affecting factors in building maintence and was analysed through SPSS and highly affected factors were found out through analysis using two different techniques. They are: Relative Rank Index (RII) and Analytical Hierarchy Process (AHP). RII is used to know the relative importance of each factor affecting the maintenance while in AHP all the factors are organised based on complexity and importance.
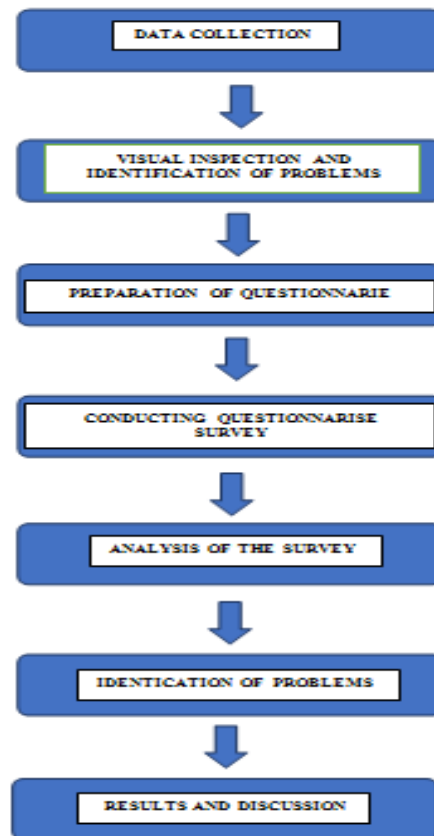
Figure1.Flow chart for methodology

3.1 Data collection

For the research work, an apartment in Sahakarnagar in Bangalore was taken up as the case study. A set of questionnaire was designed to identify the major problems the residents were facing in the apartment. Another questionnaire was circulated online to get responses from all civil engineering professionals to analyse the important factors.

3.2 Questionnaire design

Table1: Questionnaire on facilities provided

Sl.No	Questions
1	How long have been living in your current apartment?
2	How satisfied or dissatisfied are you with the house you live in terms of the building type?
3	How satisfied or dissatisfied are you with the quality of natural light?
4	How satisfied or dissatisfied are you with the quality of Artificial light?
5	Do you feel your apartment is safe and has good security system?
6	On the scale below, please rate your satisfaction with the following amenities.
7	How do you rate the infrastructure and amenities provided overall?
8	Do you utilize all the amenities provide in your apartment?
9	How often do you see the lift?
10	Frequency of water supply?

Table2: Questionnaire on maintenance issues

Sl.No	Questions
1	Which season do you face more maintenance issues?
2	Is the budget allocated for maintenance properly being utilized?
3	Do you face issues regularly with respect to the lifts?
4	Where do you find the leakage problems the most?
5	Do you face seepage issues in your flat?
6	Are the seepage symptoms wide spread or discrete?
7	Have you faced any property/material damage due to dampness?
8	Are the power failures immediately addressed and fixed?
9	Have you found any of the following symptoms on your apartment walls?
10	What are the minor maintenance problems you are facing in your apartment?
11	Does your apartment have an automatic maintenance problem identification system?
12	Is the increase in maintenance cost every year being justified and fixed accordingly?
13	Do you have any suggestions about the maintenance works for your apartment from your point of view

## Table.3: Questionnaire on maintenance factors

Sl.No	Criteria
1	Lack of preventive maintenance(maintenance culture).
2	Faulty workmanship during construction maintenance.
3	Design deficiency affecting building resolution/Outcome.
4	Use of substandard materials and building components.
5	Insufficient funds to mauntain the building.
6	Ignorance about the basic properties of building materials and components.
7	Unavailability of skilled maintennace team.
8	Lack of building maintenance standard and policy.
9	Client's attitude to maintenance.
10	Poor management of maintenance group.
11	Use of new/alternate material and components in building as per engineering standards.
12	Low concern to future maintenance.
13	Delay in occupancy after completion.
14	Incorrect selection of building material component and system.
15	Inappropriate behaviour of occupants.
16	Lack of communication between maintenance contractors, clients and users.
17	Advanced technology and design as per current engineering standards.
18	Non availability of replacement parts and components.
19	Lack of understanding the importance of maintenance work.

4. Results and Discussion

From the following pie chart, it can be depicted the major maintenance problems in building/ apartment. The responses werecollected, analysed and major problems were derived based on the survey conducted. It shows that
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34% of the responses have leakages and plumbing works as the main reason for maintenance problems. Whereas 26% for the building amenities, 22% include other problems like floor works, painting works etc. And 12% for the lifts maintenance

Figure 2: Percentage of each problem identified from the questionnaire.
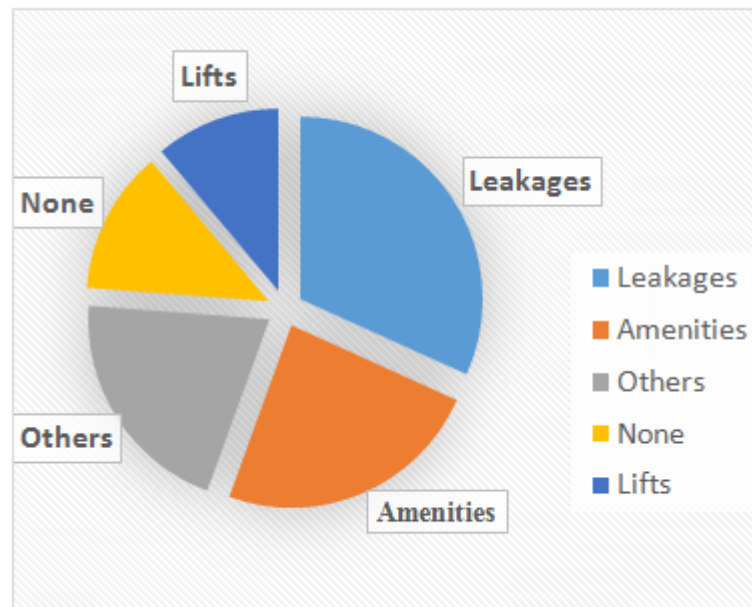
It thus depicts that leakages, amenities and other factors are the major problems that was identified through analysis from SPSS

4.1 Identified problems in apartment

According to the above studies, many problems were noticed in the apartment and recommendations were provided. Respondents mentioned that improper communication between maintenance managers and professionals andengineers would lead to unsatisfactory output. The residents faced major issue with leakages, property damages due to dampness, and residents living in lower floors had ventilation problems, electrical issues like faulty switches and lights , addressing power cuts etc. , no proper access to all the amenities was the major problem faced in the apartment. The management team also mentioned about sunken floors, no solar water heater, no proper security system, fire safety is not effective, no intercom facilities etc.

4.2 Relative Rank Index

The obtained data has to be analysed. Thus this technique is used for comparing between the importance's of every variables. The variables are represented with Likert scales which range from 1 to 5 explaining the importance of each variable obtained from respondents which have to be converted into RRI factor with a value of either one or less. Higher the value, more important was the factors affected.

Relative index ranking can be derived by using the given equation:

$$\text{RRI} = \frac{1}{nN} \sum_{i=1}^{n} l_i x_i$$

4.3 Major factors affecting themaintenance of any structure

This study presents the identification of the different factors affecting the building maintenance. Here nineteen factors have been identified and ranks were given based on the RRI factors.

Table 4: Factors with their ranking

Rank	Criteria	RRI%
1	Design deficiency affecting building resolution/Outcome	82%
2	Faulty workmanship during construction/maintenance	81.4%
3	Use of substandard materials and building components	80.7%
4	Lack of understanding the importance of maintenance work	77.8%
5	Lack of communication between maintenance contractors, clients and users.	75.2%
6	Incorrect selection of building materials and components	74.5%
7	Ignorance selection of building material component and system	72.7%
8	Unavailability of skilled maintenance team	71.6%
9	Poor management of maintenance group	71.2%
10	Lack of preventive maintenance(maintenance culture)	69.4%
11	Lack of building maintenance standard and policy	69%
12	Non availability of replacement parts and components	69%
13	Client's attitude to maintenance	69%
14	Insufficient funds to maintain the building	67.6%
15	Low concern to future maintenance	65.8%
16	Advanced technology and design as per current engineering standards.	60%
17	Inappropriate behaviour of occupants	58.9%
18	Delay in occupancy after completion	57.8%
19	Use of new/alternate material and components in building as per engineering standards	55.6%

4.4 Analytical Hierarchy Process

Also termed as AHP technique is a decision making tool or technique widely used for calculating and rearrange the relative weights of factors in accordance with their priorities and break large complicated problems into smaller fragments and make it much easier.

Steps to be followed for preparing a comparison matrix:

- Evaluation of weightages is done by specifying the set of criteria.

- The consistency ratio should be less than 0.1If it is more than 0.1 then change the pair wise comparison matrix with different importance scale values or the comparison

- Formulate a pair wise comparison matrix with set of criteria (n× n) using Saaty's scale of pair wise comparison.
- The pair wise comparisons are done in terms of which most important element is chose amongst the two.
- Determine the relative importance of each factor to accomplish priority weightages.
- Calculate the Eigen vectors and find their consistency index based on their Eigen value.
- Then calculate the consistency ratio.

Table 5: Factors considered

Factors	Values
Principal Eigen value	10.1
Size of matrix (n)	9
Consistency index (CI)	0.137
Average random consistency for a 9*9 matrix (RI)	1.45
Consistency ratio (CR)	0.094

The Consistency Ratio value should be less or equal to 0.1. Only then the inconsistency is acceptable. The Consistency Ratio should not be greater than 0.1. If it is greater, then the vectors should be revised according to the conditions.

- Thus it is observed that design deficiency is the first and major factor that affects a building maintenance.
- The second most important factor is faulty workmanship either during construction and while maintenance.
- Use of incorrect materials, lack of maintence and lack of communication between the professionals have been listed as the top five factors according to the respondents.
- Whereas inappropriate behaviour of occupants, delay in occupancy and usage of alternate materials are termed to be the least affecting factors according to the respondents.

5. Recommendations

The following recommendations should be considered or implemented for minimizing maintenance problems:

1. Introduce effective maintenance performance evaluation system through authorised maintenance department.
2. Perform periodic condition assessment / regular surveys on the problems faced for prioritization of maintenance work is determined.
3. Using planned preventive maintenance practice is preferable rather emergency or condition based maintenance.
4. Maintenance department should implement maintenance tasks into a fixed system and keep record of all maintenance works manually or by digital mean. The preventive maintenance should be checked to improvise it in future.
5. Develop building maintenance culture
6. Manage adequate building maintenance fund.
7. The maintenance cost of buildings can be reduced considerably by taking precautions from the designing stage itself.

6. Conclusion

- The maintenance management of any structure is necessary to ensure safety of the structure and for its life cycle. Identification of problems and evaluating them is the first step towards improvement and development of maintenance management.
- Building maintenance works consists of all administrative, managerial actions and technical with effective and efficient program. Building elemental and service related maintenance problems such as plumbing , electrical , sanitation , finishing ,peeling of paints , cracks and many more seems to be the most common problems being faced.
- Therefore, the main aim of this study is to highlight the significance of building maintenance. The focus is to find out the major problems being faced in regular operation and maintenance of the particular case study.
- Through Questionnaire survey it was easier to find out the major factors that contribute for building maintenance and thus focus on those majorly
- Through the second survey conducted and analysis on SPSS, we were able to find out the major problem being faced by the residents. Suitable recommendations were given in order to minimize the maintenance costs.
- AHP is a decision making technique widely used for calculating and rearrange the relative weights of factors in accordance with their priorities. A questionnaire survey from civil line professionals and tenants conclude that "manpower input" is considered as a main criteria for building maintenance studies.
- Buildings and facilitates provided, that aren't well maintained can result in discomfort and result in injuries and harm to the users.

References

1. Arts, R. H. P. M., Knapp, G. M., & Mann, L. (1998). Some aspects of measuring maintenance performance in the process industry. Journal of Quality in Maintenance Engineering.
2. Alshehri, A., Motawa, I., & Ogunlana, S. (2015). The common problems facing the building maintenance departments. International Journal of Innovation, Management and Technology, 6(3), 234.
3. Waziri, B. S., & Vanduhe, B. A. (2013). Evaluation of factors affecting residential building maintenance in Nigeria: users' perspective. Civil and Environmental Research, 3(8).
4. Au-Yong, C. P., Ali, A. S., & Chua, S. J. L. (2016). Interval of routine maintenance and maintenance performance: a literature review. In MATEC Web of Conferences (Vol. 66, p. 00007). EDP Sciences.
5. Dhillon, B. S., & Liu, Y. (2006). Human error in maintenance: a review. Journal of quality in maintenance engineering.
6. J. Bhattacharjee (June 2016)"Repair and Rehabilitation of RCC for sustainable development with case studies" Civil Engineering and Urban Planning: An International Journal (CiVEJ) Vol.3, No.2,
7. Ranjeeth, S., & Latchoumi, T. P. (2020). Predicting Kids Malnutrition Using Multilayer Perceptron with Stochastic Gradient Descent. Rev. d'Intelligence Artif., 34(5), 631-636.
8. Prasath, D. S., & Selvakumar, A. (2015). A Novel Iris Image Retrieval with Boundary Based Feature Using Manhattan Distance Classifier. International Journal Of Innovative Technology And Creative Engineering (Issn: 2045-8711) Vol, 5.
9. Balamurugan, K. (2021). Fracture analysis of fuselage wing joint developed by aerodynamic structural materials. Materials Today: Proceedings, 38, 2555-2562.
10. Mohd Nawi, M. N., Salleh, N. A., & Anuar, H. S. (2014). A review study of maintenance and management issues in IBS commercial building. International Journal of Computer Informatics & Technological Engineering, 1(1), 1-5.
11. Rafiq, M. I. (2015, October). Structural health monitoring for maintenance management of deteriorating structures: Current practice and state of the art. In Proceedings of the 2nd International and 6th National Conference on Earthquake & Structures, Kerman, Iran (pp. 14-15).
12. Reddy, P. B., Reddy, B. R., & Asadi, S. S. (2018). Evaluation of Maintenance Management in Construction to Reduce the Maintenance Cost. International Journal of Mechanical Engineering and Technology, 9(3), 2018.
13. S. Arunachalam ,Anna University , "Maintenance Management for Buildings" , "Twelfth AIMS International Conference on Management" .

COST OPTIMIZATION OF RCC BUILDING BY MODERNIZING EQUIPMENT'S USING PRIMAVERA

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ABSTRACT

Construction works are ultimate objective of a design and this transformation of a design by construction to achieve successful structure in integration of labour and machines, which transform a project into a reality. The non mechanical process of construction work requires huge number of labours and consumes more time sometimes labor cost is accountable for the rise in cost of construction work, The standardization of work is mainly relayed on the expertization of the labour. Where in semi mechanical machines makes the work effortless, secure & rapid. Thus minimal skilled labours are required for handling. This paper determines the integrated study of non mechanical and mechanical based construction, The automatic wall plastering machine & stirrups bending machine are taken into consideration for an RCC building as a case study. The comparison of budgeted cost of the building model is been carried out using primavera P6

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Keywords: Mechanical machines, Non mechanical, Optimization, Project management, Primavera..

Introduction

Construction venture entail transform the specified plan developed by an engineer or architect into a complete project. Construction revolt has made the builder provide their construction such as maximum output with minimal construction cost as possible. In order to have maximum output of the construction work parameters like perfection, distinct and exactness .This is possible either by the skilled workers or by automatic mechanical machines work by the non mechanical skilled workers takes long time and sometimes results in under efficiency .So it is preferable to make the work as a automatic system for large construction work using new automatic mechanical machines available in the market. Thus make the work possible to have perfection, distinct and exactness. The builder is also concern about the safety of the workers. This automation of the work will give a solution for safety to the worker in the site. The increase in demand of the construction. The builder has to increase their construction with good quality to carry on the further constructions in the market .In order to obtain the good quality of the construction work requires skilled workers where as for the large construction required more number of skilled workers and results rise in cost of the construction work and also sometimes there will be a shortage of the skilled workers. Thus motivating the automation in construction industry.

Objectives of the project

i. To study factors supporting choice of building equipment

ii. To study the automatic mechanical machines their operation, productivity, speed, and cost of the machine.

iii. To study a project management tool primavera p6 to make use of accomplishment of the project.

To calculate the actual difference in cost of non-mechanical work and the mechanical work of construction for a particular building

About primavera

In major construction projects the numerous tasks are involved in the project with huge budget, it becomes difficult to manage the numerous tasks manually by the project team.

Thus it is useful to handle a management software tool primavera p6. It enables better planning and control over the entire project tasks and also the project budget management. The major desire of this paper is to focal point on the difference of budgeted cost of the building when it is constructed using automatic mechanical machines and non mechanical machine or skilled workers using primavera.

Factors Supporting The Choice Of Construction Equipment:-

Some of the factors supporting the choice of construction   equipment are listed below

i. **Economic consideration:** Owning cost and fuel cost are the most necessary in selection of equipment vend value, replacing cost of existing   equipment and retrieve value of equipment is also important.

ii. **Company specific:** The choice of equipment by company may be control by its plan on owning or renting. When it comes to owning it result in purchasing of equipment considering the future need of projects. When it comes to renting can be attentive on short period of benefits.

iii. **Operating requirement:** The equipment being purchased should be not difficult to operate and it should consume less fuel and it should have good retrieve value at the period of its disposal.

iv. **Manufacturer specific:** A company may like better to purchase equipment from the same manufacturer afresh and new this may lead to get consistency in the tools fleet by the company or the company is intimate with the working style of the equipment.

v. **Labor consideration:** Sometimes there will be a shortage of manpower will lead to decide in good turn of acquire automated equipment. Further, the choice of the equipment may be control by the accessibility or non-accessibility of trained manpower.

Literature review

Abdullah azmi , DR, Syed khursheed ahmad, mohd danish (2017) [1], "selection criteria of equipment in construction project" In this paper the authors have explained that equipment plays a necessary role in the construction industry .Thus considering newly discovered automatic machines in the project which speed up the construction work and reduce effort of the labors. The comparative analysis between the manual work and the automatic machine have been done finally concluded that machines can reduce the specified time which is much more required for the manual work.

Prajeesh.v.p, **Mr.N.Sakthivel [2016] [2**], "Management of equipment and machinery in construction" This paper is to study how to handle the equipment in construction industry and comparing the equipment handling plans with a case study of a construction industry. A questioner survey has been carried out to understand about the equipment management plans in the construction industry and it has been analyzed using tool (spss). Sobha city project is considered as a case study. In sobha company there is a separate department for equipment management. This a group of workers mechanics and engineer guide by the project manager. The project manager is in charge for taking decisions and to interrelate with the head office. This paper concluded that one third of the construction industry have maintained a document plans and the major aim of the management plan is to improve the resources and build up the profits and management plans of the builder   and construction industry to India advise that they reach the aim of superior management and stick to the finest plan suited to their condition.

M. Manikandan, prof. M .Adhiyaman, DR. K.C Pazhani (2018) [3], The carried out a work on " A study and analysis of construction equipment management used in construction projects for improving productivity" The set of questionnaires survey carried out for 15% major companies in India and collected the data analyzed the result using RII method. This paper concluded that the production output is attained by the major equipment availability, To upgrade productivity it is necessary to improve the production of the construction quality of control resource management, site planning constructability are the most powerful management related factors that directly effects productivity.

Mr.Mundada yogesh, Daunge Gajendrakuma, Ghuge Rahul, Gaikwad Kiran, Prof .Savant sachin (2018) [4],The carried out a work on " Review paper on design of automatic wall plastering machine" This paper aim to propose a quiet approach of plot a plastering machine by automation Automation is one of the best technology among all. The goal of this plan is to rendering the wall plastering mechanically. This approach reduces the effort of the labors. This automation machine is simple easy to operate and light weight. This conception will also reduce a 20% of raw material conclusion of this paper is development of this method of wall plastering in the construction industry will reduce the problem of shortage of worker and quality of construction can be maintained with minimal wastage of materials.

Magbert Fernandes, Prescily Morais, Devanand adelkar, Branzio Dacosta, Aaron Desouza, Dr.h.k amaranth (2019) [5] "Rod bending machine for   variable stirrup sizes", This paper explains that in construction works bending of rod is very essential, bending of rod making manually wastes time and effort of the labour.Hence replaces manual work to the machine work into the construction sector. In this project only the labor work is to loading and unloading the rod from the machine. Stirrups of different sizes can be made using this machine.This paper concludes that utilizing machine in construction work reduces time with maximum efficiency in work.

 Chiranjeevi D.S,Dr.G Narayana,Rajeeva S.S (2017) [6],They carried out study on "Analysis on cost, schedule and tracking of residential project by earn value management method using primaverap6".In this paper G+10 apartment with 2 blocks A and B are considered as a construction project. The project is tracked to obtain values of planned value(PV) actual value (AV) and earned value (EV) was scheduled using primavera p6.This tool is used to analyses cost schedule and project tracking also PMBOK will provide a plans to maintain a project in a best manageable way. The paper gives conclusion to complete project on actual time, project has to achieve 1.02% of quickness of planned value on the third tracking duration 138 days are left to finish all the activities. The schedule

performance index was 98% as planned value this indicates that project is under planned schedule.

 Rajat, Masoom reza,(2019) [7],They carried out a study on "Time and cost control using primavera p6 in construction of contractor just by using". In this paper the project was scheduled using primavera p6 and was undertaken for an residential building (G+2) to display how proper planning and scheduling is done using tool primavera p6.The conclusion was 40 days can be reduced by an contractor just by using planning software tool and the contractor will face a loss of about 25.5% without proper planning and scheduling this problem can overcome just by using a proper tool for planning scheduling and tracking of the project.

Methodology

To attain the objectives the methodology is adopted in the project and stated as a flowchart.
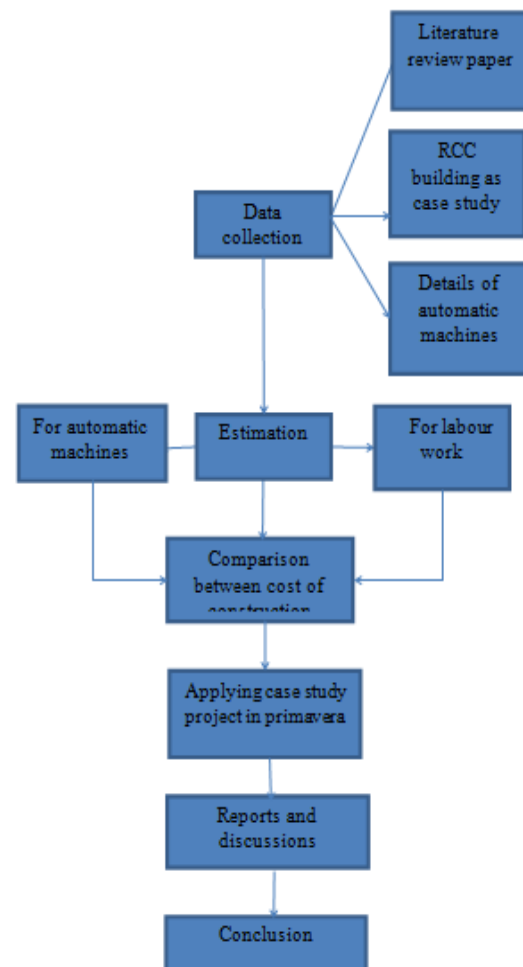
Flowchart-1 Shows the methodology of the project

and finally compared with the cost of construction.

Data collection:

i.   Collected literature papers related to the title of the project.
ii.   RCC building (G+2) duplex is considered as case study, related these drawings and details about the site and construction are collected
iii. Automatic mechanical machines
a.   Automatic wall plastering machine
b.   Automatic stirrup bending machine

Their productivity, capacity, speed, cost of the machine and workers required to operate machine all these information   are collected by referring from various literature papers and also from the internet sources.

Detailed estimation:

Estimation of (G+2) duplex building is carried out to know the cost of construction. The wall plastering and stirrup bending manual works are replaced by the automation system, Thus replacement of manual work to the automation cost of construction of building will vary hence revised the estimation work of G+2   building

Software:

(G+2) duplex building which is considered as a case study of the project is been planned, scheduled in primavera and proper resources are allocated, analyzed and leveled based on the working as in this project study some of the manual work in construction site is replaced with the automation system hence the budgeted cost and time of construction will vary based on that reports will be generated reports will be studied and populated to meet the objective of the project and proper conclusion will be framed.

Details of Automatic Machines

Now days in construction sectors are highly motorize to speed up the construction projects there are various different types of equipment's are available in market which is useful in construction industry.

Two machines considered for this project study are listed below.

i.   Automatic stirrup bending machine
Automatic wall plastering machine

Automatic Stirrup Bending Machine

Figure-1: Automatic stirrup bending machine

D2N sona automatic stirrup making machine the front panel of this machine is made up of chromium steel and it has 2 motors on operating unit. This makes the machine to work at a speed of 150m/min. Machine is fixed with a gather flap, cable inlet unit, anti twist device in internal unit. Maximum feeding speed is 70m/min, Net weight of machine is 1900kgs and it produces 200x200 mm units stirrups in 2 seconds and 4000 stirrups per hour

Automatic Wall Plastering Machine

Figure-2: Automatic wall plastering machine

This wall plastering machine is very much request for construction field. The wall plastering machine works with the standard cement mortar which gives smooth flat finish to the wall. The thickness can be adjustable to suit each application.

Working process:

The machine should be set near to the wall that as to be plastered, place the machine in horizontal position. Then the cement mortar is poured into the hopper. The machine lifted up with the help of rails, the mortar to the inclined portion/plane and then the mortar sticks to the wall by the pressure of the machine on the wall. When the machine moves downwards makes the plaster smooth on the surface of wall. Machine as two rails for moving automatically hence it can be used for different width and height of the wall

Table 1 comparison between manual and machine of stirrup bending

Specification	Manually	Machine	Outcome
Price	Rs.87.5	Rs.1240	
No of stirrups	30	4000	
Time	1 hour	1 hour	Benefit of Rs.2.59 over by machine
Cost of 1 stirrup	Rs.2.9	Rs.0.31	

**Chart 1 Manual and machine work of stirrup bend**
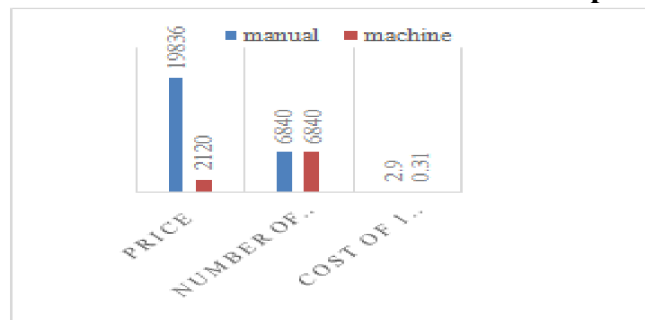
Comparision Between Automatic Wall Plastering Machine And Manual

- Suppose if we buy this machine for 5 years its price is Rs.2,50,000
- Calculating it per hour will cost around
- Rs.7.00 per hour inclusive of worker charges and power charges.

Table 2 comparison between manual and machine of plastering work

Specification	Manually	Machine	Outcome
Price	Rs.150	Rs.18.75	
Plastering quantity	50sqft	538sqft	
Time	1 hour	1 hour	Benefit of Rs.2.97 over by machine
Cost of plastering of 1 Sqft	Rs.3	Rs.0.03	

Chart 2 Manual and Machine work of plastering
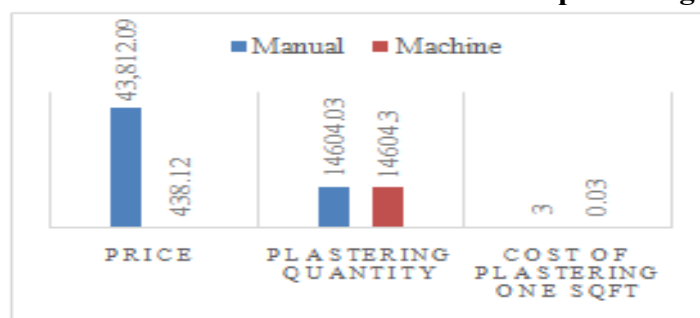
About The Case Study Model

i.   Case study model considered for the works-DUPLEX VILLA OF G+2.
ii.   Location of building-Srirampura, penn field gardens Bangalore.
iii. Total Gross area-5500 Sqft.
iv.   Estimated budget-Rs.16,299, 979.685.3

Details Of Stirrup

Formula for calculating number of stirrups

Number of stirrups- $\dfrac{\text{Total length}}{\text{c/c distance}} + 1$

Table 3 Total number of stirrups

TOTAL NUMBER OF STIRRUPS		
Sl.no	**Description**	**Number of stirrups**
1	Column	3204
2	Plinth beam	376
3	Lintels	1049
4	Roof beam	2211
5	**Total**	**6840**

Table 4 Comparison between manual and machine work of stirrup making

COMPARISION BETWEEN MANUAL AND MACHINE OF PLASTERING WORK			
Specification	**Manual**	**Machine**	**Outcome**
Plastering quantity	14,604.03 Sqft	14,604.03 Sqft	Benefit of Rs.43,373.97 over by machine
Cost of plastering 1 Sqft	Rs.3.00	Rs.0.03	
Amount	Rs.43,812.09	Rs.438.12	
Duration	12days	2 days	

Table.5 Comparison between manual and machine work of plastering

COMPARISION BETWEEN MANUAL AND MACHINE WORK OF STIRRUP MAKING			
Specification	**Manual**	**Machine**	**Outcome**
no of stirrup	6840	6840	Benefit of Rs.17,715 over by machine
Cost of 1 stirrup	Rs.2.9	Rs.0.31	
Amount	Rs.19,836	Rs.2120	

Table 6 Total quantity of plastering work

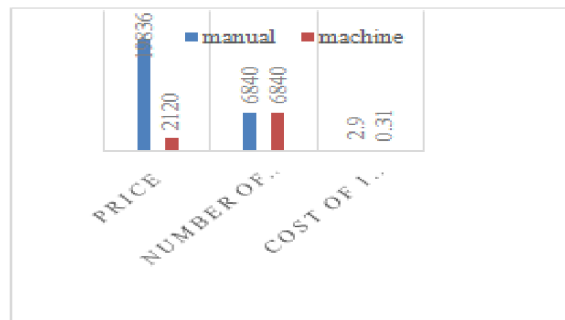| TOTAL QUANTITY OF PLASTERING WORK		
Sl.no	**Description**	**Quantity of plastering work in Sqft**
1	Ground floor	5132.7
2	First floor	5845.95
3	Second floor	3625.38
4	**Total**	**14604.03 Sqft**

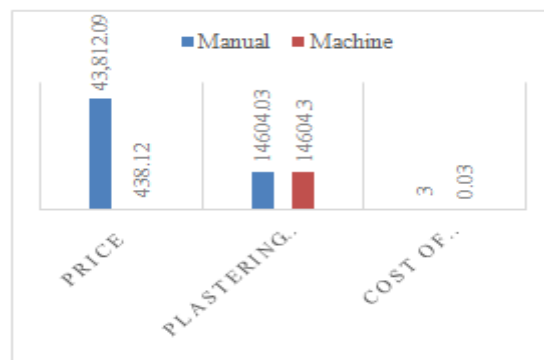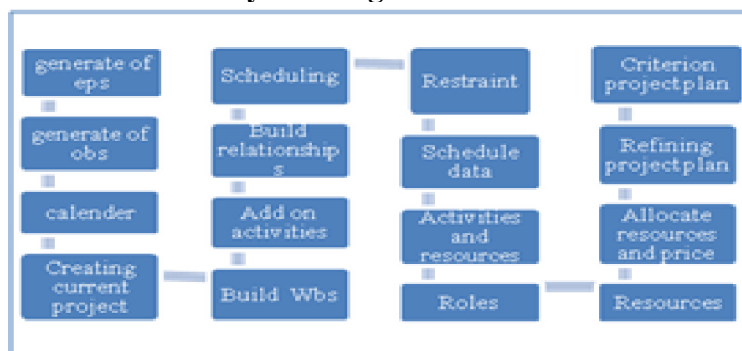**Chart 3 Difference between manual and machine work of stirrup bending**

Chart 4 Difference between manual and machine of plastering work

Analysis Using Primavera P6

The above flowchart explains the sequence of analyzing of a project in primavera p6.Primavera has a several features which permits it to track price, schedule and allocate resources
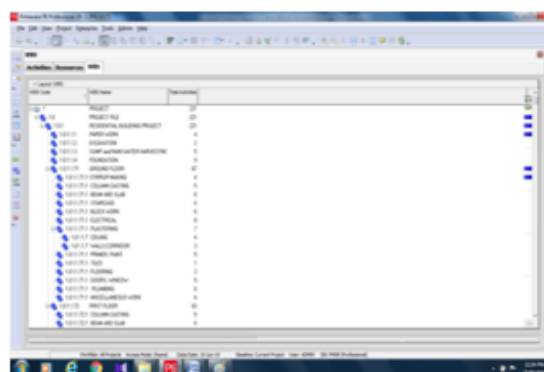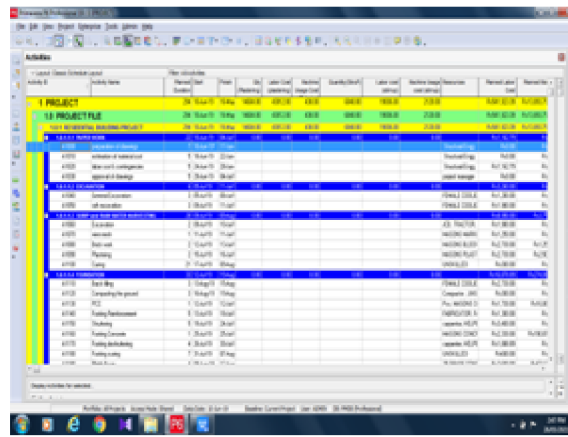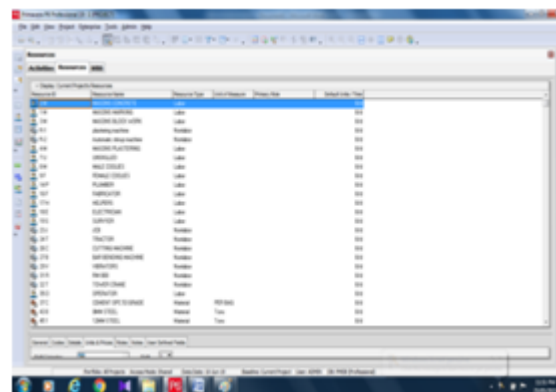

Figure-1WBS
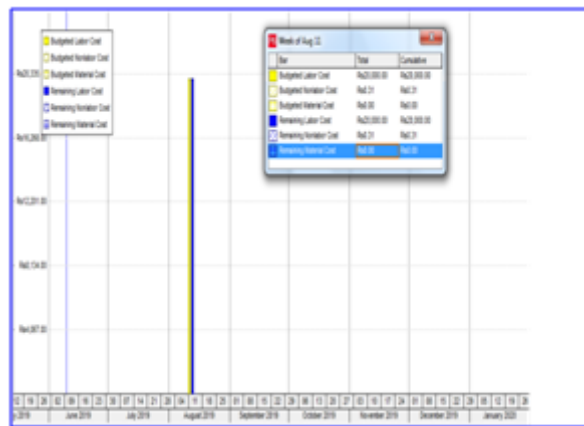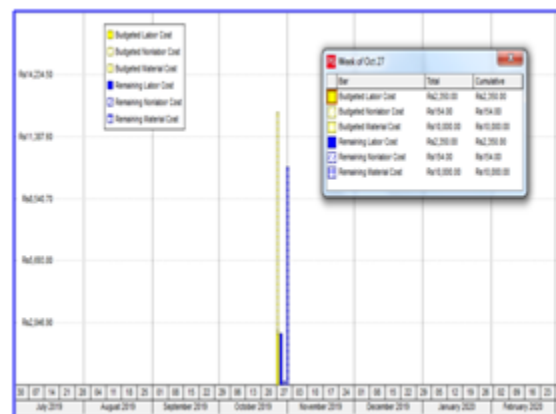
Figure-2 WBS and Activity

Figure-3 Resources of project

Results And Discussions

Graph-1 Activity usage profile of wall plastering machine with cost
Graph-2 Activity usage profile of stirrup bending machine with cost

i.   (G+2) duplex of overall area 5500 Sqft. Project is analyzed in primavera p6,In this study automatic stirrup bending and plastering machine is adopted in place of manual work.

ii. The results obtained using automatic machines the optimization of project were verify by differentiate it with results acquire by manual work.

iii. For the activity of plastering work actual duration is 29 days when the task is completed using automatic machine the duration reduced to 2 days

iv. For the activity of stirrup making manually it takes around 10 days when this activity is done using machine it reduced to 2hours.

v. Cost comparision of plastering and stirrup making machine is done by manually and also in primavera.The results obtained is for the plastering work manually is found around Rs.43,812.09 and were has using machine it cost around Rs.438.12 for same quantity of plaster.

Similarly for stirrup bending the results found are manually it costs Rs.19,836 were has using machine it costs Rs.2120 for same number of stirrups.

Conclusion

i.   According to my research study, machine plays a vital role in today's scenario they are very challenging and motorizing the projects which finishes the task in specify time with effortless, secure and perfection of the task with less wastage of material

ii. Proper choice of the machine or any equipment is also very necessary in construction because it directly effects the cost of the construction work.

iii. It is important for the contractors and site managers to know the factors supporting the selection of construction equipment before selecting any machine or equipment for the construction.

iv. By the application of the (G+2) duplex project in primavera it gives an idea of proper planning, monitoring, controlling and timely finish of a project.

v. This can be concluded that primavera p6 software is most useful for the project manager for managing the project in proper way.

vi. The use of automatic wall plastering and stirrup bending machine for the case study (G+2) duplex. Based on the results obtained could like to conclude that overall budgeted cost of the building reduced to 10 % .

vii. When it is compared with the individual activity plastering work it is found that 98 % reduction and 12days reduction in duration. Were as for the stirrup bending activity results found that 89 % of cost reduction and 10 days reduction in duration.

viii. The case study project considered for the project is (G+2) duplex having area 5500 Sqft, it is small project consists of only 221 activities .For this small project of case study using automatic machine for only 2 activities that is plastering and stirrup bending machine overall budgeted cost found 10 % reduction.

ix. Suppose If we consider bigger project of larger area and with more number of floors then nearly 20 to 25% reduction can be found in cost of construction.

x. For this small project plastering work completing it manually duration found to be 12days but completing it using machine reduced to 2days if this automatic machine is taken into account for the larger construction duration will reduce around 1 or 2 months.

xi. In this project bending stirrups manually the duration is around 10 days by using machine it is only 2 hours if we consider this machine for the bigger project which takes 2 years to complete the project then simply by using this machine 2 or 3 months can be reduced.

xii. Finally like to conclude that using automatic machines for any   project

completes the work in specify time along with higher productivity and standard of .

work with lesser wastage of material

References

1. Kanchana, S., Niranjan, V., Kavitha, S., & PremKumar, S. A Study on Equipment Management and its Effects on Construction Projects.

2. Rukijkanpanich, J., & Pandara, S. (2021). การ วิเคราะห์ นโยบาย การ จัดหา เครื่องจักร สำหรับ ธุรกิจ สร้าง ถนน. *Engineering Journal of Research and Development*, *32*(2), 129-144.

3. Manikandan, M., Adhiyaman, M., & Pazhani, K. C. (2018). A Study and analysis of construction equipment management used in construction projects for improving productivity. *Int. Res. J. Eng. Technol.*, *5*, 1297-1303.

4. Mr.Mundada yogesh, Daunge Gajendrakuma, Ghuge Rahul, Gaikwad Kiran, Prof .Savant sachin (2018), " Review paper on design of automatic wall plastering machine".

5. Ranjeeth, S., & Latchoumi, T. P. (2020). Predicting Kids Malnutrition Using Multilayer Perceptron with Stochastic Gradient Descent. Rev. d'Intelligence Artif., 34(5), 631-636.

6. Prasath, D. S., & Selvakumar, A. (2015). A Novel Iris Image Retrieval with Boundary Based Feature Using Manhattan Distance Classifier. International Journal Of Innovative Technology And Creative Engineering (Issn: 2045-8711) Vol, 5.

7. Balamurugan, K. (2021). Fracture analysis of fuselage wing joint developed by aerodynamic structural materials. Materials Today: Proceedings, 38, 2555-2562.

8. MagbertFernandes,Prescily Morais,Devanand adelkar,Branzio Dacosta,Aaron Desouza,Dr.h.k amaranth (2019), "Rod bending machine for variable stirrup sizes",

9. Chiranjeevi D.S,Dr.G Narayana,Rajeeva S.S (2017), They carried out study on "Analysis on cost, schedule and tracking of residential project by earn value management method using primaverap6"

10. Rajat, Masoom reza,(2019),They carried out a study on "Time and cost control using primavera p6 in construction of contractor just by using".

CRITICAL THINKING IN UNIVERSITY STUDENTS THEORETICAL REVIEW

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ABSTRACT

The objective of this research is to analyze and reflect on critical thinking in university students in the range 2009-2021. In order to review the literature, 33 articles were examined, of which 21 articles obtained from the open access databases: Scopus, Ebsco and Science direct; in English and Spanish were analyzed. The search equations were: "critical thinking" AND "university student", and in English: "critical thinking" AND "university student". In addition, the analysis focused on the psychological, philosophical, social and innovative aspects of thinking, critical thinking as a competence and the level of critical thinking in universities. The results show that teachers and students vaguely understand the meaning of critical thinking; likewise, it is established that the critical thinking of university students is at an intermediate and low level; in addition, the working world demands professionals with competencies in critical thinking, problem solving and decision making. Consequently, students should develop skills that allow them freedom of expression, participate in debates and time to reflect, in order to make good personal, professional, labor and political decisions.

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Keywords: *Autonomy, argumentation, active learning, metacognition, competence.*

Introduction

In the literature of critical thinking, it has its origins in philosophy and psychology, later it arises in the context of education. At the same time, philosophy sees the critical thinker based on his qualities and characteristics, while psychology sees the critical thinker based on his abilities or actions, just as education is framed in the teaching and evaluation of skills, including skills. The main concepts of critical thinking are those that make up decision-making, judgment and reasoning (Carbogim et al., 2016).

Likewise, teachers define critical thinking in six categories: capacity for analysis and organization, reasoning and argumentation, questioning and inquiring, evaluation, positioning and decision-making, action and commitment. Additionally, the competition does not end in the classroom, but is transferable for the entire life of the student (Bezanilla-Albisua et al., 2018).

However, the activity of thinking critically allows to make rational and contextualized questions to the subject that is being dealt with, hence, one could have different positions; There may even be poorly constructed arguments and inconsistencies, all of which depends on experience (Tamayo et al., 2020).

Similarly, critical thinking encompasses intellectual processes such as conceptualizing, applying, analyzing, synthesizing, and evaluating; However, when critically processed through observation, reasoning and reflection serve for rational guidance and belief (Scriven & Paul, 2015, cited in Fandiño et al., 2021). Hence, critical thinking could be exercised through reading and writing (Fandiño et al., 2021)

Additionally, it is evident that in current research there is no consensus between educators and researchers regarding the definition and instruction of critical thinking, in this sense, it could encompass one or more components such as informal logic, metacognition, problem solving, and media literacy (Mena, 2020).

We also see that critical thinking is multidimensional in nature and cannot be approached with a single educational medium, however, it is a transversal work of educational means focused on the way of thinking and with actions in textual typologies such as narration, description, explanation, argumentation and dialogue, in a way that would help the development of thought (Mena, 2020). Along the same lines, every person who has developed critical thinking shows the following characteristics: openness to change, cognitive

simplicity, free thinking, intellectually integrity, trusts their criteria, self-motivation and willingness to change (Guevara et al., 2019).

Importantly, the most significant technological learning means for increasing critical thinking are, among others: 3D projects, 2.0 tools (personalized teaching, social and educational social networks), software development, forums, blogs, chats, group of news, online advertisements, online games, forms, online questionnaires, email and applications for file transfers. Likewise, there is no research that affirms that artificial intelligence helps humans to achieve higher-order thinking such as critical (Lengua et al., 2020).

Continuing in this order of ideas, it is important to highlight that critical thinking is involved in the work context, so it is necessary to build tools that facilitate the development of cognitive skills for the learner; to be able to learn to think from an investigative perspective in the field of education; Likewise, the constitutive elements of critical thinking are: "flexibility in thinking, metacognition, cognitive abilities, predisposition and beliefs" (Aguilar et al., 2020, p.3-4).

It is important to note that we live in a globalized, pluralistic society with a lot of information, it is even recognized that critical thinking is a significant competence that must be developed in university classrooms, shared with teachers, since it would help to train good professionals in a complex world, if and only if active methodologies are used that allow reaching minimum levels of critical thinking competence (Bezanilla et al., 2021).

It is also stated that university students and teachers consider critical thinking as an implicit knowledge that is developed through social interactions, and highlights the importance of explicit debate that would help promote critical thinking (Duro et al., 2013). In the same way, argumentation is a skill that is part of critical thinking and that is related to the ability to have an independent opinion; However, activities to develop critical thinking have been disappearing in the higher education curriculum of various countries, labeling

cooperation, teamwork, among others, as critical thinking capacities (Mosquera et al., 2017).

On the other hand, the employability of critical thinking has fundamentally influenced as an irreplaceable competence in professional improvement in a context of change; Hence, it is essential for innovation, improvement, creativity and commitment, all this leads to the issuance of judgments with freedom, autonomy, sovereignty and the truth. Even employers consider critical thinking at the managerial, technical, middle management, administrative employee and operator levels as a requirement because they all have a responsibility, even in the cited research (Committee for Economic Development 2015) it is stated that more competence difficult to find in workers is critical thinking and problem solving (Bezanilla-Albisua et al., 2018).

Additionally, the investigation is rescued where the measurement was carried out on 310 Paraguayan university students who were completing their studies in education, communication, letters, history, philosophy and psychology, to establish how critical thinking skills were developed; The research concluded that 68.85% of the participants were located at the intermediate level of critical thinking; However, despite efforts to develop these skills, traditional uncritical thinking and technical thinking are still followed (Canese de Estigarribia, 2020).

In the following research, carried out on 100 university students from Colombia from the program of sports science, engineering and a degree in linguistics and literature of the second semester in order to measure the analysis, interpretation, evaluation, inference and explanation of critical thinking; The results showed a moderately achieved level of critical thinking, which limits them to make arguments below what is expected in university students; For this reason, the need to design strategies in enriched environments and in didactic sequences is imposed (García et al., 2020).

On the other hand, research carried out on undergraduate students in Peru showed a direct relationship between critical thinking and

academic performance (Guevara et al., 2019). In addition, studies carried out in the specialties of economic engineering, social sciences as well as statistics showed low and medium levels of critical thinking, especially in the inference dimension (Dávila, 2018, cited in Betancourth et al., 2019).

Continuing with the description of the research, on the transcendence of critical thinking in higher education, 142 university teachers among Latin Americans and Spaniards were asked about the importance of teaching critical thinking at a higher level, which they argue is essential, of a nature cross-sectional since it is multidisciplinary, and it is a complex competence because it requires time to develop it, however, there was a deficit to get involved both from the university institution and the teachers, additionally it is stated that not all teachers are trained, especially the teachers. of exact sciences, the lack of interest of the students is not alien either since they do not deepen the topics, it is suggested that methodologies be developed that can develop cases, debates and other activities that awaken a critical spirit among the students. Likewise, dogmatism in universities does not allow the acceptance of new opinions and behaviors that contradict what is established (Bezanilla et al., 2021).

In the 10th international congress on research in didactics of science in Seville-Spain, it is mentioned that critical thinking skills imply interpreting, analyzing, inferring, evaluating, explaining, self-regulating; Likewise, the dispositions of critical thinking are the search for certainty, open mind, analytical thinking, capacity to systematize, self-confidence, inquiring and cognitively mature, even the importance of Socratic dialogues that allows developing their own knowledge (Mosquera et al., 2017).

In Brazil, the national curricular guidelines allow a curricular permeability that makes possible the pedagogical projects oriented to the needs such as teaching, job generation and satisfaction to the community, this does not imply that the problematization of critical thinking is left aside, which runs its course (Carbogim et al., 2016).

In the research carried out in Mexico at a private university, 512 students of the second, third, fourth, seventh and eighth cycle of medicine were sampled, in whose results it is evidenced that students express themselves fluently by looking at the face, demonstrate confidence when interacting with the evaluator and evaluate their thoughts with support, but they are not able to fully defend their position in the face of the questions (Olivares et al., 2018).

On the other hand, in the Western world both in the last century and in the present, the tendency is to impose universal principles in a globalized multicultural reality, since many power groups consider it as dangerous to critical thinking, for this reason universities do not There is constant work in the development of thought, but there is a resurgence through the web such as virtual communication, social networks, among others (Huitrón, 2014).

In the same way, a consumerist society is appreciated which imposes a way of life dedicated to leisure and the superficial, therefore it is required to encourage and execute actions that favor the development of critical thinking and what better from the hand of education, since It is crucial to have more sociable human beings (Chuquimarca et al., 2017).

Participation based on dialogue allows the construction of critical reasoning, for this reason it is necessary to promote the processes of inquiry and problematization of knowledge and inferences, which allows promoting the generation of alternative solutions. Likewise, it is evidenced that the participation of university students in the first cycle of their university career is low, but as they go to higher cycles it increases (Monarca, 2013). Even in an environment of dialogue and debate it is an opportunity to build, rebuild and validate the personal meanings of students (Pérez, 2010, cited in Monarca, 2013).

The great challenge for educational institutions is not to transmit information but to develop a critical reading for decision-making (Oliveras & Sanmartí, 2009). However, in the reading process, university students can identify

relevant aspects, but the comparison and reflection with the current reality is scarce; Additionally, research reveals that critical reading, apart from being considered a competence in university classrooms, is little studied (Díaz et al., 2015). In the same way, the reflection process begins with recognizing the positive and negative aspects, comparing the development and results of an activity reflected in the university classroom, therefore it allows to establish the causes generating a self-judgment (Hernández & Camargo, 2017).

In addition, it is important to highlight that the goal of universities is to cultivate critical thinking, personal autonomy and, above all, to reinforce the concept of always learning with a constructivist critical spirit (Unesco, 2009). Likewise, every teacher must be a catalyst for designing new pedagogical and didactic proposals in order for the university student to acquire application knowledge, skills, aptitudes, innovative analysis, autonomous reflection and collaborative work in multicultural contexts where theory, practice are interrelated. , contemporary science and technology without neglecting the common welfare even though there are social differences (Martí et al., 2014).

Along the same lines, it must be taken into account that critical thinking can be built through an incident that is reflected in different contexts; but, especially in private companies to understand the most relevant problems and give them possible solutions; To do this, the following steps must be followed: write a critical incident report (space, time and actors), describe the emotions involved in the actors involved in the problem, find out how the actors face this problem, collect the evidence of the actions of the participants (problems and consequences), pose dilemmas and finally, extrapolate the teachings of the incident (Morán-Barrios et al., 2020).

Critical inquiry helps identify what hinders human self-actualization. However, it proposes the revitalization of critical thinking not only by having a position of reality but also by analyzing the scientific, philosophical, political and artistic field (Jaimez, 2016).

The National Association of Higher Education Universities highlights that it is not possible that through traditional methods competences that allow comprehensive training can be achieved both in the academic, social, cultural and emotional aspects, either in the basic school training stage or after graduation from the university (Malo, 2000). Even UNESCO and the OECD emphasized that comprehensive training in academic knowledge and socio-affective skills is of the utmost urgency in order to achieve success in the labor field; For this reason, it is important to apply public policies that guide knowledge about what to investigate and what skills to develop (Fragoso-Luzuriaga, 2015).

The judgment is a personal intuition tool that is frequently used in the field of engineering, giving it a greater connotation of art than purely science, this is reflected after performing engineering calculations where not so clear hypotheses are generated, where the use of the judgment and reason (Serna & Polo, 2014). Consequently, it is important to promote critical thinking as a key element for the training of people useful to society (Unesco, 1998).

The purpose of this research is to carry out a reflective analysis about the critical thinking of university students in the 2009-2021 range.

Methods

In this research, the literature was reviewed analyzing the psychological, philosophical, social and innovative conception of critical thinking, likewise, critical thinking as competence, and the level of critical thinking in universities.

The analysis-synthesis method was used, which allows a previous study of identification, comparison, application of the scientific evidence found to be carried out in order to then synthesize the most significant information, and thus make known the behavior of critical thinking in university students and that variables affect its development.

The search was carried out in Spanish and English, between the years 2009-2021, in the open access database: Scopus, Ebsco and Science direct, likewise, the selection of the

articles was carried out using the following equations in Spanish: "Pensamiento crítico" AND "estudiante universitario", and english: "Critical thinking" AND "university student". The inclusion criteria were critical thinking and university students; and the exclusion criteria were primary and secondary student, teachers. The search result gave a total of 306,478 documents, of which 295,613 and 10,832 were excluded because they were not freely accessible because it was considered that the title, abstract, and keywords did not fit our review line; Consequently, 33 investigations were selected from the total of those reviewed, of which they were: 6 in English and 27 in Spanish. In Scopus 2; Ebsco19 and in Science direct 12.

Results

During the review process of the scientific articles, various studies were compiled with a qualitative (27), quantitative (5) and mixed (1) approach related to critical thinking in university students.

Research around the critical thinking of university students shows that they are at an intermediate and low level; affecting the ability to analyze, interpret, evaluate, infer and argue; Furthermore, despite the work aimed at increasing these skills, no significant changes have been observed to reason, deduce and induce and apply it in pragmatic activities (Guevara et al., 2019; García et al., 2020; Betancourth et al., 2019; Canese de Estigarribia, 2020).

Research carried out in the United Kingdom with 26 students and 4 university professors from the specialty of psychology at the University of Derby shows that both students and teachers vaguely understand the meaning of critical thinking; Likewise, it is concluded that it could not be explicitly taught since it is an intuitive ability, and the acquisition of critical thinking skills are part of an evolutionary learning since it is demonstrated at the end of the process (Duro et al., 2013).

The research carried out in Mexico with 27 univesity students from the graphic design branch of the Autonomous University of Aguascalientes shows that they need to increase their abilities to argue facts related to the foundations of critical thinking through instrumental, iconic, iconological and hermeneutical reading. ; in order to increase the capacities to raise and understand the arguments related to the constructs that make up the iconosphere and strengthen the qualification of its professionals (López & Villa, 2017)

In the same way, critical thinking is difficult to work in a focused, interrelated and coherent way in the university environment because it is not possible to work with a single educational resource; In addition, actions of narrative, descriptive, explanatory, argumentative, and dialogic help must be taken to help the development of thought (Bezanilla et al., 2021; Mena, 2020).

The ability to criticize and argue of students is achieved by strengthening critical reading ability and the narrative of academic argumentation through intervention programs in communication skills; Additionally, reading and writing for concrete and specific purposes may limit the student's awareness, reflection and criticism (Torres, 2020).

University teachers should promote critical thinking, through the use of reflective thinking as it encourages the construction of knowledge and promotes the use of critical study methods (Lossio & Ferrero, 2013)

It should be noted that the university must channel the teaching-learning process, so that it consolidates truly significant learning and plays a fundamental role in the development of critical thinking both when reading, writing and communicating (Chuquimarca et al., 2017; Díaz et al.., 2015).

On the other hand, university teachers consider essays the most effective tool for developing the basic and complex cognitive skills that critical thinking involves (Fandiño et al., 2021). Even writing, inquiry, collaboration and reflection effectively help the development of critical thinking skills if applied in a laboratory, but if applied in a traditional way the results will be the same (Stephenson & Sadler-Mcknight, 2019).

In the same way, educational intervention programs based on active learning strategies such as critical debate, argumentation, ICT, cognitive skills and research lead to improving independence, decision-making, solving problems and above all improving academic performance (Betancourth et al., 2019; Canese de Estigarribia, 2020; Duro et al., 2013; Aguilar et al., 2020). Additionally, various strategies are used, such as: brainstorming, holding workshops and seminars, time management, perseverance in carrying out an activity, working with peers, contrasting new and old information to generate a new one, repeating the information, having an organizational spirit, using critical thinking and the search for an expert on the subject reinforce active learning, generating autonomy and self-control (Fandiño et al., 2021; Broadbent & Poon, 2015)

Even, we must give importance to the practice of argumentation to have people with participatory and democratic capacity who support political, economic and moral power (Mosquera et al., 2017; Huitrón, 2014); An evidence of this is the teaching policies in Brazil that have driven discussions as part of the training of nurses in critical thinking (Carbogim et al., 2016).

The world of work requires professionals with skills in critical thinking, problem solving and decision-making, likewise the first two skills are difficult to find in future professionals (Carbogim et al., 2016; Bezanilla-Albisua et al., 2018 In addition, decision-making leads to the use of logical and hierarchical thinking and develops from exposure to similar situations (Avila-Tomás et al., 2020). Finally, let's not forget to connect science with the real world to have better results (Oliveras & Sanmartí, 2009).

Discussion

Critical thinking will always be considered a stumbling block because of the thinking that is leading in this globalized world (Huitrón, 2014); Hence, study centers should not necessarily focus on developing critical thinking from a psychological approach, but also on a philosophical, social, scientific and technological basis.

Likewise, critical research goes beyond awareness of how to channel real utopias (Jaimez, 2016), in this sense, while there is life, we must materialize our objectives as teachers for the effectiveness of the development of critical thinking in university students.

On the other hand, it is important to sow reflection through the use of identification, comparison and analysis to establish the causes that generate the problem; therefore, the aforementioned actions would allow the development of self-judgment (Hernández & Camargo, 2017).

In the same way, there is little research on the implication of critical reading in the development of university students in the last academic semesters (Díaz et al., 2015), given what has been stated, if we want to develop critical thinking, all of them have to be investigated. the variables that help its development.

Undoubtedly, we are in a time where artificial intelligence is in its immature state, even so, machines continue to control, in that sense there are no studies that relate the aforementioned intelligence to critical thinking (Lengua et al., 2020).

All these changes allow decisions to be made in the didactic aspect, teaching-learning and mediation mechanism, to strengthen student, teacher and interest group interactions to have critical students who can overcome their difficulties after self-regulation.

Conclusions

Higher education aims to generate autonomous and proactive behavior in university students that promotes the common good through good judgment (Martí et al., 2014); Hence, the following competencies should be worked on in university students: collaborative work, motivating interactions, interpersonal skills, decision making, problem solving, organization, help, commitment, respect, recognition of multiculturalism and especially critical reasoning (Morán-Barrios et al., 2020).

However, the level of critical thinking in universities is at an intermediate to low level, in this sense it cannot be continued in

universities applying traditional active strategies, since we would continue with the same results. Additionally, after the investigation, it is found that the tools of the web 2.0 and the application of the skills of critical thinking in the laboratories allow obtaining efficiency in the development of critical thinking.

Finally, the university is the environment where the university student consolidates the development of critical thinking using active learning strategies to be a professional agent of change for society. That is why every university student who has developed critical thinking is open-minded, listens to his neighbor, identifies problems, reflects and generates solution proposals through decision-making and complements it with innovation.

References

1. Vargas, L. R. I. A., Llanas, I. T. A., & Mondragón, K. A. B. (2020). Impacto del Pensamiento Crítico en las habilidades para el campo laboral. ACADEMO Revista de Investigación en Ciencias Sociales y Humanidades, 7(2), 166-174.

2. Avila-Tomás, J. F., Mayer-Pujadas, M. A., & Quesada-Varela, V. J. (2020). Artificial intelligence and its applications in medicine I: introductory background to AI and robotics. Atencion Primaria, 52(10), 778-784.

3. Díaz, Y. A. T., Zambrano, S. M. B., & Daza, V. A. M. (2020). Programa de intervención en debate crítico sobre el pensamiento crítico en universitarios. Educación y Humanismo, 22(38).

4. Bezanilla-Albisua, M. J., Poblete-Ruiz, M., Fernández-Nogueira, D., Arranz-Turnes, S., & Campo-Carrasco, L. (2018). El pensamiento crítico desde la perspectiva de los docentes universitarios. Estudios pedagógicos (Valdivia), 44(1), 89-113.

5. Bezanilla, M. J., Galindo-Domínguez, H., & Poblete, M. (2021). Importance of Teaching Critical Thinking in Higher Education and Existing Difficulties According to Teacher's Views. REMIE-Multidisciplinary Journal of Educational Research, 11(1).

6. Broadbent, J., & Poon, W. L. (2015). Self-regulated learning strategies & academic achievement in online higher education learning environments: A systematic review. The Internet and Higher Education, 27, 1-13.

7. Canese de Estigarribia, M. I. (2020). Perception of development of critical thinking skills at Asuncion National University, Paraguay. Perfiles educativos, 42(169), 21-35.Carbogim, F. da C., de Oliveira, L. B., & Püschel, V. A. de A. (2016). Pensamento crítico: Análise do conceito sob a ótica evolucionista de Rodgers. Revista Latino-Americana de Enfermagem, 24. https://doi.org/10.1590/1518-8345.1191.2785

8. Sánchez, C. C. E. P., & Ramírez, C. H. A. R. (2017). La clase y sus tipos como forma de organización esencial de la docencia en la educación superior. Universidad y Sociedad, 9(5), 313-318.

9. Pablo Díaz, J., Bar, A. R., & Ortiz, M. C. (2015). La lectura crítica y su relación con la formación disciplinar de estudiantes universitarios. Revista de la educación superior, 44(176), 139-158.

10. Duro, E., Elander, J., Maratos, F. A., Stupple, E. J., & Aubeeluck, A. (2013). In search of critical thinking in psychology: an exploration of student and lecturer understandings in higher education. Psychology Learning & Teaching, 12(3), 275-281.

11. Fandiño, Y. J., Muñoz, A., López, R. A., & Galindo, J. A. (2021). Teacher education and critical thinking: Systematizing theoretical perspectives and formative experiences in Latin America. Revista de Investigacion Educativa, 39(1), 149–167. https://doi.org/10.6018/RIE.416271

12. Fragoso-Luzuriaga, R. (2015). Inteligencia emocional y competencias emocionales en educación superior, ¿un mismo concepto?

Revista Iberoamericana de Educacion Superior, 6(16), 110–125. https://doi.org/10.1016/j.rides.2015.02.001

13. García, M., Acosta, D., Atencia, A., & Rodríguez, M. (2020). Identificación del pensamiento crítico en estudiantes universitarios de segundo semestre de la Corporación Universitaria del Caribe (CECAR). Revista Electrónica Interuniversitaria de Formación Del Profesorado, 23(3). https://doi.org/https://doi.org/10.6018/reifop.435831

14. Guevara, F., Pérez, Y., & Macazana, D. (2019). Pensamiento crítico y su relación con el rendimiento académico en la investigación formativa de los estudiantes universitarios. Aγαη, 8(5), 1–18. https://n9.cl/l3b5

15. Hernández, A., & Camargo, Á. (2017). Adaptación y validación del Inventario de Estrategias de Autorregulación en estudiantes universitarios. Suma Psicologica, 24(1), 9–16. https://doi.org/10.1016/j.sumpsi.2017.02.001

16. Huitrón, A. M. de los Á. O. (2014). Vaivenes del pensamiento crítico universitario en la era digital. 83–102.

17. Jaimez, R. (2016). La Investicación De La Pobreza, La Ciencia Social Emancipatoria Y El Pensamiento Crítico. Acta Sociológica, 70, 29–48. https://doi.org/10.1016/j.acso.2017.01.002

18. Cantero, C. L., Oviedo, G. B., Balboza, W. F., & Feria, M. V. (2020). Tecnologías emergentes en el proceso de enseñanza-aprendizaje: hacia el desarrollo del pensamiento crítico. Revista Electrónica Interuniversitaria de Formación del Profesorado, 23(3).

19. León, R. L., & Carmona, G. A. V. (2017). El aula de diseño como escenario de exploración entre alfabetidad visual y pensamiento crítico. Kepes, 14(15), 173-194.

20. Lossio, O., & Ferrero, L. (2013). ¿ Cómo interpretan sus prácticas los profesores memorables de Historia y de Geografía que promueven el pensamiento crítico en la Universidad?. Cuadernos de Educación, (11).

21. Malo, S. (2000). La educación superior en el siglo XXI. Líineas estratégicas de desarrollo. Una propuesta de la ANUIES. Revista de La Educación Superior, 29(113), 1–8.

22. Martí, J. J., Martí, M., Vargas, Ó. H., & Moncayo, J. E. (2014). Reflexión sobre los discursos en educación superior, una mirada desde la psicología social crítica. Revista de La Educacion Superior, 43(172), 33–55. https://doi.org/10.1016/j.resu.2015.03.008

23. Mena, A. E. (2020). Una taxonomía de medios educativos para el desarrollo del pensamiento crítico: Dominios de acción y tipologías textuales. Estudios Pedagógicos (Valdivia), 46(1), 203–222. https://doi.org/10.4067/s0718-07052020000100203

24. Monarca, H. (2013). Participación dialógica en la universidad: condición para el desarrollo del pensamiento crítico y el compromiso social. Revista Iberoamericana de Educación Superior, 4(9), 53–62. https://doi.org/10.1016/s2007-2872(13)71916-4

25. Morán-Barrios, J., Ruiz de Gauna, P., Ruiz Lázaro, P. M., & Calvo, R. (2020). Complementary learning methodologies for the acquisition of competencies in postgraduate medical education and Entrustable Professional Activities (EPAs). Educacion Medica, 21(5), 328–337. Morán-Barrios, J., de Gauna,

26. R., Lázaro, P. M. R., & Calvo, R. (2020). Metodologías complementarias de aprendizaje para la adquisición de competencias en la formación de especialistas y actividades profesionales confiables. Educación Médica, 21(5), 328-337.

27. Olivares, S. L., López, M. V., & Valdez, J. E. (2018). Challenge based learning: Innovation experience to solve healthcare problems. Educacion Medica, 19, 230–237. https://doi.org/10.1016/j.edumed.2017.10.001

28. Oliveras, B., & Sanmartí, N. (2009). La lectura como medio para desarrollar el pensamiento crítico. Educación química, 20, 233-245.

29. Serna, E., & Polo, A. (2014). Lógica y

abstracción en la formación de ingenieros: una relación necesaria. Ingeniería, Investigación y Tecnología, 15(2), 299–310. https://doi.org/10.1016/s1405-7743(14)72218-8

30. Ranjeeth, S., & Latchoumi, T. P. (2020). Predicting Kids Malnutrition Using Multilayer Perceptron with Stochastic Gradient Descent. Rev. d'Intelligence Artif., 34(5), 631-636.

31. Prasath, D. S., & Selvakumar, A. (2015). A Novel Iris Image Retrieval with Boundary Based Feature Using Manhattan Distance Classifier. International Journal Of Innovative Technology And Creative Engineering (Issn: 2045-8711) Vol, 5.

32. Balamurugan, K. (2021). Fracture analysis of fuselage wing joint developed by aerodynamic structural materials. Materials Today: Proceedings, 38, 2555-2562.

33. Stephenson, N. ., & Sadler-Mcknight, N. . (2019). Total iron measurement in human serum with a smartphone. AIChE Annual Meeting, Conference Proceedings, 2019-Novem. https://doi.org/10.1039/x0xx00000x

34. Alzate, O. E. T., Zuluaga, Y. E. L., & Ortega, F. J. R. (2020). HACIA LA CONSTRUCCIÓN DE UN MODELO DE PENSAMIENTO CRÍTICO DOMINIO-ESPECÍFICO. Poiésis-Revista do Programa de Pós-Graduação em Educação, 14(26), 347-363.

35. Torres, A. (2020). Leer y escribir en la universidad. Didac, 75_ENE-JUN, 48–56. https://doi.org/10.48102/didac.2020..75_ene-jun.37

THERMODYNAMIC MODELING OF EXTENDED EXPANSION LEAN BURN SPARK IGNITION (EELBSI) ENGINE WORKING ON OTTO-ATKINSON CYCLE FUELED WITH NATURAL GAS

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ABSTRACT

The In the evolution of internal combustion (IC) engines, there has been a long-term endeavor to decrease fuel utilization and exhaust pollutants. One of the major issues battling scientists and engineers in the automotive sector is to improve fuel efficiency while lowering pollutants. One way of improving thermal efficiency and reduction of exhaust emission pollutants is the EELBSI engine. Extended expansion (EE) Engines are those that have a larger expansion ratio (ER) than compression ratio (CR). A lean-burn (LB) engine is alluding to the combustion of fuel with excess air, i.e., a lean amount of fuel. This paper describes the development of a thermodynamic model for the processes of compression, combustion, and expansion of a 4-stroke EELBSIE working on the Otto-Atkinson (OA) cycle fueled with Natural Gas (NG). The combustion and exhaust properties of the EELBSI engine fueled with NG working on the OA cycle were studied in this work. Emission characteristics such as nitric oxide and unburned hydrocarbons were projected. The result showed differentiates the performance and emission properties of 4-stroke EELBSI engine fueled with NG with an expansion to compression (ER/CR) as 1.5 with the base lean burn engine. NO_x emissions can be considerably reduced by using a LB method.

Keywords: Extended expansion, Lean Burn, Thermodynamic modeling, Otto-Atkinson cycle, Natural Gas

Abbreviations:
BTE – Brake Thermal Efficiency
CR – Compression Ratio
EE – Extended Expansion
EELBSI - Extended Expansion Lean Burn Spark Ignition
ER – Expansion Ratio
GHG – Green House Gas
IC – Internal Combustion
IVCT – Inlet Valve Closing Time
LB – Lean Burn
LIVC – Late Inlet Valve Close
NG – Natural Gas
OA – Otto-Atkinson
SI – Spark Ignition

Introduction

Thermodynamic modeling is a method for studying several variables in a parametric way. Thermodynamic models can aid in the prediction and comprehension of temperature. When utilizing thermodynamic equations for simulating, all of the reactions that are taken into account must reach equilibrium [1]–[3]. CR is equivalent to ER in a traditional SI engine. Throttling is used to control load in such engines, which again is primarily liable for low part load efficiency [4]. The combustion process limits the CR in SI engines, although the ER can be extended. The IC engine with more ER than the CR is alluding as an EE engine [5]. In a SI engine, the CR is deterred by the ignition process; however, the ER can be prolonged. Increasing the ER regrettably increases the CR also. The inlet valve can be closed late in the compression phase or early in the compression process. The p-V diagram of the Otto cycle is changed into an OA cycle when the inlet valve is closed late. The principle of EE process is adapted to a 4-stroke SI engine based on the OA cycle. According to Atkinson cycle,

$$Expansion\ Ratio(ER)$$
$$= \frac{Volume\ at\ the\ begining\ of\ expansion}{Volume\ at\ the\ end\ of\ compression}$$

$$Compression\ Ratio(CR)$$
$$= \frac{Volume\ at\ the\ begining\ of\ compression}{Volume\ at\ the\ end\ of\ compression}$$

OA Engine has more efficiency than a SI engine working on the Otto cycle at part loads. The expansion process is prolonged in an OA cycle till the pressure at the completion of expansion is ambient. In an IC engine, LB alludes to the combustion of fuel with an excess of air. The optimal air-fuel ratio is 14.7:1, although a real LB engine can reach 32:1 [6]. CO_2 emissions are lowered by better efficiency, while NO_x emissions are lowered by lower combustion temperatures with lean burn. In a vast scope of combustion settings, LB can give low emissions, especially NO_x emissions. More oxygen available, combustion process is more efficient and more amount of power is produced from the same amount of fuel [7].

The OA cycle-based 4-stroke SI engine can use the EE principle. The expansion process is extended in an Atkinson cycle till the pressure at the completion of expansion equals atmospheric pressure. When the ER is increased, the compression ratio is likewise increased. By opening the inlet valve for extended periods of time, the CR can be reduced. This thermodynamic modeling shows how the Atkinson cycle improves thermal efficiency and can be used to evaluate engine performance [8].

Fig.1 p-V diagram of Otto-Atkinson cycle (Theoretical)   Fig.2 T-s diagram of Otto-Atkinson Cycle (Theoretical)
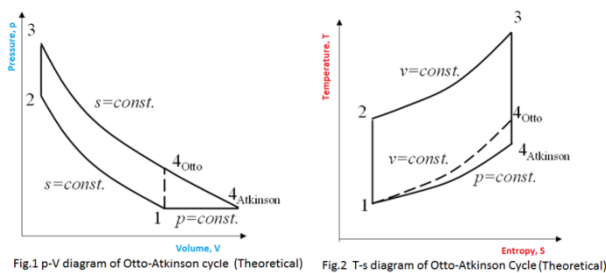
Thermodynamic Modeling Of Eelbsi Engine

In order to outfit the practical situations, the following assumptions are taken into account when developing the thermodynamic model.

➢ The ideal gas formula is appropriate.
➢ The charge within the cylinder at any moment comprises of the fuel-air mixture and leftover gasses.
➢ The walls of the combustion chamber are considered without any deposit formation.
➢ The pressure of burned and unburned zones is considered to be invariable at a specified crank angle.
➢ Metal superficial temperatures of all the surfaces are fixed throughout the cycle.
➢ The flow rates are measured from the equations of one-dimensional, quasi-steady flow rate.
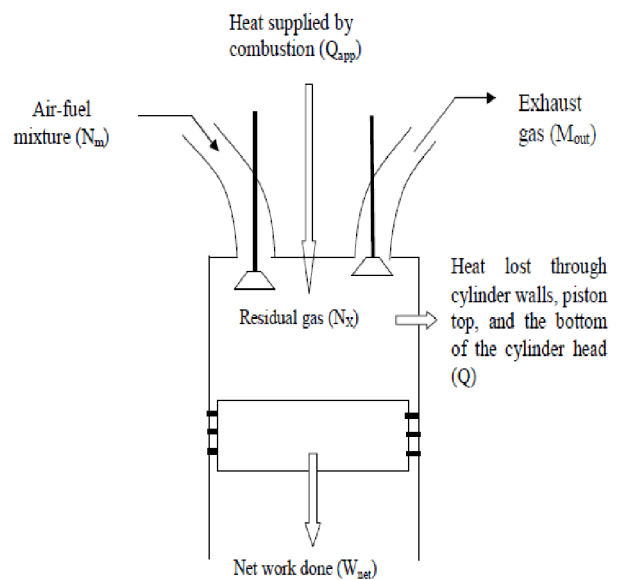
Fig. 3 Simplified Diagram of Thermodynamic Modeling

Fig. 3 shows a simplified diagram of the thermodynamic modeling of an EELBSI engine. Modeling consists of different processes such as compression, ignition, and expansion.

The p-V diagram of the OA engine at 1500 rpm is shown in Fig. 4. After the intake process, compression begins at a lower volume than the end of expansion. Over expansion occurs as a result of the volume discrepancies, which is why this engine can operate in the Atkinson thermodynamic cycle. The combustion process will start after the compression phase, which was completed at a practically constant volume for the most part.

Fig. 4 P-V diagram of Atkinson engine
WorkingFluidVolume, m^3

The utilization of a constant volume ignition chamber in this engine allows for essentially constant volume combustion. The expansion was also carried out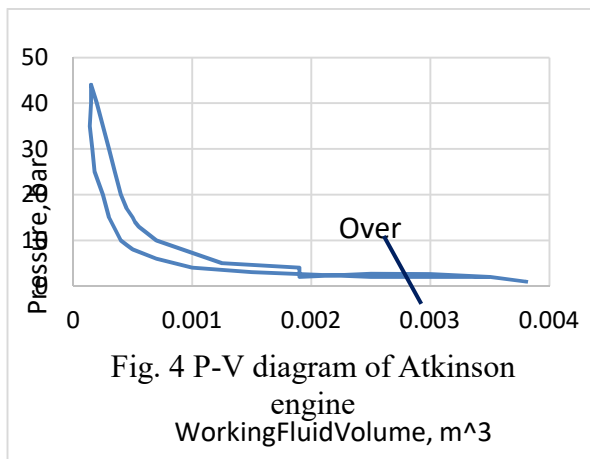 in two phases because of recovery and fusion of the centre intake volume in the middle of the induction process, so we did it.

Compression Process:

The computation was started from the closing of the inlet valve, and the process of compression was considered to begin from this point. During the process of compression, the mixture in the cylinder was considered to consist of the fuel-air mixture and the unburned gas. In the first iteration, temperature and pressure at the start of compression were considered and the fraction of residual gas was considered to be zero. At the end of the first iteration, the parameters are calculated and the iteration is repeated until the intake temperature converges. The parameters are determined at the end of the first iteration, and the iteration is repeated until the temperature of intake converges.

Combustion Process:

The Wiebe's equation was used for the fraction of mass burnt

$$X(\theta) = 1 - \exp\left[-a\left(\frac{\theta - \theta_i}{\Delta\theta_c}\right)^{m+1}\right]$$

Where,

θ = Crank angle (deg),

θ_i = Crank angle at the beginning of combustion   (deg),

$\Delta\theta_c$ = Total combustion duration (deg)

The parameters 'a' and 'm' are adjustable, selected to contribute a match with the experimental information.

Where a = 5 and m = 2.2 as per the Heywood, et al. [10].

Emission Characteristics:

Level Kinetics of Nitric Oxide Formation

The measurements were built on the equilibrium consideration except for the NOx formation, where the mechanism of extended Zeldovich was used [11]

$$N + NO \leftrightarrow N_2 + O$$

$$N + O_2 \leftrightarrow NO + O$$

$$N + OH \leftrightarrow NO + H$$
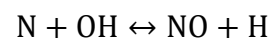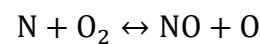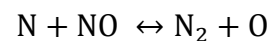
The final equation rate for [NO]

$$\frac{1}{Ven} \cdot \frac{d([NO].V_{en})}{dt}$$

$$= 2(1 - \alpha^2 NO)\left[\frac{RI}{1 + \alpha NO\left(\frac{R_1}{R_2 + R_3}\right)}\right]$$

Unburned Hydrocarbon (UBHC):

The rate expression used to forecast unburned hydrocarbon is a fair match to experimental data on unburned hydrocarbon burning [12].

$$\frac{d[HC]}{dt}$$

$$= -6.7 * 10^{15} exp\left[\frac{-18735}{T}\right][HC][O_2]\left(\frac{P}{RT}\right)$$

Carbon Monoxide (CO):

The emissions of CO lie between those at high pressure for balance and the equilibrium at the opening of the exhaust valve [13]. In this analysis, the CO emission was estimated at peak pressure and temperature based on equilibrium.

Experimental Setup:

A 4-stroke, single-cylinder, water-cooled CI engine was used for the experiment. The CI engine was modified to work on the OA cycle by substituting the fuel injector and fuel injection pump with a Venturi type carburetor, an ignition system, and a spark

plug. The CR of the engine was decreased to the necessary values by adjusting the clearance volume. To run the engine as an EELBSI engine the following changes were made. The sparkplug is fitted in the injector hole as the layout of the valve did not permit the middle portion of the plug though the middle portion of the plug is assumed to be ideal as shown in figure 4. A decrease in the CR is attained by decreasing the clearance volume.
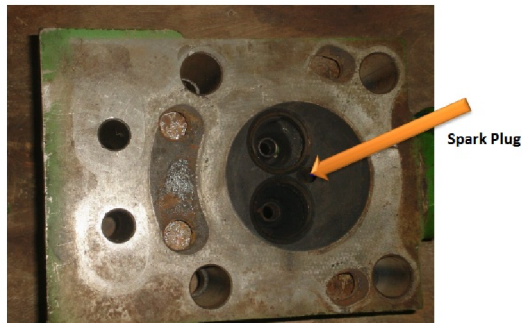

Fig.5 Location of Spark Plug in the Cylinder Head

The clearance volume of the actual engine was decreased by inserting the shims of standard thickness in between the crankcase and cylinder block. The clearance volume was decreased to change the ER and to maintain CR fixed depending on the LIVC. The current work distinguishes the performance and emission properties of the original lean burn engine with the EELBSI engine. The ER/CR is 1.5 and the CR of 8.5.

Brake Power

The results shown here distinguishes the lean burn operation performance properties of base LB engine ER/CR = 1 as shown in figure 6 and the EELBSI engine ER/CR = 1.5 for various air fuel ratios. As the mixture grows leaner, the BP output falls. When a mixture is extremely lean, power output drops dramatically.
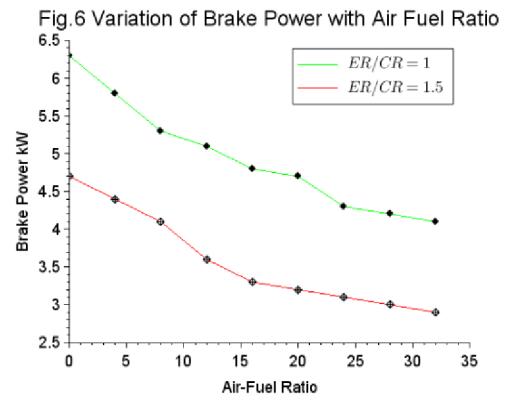
Figure 6 indicates the change of BP with the air-fuel ratio for the ER/CR of 1 and 1.5. The BP reduces as the charge becomes lean. The power output decreases suddenly due to decreased maximum pressure when the charge becomes lean. The percentage reduction of BP when the air-fuel ratio increases from 17 to 21 is about 17.43% in EEELBSI engine with ER/CR 1.5 whereas the base engine is 19.72%.

Brake Thermal Efficiency (BTE):

BTE of the IC engine increases with the increase of the air-fuel ratio, and it reaches apparently maximum value when the air-fuel ratio becomes immense (i.e., working fluid is only air).
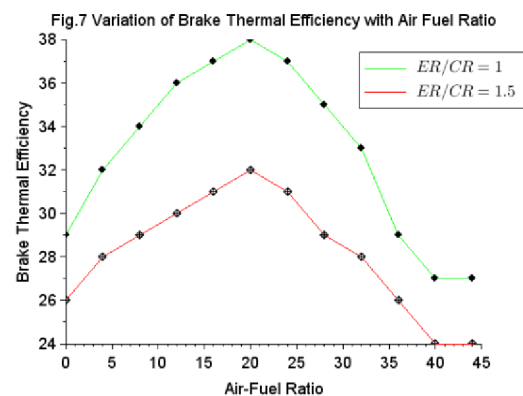
Fig. 7 indicates the difference in the BTE with air fuel ratios for the ER/CR of 1 and 1.5. It was observed that, as the charge turns into lean up to an air-fuel ratio of 20; the BTE increases and then brake thermal efficiency decreases rapidly. The percentage improvement in thermal efficiency is about 12.71% when the air-fuel ratio rose from 18 to 21% in the base engine and in the EE engine when ER/CR of 1.5 is about 16.34 %.

NO_X Emissions:

The rate of formation of NO_X depends on the temperature of the gas temperature and

concentration of oxygen. The maximum gas temperature takes place at an Air-Fuel ratio of 13.4 (A/F =13.4), at this ratio, the concentration of oxygen is low. As the charge becomes lean, increasing the concentration of oxygen at the beginning balances the decreasing NO_X emissions and gas temperatures maximum at an Air-Fuel ratio of 16.3 (A/F = 16.3).

Fig.8 Variation NOx with Air Fuel Ratio
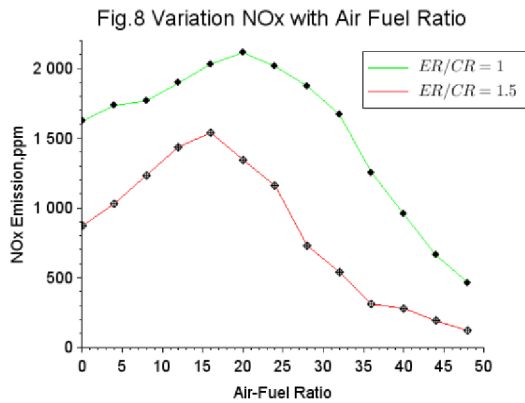
Fig. 8 indicates the effect of the air-fuel ratio NO_X emission with the ER/CR of 1 and 1.5. The emission of NO_X is found to be highest when the air-fuel ratio is around 18 and then decreases progressively as the air-fuel ratio is more than 18.

Unburned   Hydrocarbon   (UBHC) Emission:

Fig. 9 indicates the variation of emission characteristics of UBHC with the air-fuel ratio for ER/CR of 1 and 1.5. When the air-fuel ratio increases, the UBHC emission initially reduces to the air-fuel 17 and then increases. When the mixture is too lean, i.e., after the air-fuel ratio of 21, the increase in UBHC emission is abrupt.

Fig.9 Variation of unburned Hydrocarbons with Air Fuel Ratio
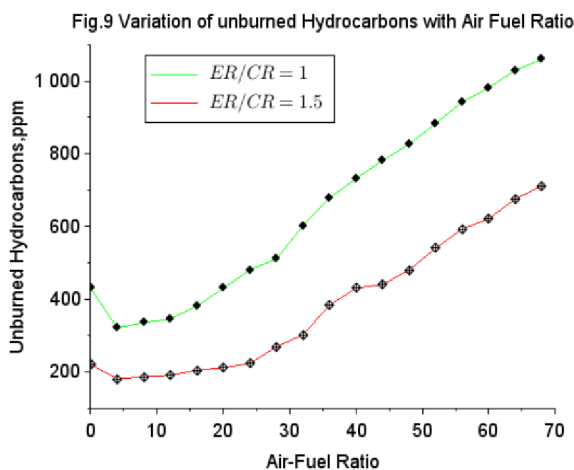
The percentage improvement of UBHC emission when the air-fuel ratio is increased from 17 to 21 is about 12.08% for the base engine and 15.39% for EEE with ER/CR is 1.5.

Carbon Monoxide (CO) emission:

CO emissions from the I.C engines are restrained mainly by the air-fuel ratio. For the rich mixtures, the concentration of CO in the exhaust increases consistently with an increase in the equivalence ratio. The percentage decrease in CO emission when the air-fuel ratio increased from 17 to 20 for the base engine is about 56.9 % and that of the EELBSI engine with ER/CR of 1.5 is around 45.38 %.

Fig.10 Variation of CO Emission with Air Fuel Ratio
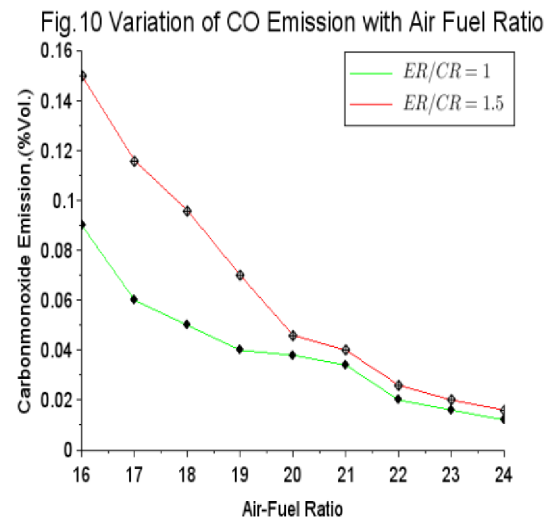
Conclusions

In comparison to the base engine with an ER/CR of 1 and an air-fuel ratio of 20, the EELBSI engine with an ER/CR of 1.5 and an air-fuel ratio of 20 has better performance and emission characteristics, including 17.88% increase in brake thermal efficiency, a 48.6% reduction in NO_X emissions, and a 48.8% reduction in UBHC emissions. For the extended period, an ER/CR of 1.5 was determined to be optimal. For the ER/CR of 1.5 the engine produces the highest BTE.

References

1. Özgül, E., Şimşek, M., & Bedir, H. (2020). Use of thermodynamical models with predictive combustion and emission capability in virtual calibration of heavy duty engines. Fuel, 264, 116744.

2. Baratta, M., Ferrari, A., & Zhang, Q. (2018). Multi-zone thermodynamic modeling of combustion and emission formation in CNG engines using detailed chemical kinetics. Fuel, 231, 396-403.

3. Zhang, Y., Fu, J., Shu, J., Xie, M., Liu, J., & Yin, Y. (2019). Use of a convenient thermodynamic model to study the effects of operating parameters on nitrogen oxides emissions for a liquefied methane fueled spark-ignition engine. Fuel, 257, 116001.

4. Yang, Z., Miganakallu, N., Miller, T., Worm, J., Naber, J., & Roth, D. (2020). Comparing methods for improving spark-ignited engine efficiency: Over-expansion with multi-link cranktrain and high compression ratio with late intake valve closing. Applied Energy, 262, 114560.

5. Tilz, A., Kiesling, C., Meyer, G., Nickl, A., Pirker, G., & Wimmer, A. (2020). Experimental investigation of the influence of ignition system parameters on combustion behavior in large lean burn spark ignited gas engines. Experimental Thermal and Fluid Science, 119, 110176.

6. Wu, H. M., & Tafreshi, R. (2019). Observer-based internal model air–fuel ratio control of lean-burn SI engines. IFAC Journal of Systems and Control, 9, 100065.

7. Boggs, D. L., Hubert, H. S., & Schechter, M. M. (1995). The Otto-Atkinson cycle engine-fuel economy and emissions results and hardware design. SAE transactions, 220-232.

8. Yang, Z., Miganakallu, N., Miller, T., Vinhaes, V. B., Worm, J., Naber, J., & Roth, D. (2020). Investigation of high load operation of spark-ignited over-expanded Atkinson cycle engine. Applied Energy, 262, 114519.

9. Li, Y., Jia, M., Han, X., & Bai, X. S. (2021). Towards a comprehensive optimization of engine efficiency and emissions by coupling artificial neural network (ANN) with genetic algorithm (GA). Energy, 225, 120331.

10. Heywood, J.B., Higgins, J.M., Watts, P.A., & Tabaczynski, R.J. (1979). Development and use of a cycle simulation to predict SI engine efficiency and NOx emissions (No. 790291). SAE Technical Paper.

11. Ranjeeth, S., & Latchoumi, T. P. (2020). Predicting Kids Malnutrition Using Multilayer Perceptron with Stochastic Gradient Descent. Rev. d'Intelligence Artif., 34(5), 631-636.

12. Prasath, D. S., & Selvakumar, A. (2015). A Novel Iris Image Retrieval with Boundary Based Feature Using Manhattan Distance Classifier. International Journal Of Innovative Technology And Creative Engineering (Issn: 2045-8711) Vol, 5.

13. Balamurugan, K. (2021). Fracture analysis of fuselage wing joint developed by aerodynamic structural materials. Materials Today: Proceedings, 38, 2555-2562.

14. Ignarro, L. J., Fukuto, J. M., Griscavage, J. M., Rogers, N. E., & Byrns, R. E. (1993). Oxidation of nitric oxide in aqueous solution to nitrite but not nitrate: comparison with enzymatically formed nitric oxide from L-arginine. Proceedings of the National Academy of Sciences, 90(17), 8103-8107.

15. Yıldız, M., & Çeper, B. A. (2017). Zero-dimensional single zone engine modeling of an SI engine fuelled with methane and methane-hydrogen blend using single and double Wiebe Function: A comparative study. International journal of hydrogen energy, 42(40), 25756-25765.

16. Heywood, J.B. (2018). Internal combustion engine fundamentals. McGraw-Hill Education.

DESIGN APPROACH OF CONVENTIONAL AND BIO ENZYMATIC STABILIZED SUBGRADE OF FLEXIBLE PAVEMENT

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ABSTRACT

In developing countries like India, demand for cost effective Roads are high. To fulfill this, highway engineers are facing tremendous problem with the cost of construction materials as they are depleting now a days. This led to think of new materials and techniques utilizing locally available materials and making overall cost economical. Many of the additives are used so far to improve the properties of sub grade soil. Hence the search of alternative ways and techniques includes the stabilizer called Bio enzyme. In this study, cost effective Bio enzyme is used to examine the engineering characteristics of different soil samples collected at three different locations in Karnataka. With the obtained optimum bio enzyme dosage based on UCS test, carried out California bearing ratio test under soaked and unsoaked condition for all the types of soil. It was resulted that, CBR value of stabilized soil found be increased by 1.5 to 2 times in all the cases. As the strength of subgrade soil is increased, which is an integral part of pavement, other layer thickness can be reduced, which in turn reduces the quantity of construction materials required. Based on obtained CBR value, each layer thickness of flexible pavement is designed using guide lines of IRC 37-2012.

Keywords: *IRC 37-2012, Bio enzyme, California Bearing Ratio, Stabilization*

1. Introduction

This work focus on optimizing the cost of Pavement by reducing the thickness of various layers of pavement as there is strength enhancement of subgrade material stabilizing with Bio enzyme. In this three different soils were collected from different places of Karnataka, determined index properties and Engineering properties of soil. Based on the optimum dosage calculated from unconfined compressive test results, CBR values were determined under both soaked and unsoaked condition of three various soils. Here, Stabilization using enzyme is adopted where stabilized soil can be used for sub grade and sub base that provides required sufficient strength for the pavement from beneath. It is found that Bio enzyme improves bonding property between soil particles which creates permanent structure resisting to percolation of water, weathering, wear and tear. Majority of pavement failures are due to interaction between water and clay particles.

So to overcome this stabilization is done for three different soils collected from various places to evaluate their strength characteristics before and after stabilization. The design of each layer thickness is done under both the conditions and compared the variation in thickness of each layer for stabilized and conventional subgrade soil.

Here, three different soils from various locations of Karnataka were selected. One is locally available soil (Red soil), Lithomargic soil from dakshinakannada and Black cotton soil from North Karnataka. As we all know BC and Lithomargic soils are problematic soil since they contain more silt and clay percentage, it is very much required to strengthen the properties of these soils before using it for pavement construction. An attempt is made to improve the strength properties using a vegetable extract Bio enzyme.

To compare the strength properties of problematic soil with non-problematic soil, locally available soil is selected for this study. Compared the engineering properties of both the soils with and without stabilizer and designed flexible pavement layers for various subgrade soils.

1.1 Objectives of study

The main objective of this work is to design the overall pavement thickness of different soil subgrade under soaked and unsoaked condition at high traffic condition and to compare the variation in thickness of each layer of conventional and stabilized subgrade soil

1.2   Scope of the study

Assessment of CBR value for all different subgrade soils under soaked and un soaked

condition for conventional and stabilized soils. Based on the obtained CBR value over all pavement thickness is designed and compared each layer thickness of different subgrade soil.

2. Materials and Methodology

The work carried out in this study in three phases:
- Selection of subgrade soil and stabilizer
- Over all pavement thickness design
- Comparing each layer thickness for conventional and stabilized subgrade.

2.1   Selection of subgrade soil and stabilizer

In this study, problematic and Non-problematic soil samples were collected from different places of Karnataka.

- o Red soil-Bangalore
- o Lithomargic soil- Dakshina Karnataka
- o Black cotton soil- North Karnataka
- o Bio enzyme- Chennai

2.2 Over all pavement thickness design

The total thickness of pavement is designed based on obtained CBR values under soaked and unsoaked condition for maximum traffic condition using IRC 37-2012 guidelines for both conventional and stabilized subgrade soil.

2.3 Compare each layer thickness for conventional and stabilized subgrade.

Each layer thickness is designed for conventional and stabilized subgrade under soaked and unsoaked condition of all different subgrade soil. Granular sub base course, base course, dense bound macadam and wearing course thickness is determined at all conditions of subgrade soil for high traffic condition.

2.4 Flow chart of work carried out

Collection of different soils and Bio Enzyme

Assessment of CBR value under soaked and unsoaked condition

Flexible pavement design using IRC guidelines for high

Comparing variation in over all thickness for conventional and stabilized subgrade
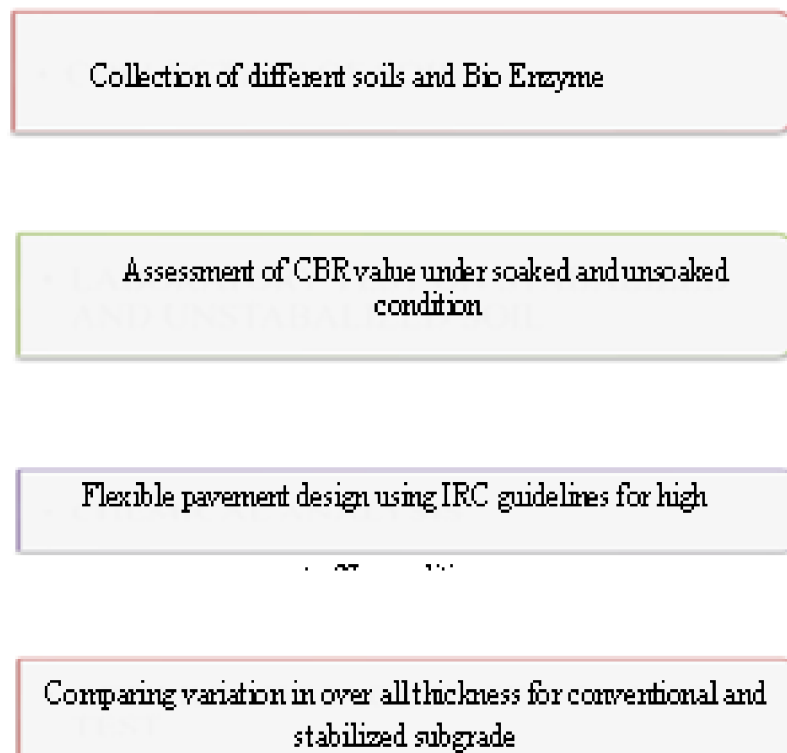
3. Results and Discussion

The CBR test is conducted for both Soaked and unsoaked Condition for the Optimum dosage of Bio enzyme based on their obtained Unconfined Compressive Strength [9]. For all the three different soil samples at an optimum dosage of Bio enzyme and for Conventional soil CBR test is conducted and based on Obtained results, design overall thickness of Pavement is done according to IRC 37-2012 guidelines.

For each soil, 3 soil samples were prepared and

carried out test considered the average value of results. Total 36 CBR samples were prepared

under soaked (4 days) and unsoaked conditions

Table 3.1: CBR values of different soil samples.

Sl.No	Type of soil	CBR value (%)			
		Un soaked without bio enzyme	Un soaked with bio enzyme	Soaked without bio enzyme	Soaked with bio enzyme
1	Black cotton soil	2.96%	4.85%	2.01%	2.36%
2	Lithomorgic soil	6.75%	8.5%	4.5%	6.2%
3	Locallyavailable soil	9.8%	13.56%	6.86%	8.5%

3.2 Design of Flexible pavement thickness based on CBR values for Conventional and stabilized subgrade at Different condition.

3.2.1 Tabulation of pavement layer thickness for black cotton soil as subgrade material for traffic 150 MSA

Sl. No	Type of soil	C B R Values of different condition of soil		Individual layer thickness(mm)		Total thickness(mm)
		Condition	C B R value			
1	Black cotton soil	Un soaked without enzyme	3%	Type of layer	Thickness of each layer(mm)	
				B C	50	850
				D B M	170	
				G BASE	250	
				G S B	380	
		Un soaked with enzyme	5%	Type of layer	Thickness of each layer(mm)	745
				B C	50	
				D B M	145	
				G BASE	250	
				G S B	300	
		Soaked without enzyme	3%	Type of layer	Thickness of each layer(mm)	850
				B C	50	
				D B M	170	
				G BASE	250	
				G S B	380	
		Soaked with enzyme	3%	Type of layer	Thickness of each layer(mm)	850
				B C	50	
				D B M	170	
				G BASE	250	
				G S B	380	

3.2.2 Tabulation of pavement layer thickness for Lithomargic soil as subgrade material for traffic 150 MSA

Sl. No	Type of soil	C B R Values of different condition of soil		Individual layer thickness(mm)		Total thickness(mm)
		Condition	C B R Value			
2	Lithomargic soil	Un soaked without enzyme	7%	Type of layer	Thickness of each layer(mm)	
				B C	50	670
				D B M	140	
				G BASE	250	
				G S B	230	
		Un soaked with enzyme	9%	Type of layer	Thickness of each layer(mm)	625
				B C	50	
				D B M	125	
				G BASE	250	
				G S B	200	
		Soaked without enzyme	5%	Type of layer	Thickness of each layer(mm)	745
				B C	50	
				D B M	145	
				G BASE	250	
				G S B	300	
		Soaked with enzyme	6%	Type of layer	Thickness of each layer(mm)	700
				B C	50	
				D B M	140	
				G BASE	250	
				G S B	260	

3.2.3 Tabulation of pavement layer thickness for Red soil as subgrade material for traffic 150 MSA

Sl. No	Type of soil	C B R Values of different condition of soil		Individual layer thickness(mm)		Total thickness(mm)
		Condition	C B R Value			
3	Red soil	Un soaked without enzyme	10%	Type of layer	Thickness of each layer(mm)	
				B C	50	625
				D B M	125	
				G BASE	250	
				G S B	200	
		Un soaked with enzyme	15%	Type of layer	Thickness of each layer(mm)	600
				B C	50	
				D B M	100	
				G BASE	250	
				G S B	200	
		Soaked without enzyme	7%	Type of layer	Thickness of each layer(mm)	670

				B C	50	
				D B M	140	
				G BASE	250	
				G S B	230	
	Soaked with enzyme	9%		Type of layer	Thickness of each layer(mm)	625
				B C	50	
				D B M	125	
				G BASE	250	
				G S B	200	

3.3 Schematic representation of pavement thickness of Black cotton soil as subgrade for traffic condition of 150 MSA

3.3.1 Un soakedcondition of BC soil
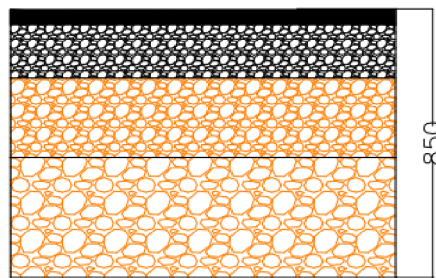
CBR=3% (Conventional soil)CBR=5%(Stabilized soil)

3.3.2 Soakedcondition of BC soil
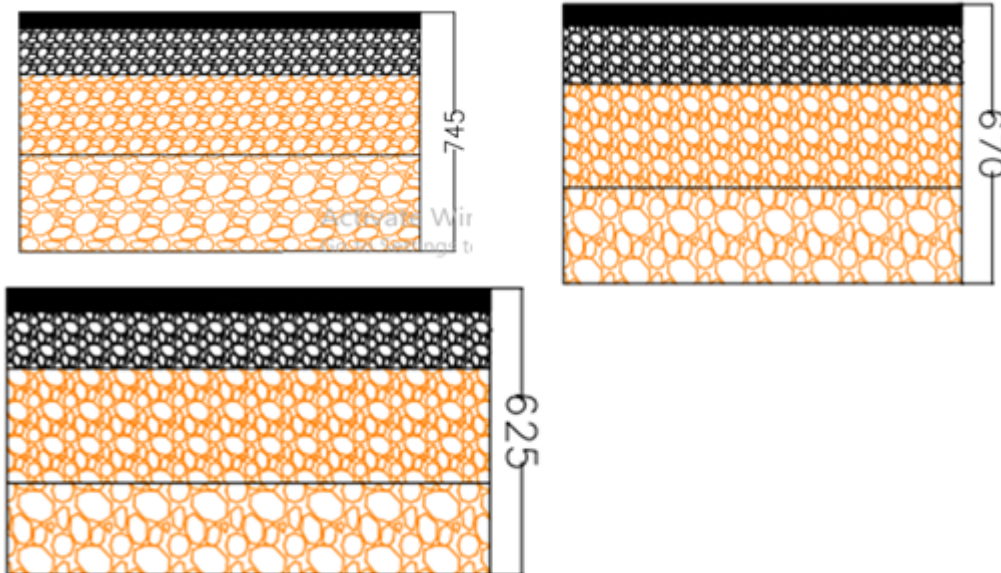
CBR=7% (Conventional soil)CBR=9%(Stabilized soil)

3.3.3 Un soakedcondition of Lithomargic soil

3.3.4 Soakedcondition of Lithomargic soil
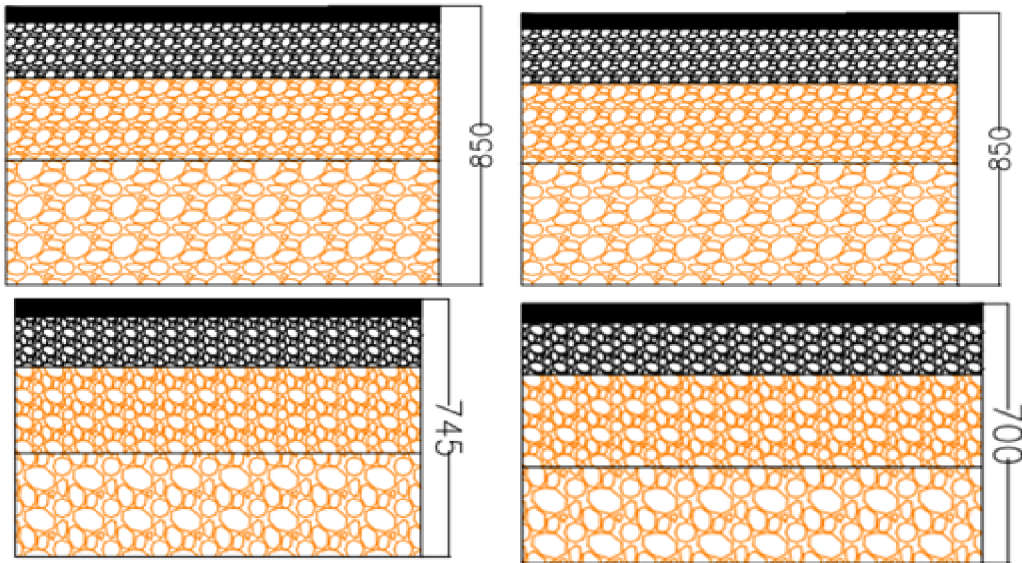
CBR=3%(Conventional soil)CBR=3% (Stabilized soil)
CBR=5% (Conventional soil)CBR=7%(Stabilized soil)

3.3.5 Soakedcondition of Red soil
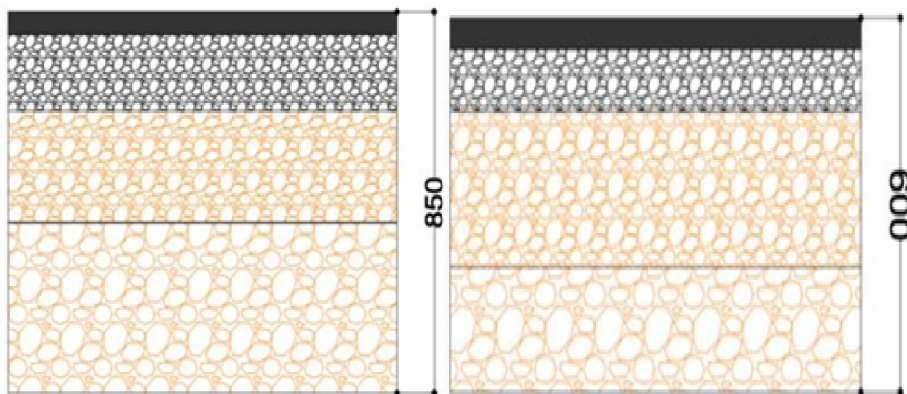
CBR=10% (Conventional soil)CBR=12% (Stabilized soil)

3.3.6 Soakedcondition of Red soil
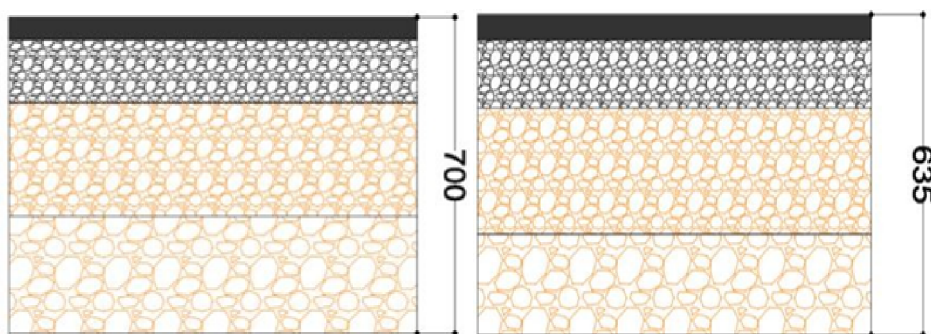
CBR=6% (Conventional soil)CBR=8% (Stabilized soil)

From the results, it was observed that In case of black cotton soil, a reduction of 100 mm overall thickness resulted in case stabilized subgrade compared to conventional subgrade.In case of Lithomargic soil, a reduction of 50mm overall thickness is achieved in case stabilized subgrade compared to conventional subgrade.In case locally available soil, a reduction of 25mm overall thickness is observed in case stabilized subgrade compared to conventional subgrade. It is found to be effective in problematic soil both BS and Lithomargic soil in terms of CBR value. As CBR value is main basis for designing thickness of each layer using IRC 37-2012 guidelines. Based on achieved CBR value, each layer thickness is determined for high traffic condition. Under Un soaked condition bio enzyme found to be effective than soaked condition. In all the three cases of subgrade soil, CBR value found be maximum under un soaked condition.As there is decrease in layer thickness, quantity of materials used for pavement construction can be reduced so that optimizing the overall construction cost of pavement making it economical.

4. Conclusion

This study was carried out to optimize the overall pavement cost by decreasing the quantity of materials used for pavement construction by strengthening the subgrade soil.

- In case of Black cotton soil, CBR value of stabilized subgrade and conventional subgrade soil found to be 4.85% and 2.01% respectively, which is2 times than conventional subgrade soil.
- In case of Lithomargic soil, CBR value of stabilized subgrade and conventional subgrade soil found to be 6.75% and 8.5% respectively, which is 1.3 times than

conventional subgrade soil.

- In case locally available soil, CBR value of stabilized subgrade and conventional subgrade soil found to be 9.8% and 13.56% respectively, which is 1.4 times than conventional subgrade soil.
- In case of black cotton soil, a reduction of 100 mm overall thickness resulted in case stabilized subgrade compared to conventional subgrade.
- In case of Lithomargic soil, a reduction of 50mm overall thickness is achieved in case stabilized subgrade compared to conventional subgrade.
- In case locally available soil, a reduction of 25mm overall thickness is observed in case stabilized subgrade compared to conventional subgrade.

5. Significance of the study

- This study is aimed at utilizing locally available soil by improving its desired strength using a bio degradable vegetable extract bio enzyme in stabilizing subgrade soil.
- As subgrade is important layer of Pavement where all the load carried on wearing course is transferred to lowest layer through all the layers, so subgrade should be in a position to withstand all the load coming from pavement as well moving traffic.
- Thiswork mainly focus on strengthening sub grade soil so that other pavement thickness can be reduced which will in turn reduce the quantity of materials required for stabilized subgrade than conventional subgrade pavement.
- And also determines each layer thickness for both conventional and stabilized subgrade and compares the reduction in layer thickness for different CBR conditions

References

1. Nagui M. Rouphail, A. M., "Minimum-Cost Design of Flexible Pavements",Volume 111, No. 3, 1985, Pp. 196-207(1-12)
2. Basma, A. A., & Al-Suleiman, T. I. (1991). Climatic considerations in new AASHTO flexible pavement design. *Journal of transportation engineering*, *117*(2), 210-223.
3. Venkatasubramanian, C., & Dhinakaran, G.

(2011). Effect of bio-enzymatic soil stabilisation on unconfined compressive strength and California Bearing Ratio. *JEAS-Journal of Engineering & Applied Sciences*, *6*(5), 295-298.

4. Shiding Miao, ZhaopuShen, Xuelian Wang, Feng Luo,Xiaoming Huang and Cundi Wei, J. Mater, "Stabilization of Highly Expansive Black Cotton Soils by Means of Geopolymerization" ,Volume 29, No.10, 2017, pp. 04017170(1-9)

5. Renjith, R., Robert, D. J., Gunasekara, C., Setunge, S., & O'Donnell, B. (2020). Optimization of enzyme-based soil stabilization. *Journal of Materials in Civil Engineering*, *32*(5), 04020091.

6. PranshulSahu, Riteshkamble, "Experimental Study On Design Of Flexible Pavement using CBR Method"(2017),International Journal of Mechanical And Production Engineering,

ISSN: 2320-2092.

7. Viswanath, D., & Asha, M. N. (2020, February). Experimental Investigations on Bio-Modified Soil. In *Geo-Congress 2020: Foundations, Soil Improvement, and Erosion* (pp. 641-648). Reston, VA: American Society of Civil Engineers.

8. Mary Stroup-Gardiner; Rod E. Turochy and Alan Carter, "Influence of Various materials traffic inputs in flexible design methods for Alabama Roadways", Volume 133, No. 8 , 2007, pp. 455-461(1-7)

9. Nandini D N, Dr.YRamalinga Reddy, "Effect Of Bio Enzymatic Treatment On The Strength Characteristics Of Different Soil Samples",International Journal of Advanced Science and Technology Vol. 29, No. 6, (2020), pp. 5200 – 5209,ISSN: 2005-4238

ECO FRIENDLY & ECONOMICAL CONCRETE MIXES AT RMC

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ABSTRACT

Urbanization is increasing and hence the building and infrastructure construction segment is witnessing an exponential growth. This has led to reinvent itself to address its main future challenges like productivity and sustainability. Ready mix concrete (RMC) will no doubt be the preferred material of the future supported by ground-breaking innovative solutions helping to reduce the carbon footprint, water footprint conserve natural resources and mineral resources to the best possible extent, which in turn helps   to improve jobsite productivity and quality. India being a developing nation needs to have newer and efficient methods of construction practices with greater emphasis on durability, stringent quality control, durability and pollution-free environment, which can be achieved only with mechanized production of concrete. It is a boon to construction industry and helps to achieve operational efficiency. The design and approach for the production of RMC involves up to ten ingredients/ components for production of engineered concrete when compared to non-engineered/semi-engineered concrete production with fewer ingredients/components, which is greatly helping the industry and it make it sustainable in India. The extensive use of RMC minimizes wastage of precious natural resources and plays a key role for the production of engineered concrete. In last 15 years Bengaluru city has systematically modernized its concrete production process with the help of ready-mix concrete (RMC) facility. However, one of the present requirements of these facilities is to lower its carbon footprint by reducing consumption of Portland cement in the concrete production process. Usage of concrete as a construction material is increasingly getting popular with the evolution of new generation concrete products and also makes it sustainable in the Indian scenario. t in particular Bengaluru. The author believes that large-scale mechanization for production of engineered concrete with mineral and chemical admixtures, newer technologies with appropriate quality control scheme, can lead to eco-friendly, optimized, sustainable and cost-effective concrete mixes in Bengaluru.

Keywords: RMC, Eco friendly concrete Mixes, Economical concrete Mixes, Strength; GGBS

Introduction

As per Bureau of Indian standard specification IS 4926:2003 , Ready Mixed Concrete (RMC)-Code of Practice, RMC can be termed as 'Concrete mixed in a stationary mixer in a central batching and mixing plant or in a truck-mixer and supplied in the fresh condition to the purchaser either at the site or into the purchaser's vehicles'. It is a premixed product, designed to specific requirements and ready to use product made by a systematic method of producing concrete and conveyed the same to project sites while maintaining the desired fresh properties of concrete. RMC usage in the industry has grown significantly and will slowly outpace the conventional site mixed concrete (SMC). Around the world there is a major concern on reducing the environmental pollution viz. greenhouse gases. In this aspect contribution of the construction sector plays a key role as industrial wastes can be used as a partial or full replacement of various ingredients of concrete effectively. It is a well-established fact that one ton of cement in the construction activities emits about 0.9 ton of CO2. The construction Industry is next to automotive sector having its role in CO2 emissions to the environment. Even natural aggregates are depleting rapidly on account of increased production of concrete.

In past two decades, Bangalore city has seen tremendous growth in the infrastructure. The primary cause for such growth has been the boom in the education, information technology and industrial sectors of urban regions. The rapid growth in infrastructure projects also puts pressure on production and consumption of construction materials like Portland cement concrete. While, Bangalore metropolitan area has effectively managed to modernize its concrete production facility by introduction of ready-mix concrete (RMC) plants, many challenges are yet to be addressed. One such challenge is to make these facilities sustainable by reducing the consumption of Portland cement in the concrete manufacturing process.

There are various supplementary cementitious materials used to substitute Portland cement, such as fly ash [1], silica fume [2], ultra-fine slag [3], ground granulated blast furnace slag

(GGBS) [4], and also rice husk, Metakaolin etc. Therefore, in practice it is crucial to choose and optimize the supplementary materials, which shall provide desirable effect on the properties of concrete such as workability, slump retention, strength, and durability, but at the same time should be easy to handle and cost effective.

In South India, the use of GGBS in RMC plants is very common, and its positive effect in reducing CO_2 emissions by lowering specific fuel consumption and reducing limestone calcinations is known [5]. Further, according to Ernst and Young estimate [6], the generation of GGBS in India will be approximately 44 Mt per annum in 2020 and 95 Mt per annum in 2030.

The addition of SCM (Supplementary Cementitious Materials) in concrete can enhance the strength, durability and provide cost-effective solution [7, 8]. The concrete durability with SCM is improved because of the secondary reaction of SCM by pozzolanic reactions with the available products of primary hydration of cement. Calcium hydroxide (CH) and calcium silicate hydrate (C–S–H) gels are the major byproducts of cement hydration. The available free lime may be soluble in water which makes the concrete permeable but it attain lesser compressive strength compare to standard mix. The C-S-H gels formed helps for pore refinement of pores which helps to arrest the passage of chemicals and water. The main drawback of using high volume GGBS i.e. 50% replacement to ordinary Portland cement is its lower gain in early strength [9, 10, 11, and 12].

The usage of SCM in concrete depends on the availability, compatibility of their physical and chemical properties. The results of research on the performance of concrete with these replacements initiated the utilization of green materials like Fly ash, GGBS etc. in the manufacture of concrete so that environmental contamination can be reduced [18]. This review paper aims to assess the feasibility of manufacturing RMC with maximum use of green materials.

Background
Global Scenario

The Ready Mix Concrete (RMC) was first patented in 1903 by Germany [14]. But the first commercial supply was made in 1913 in Baltimore, USA. By late 1930's RMC made in-roads to few of the European countries. During 20th century, America and Europe have witnessed tremendous growth in this industry. Currently, RMC is a matured Industry in Europe and USA where USA is consuming 75% of cement production through RMC because of highest level of mechanization achieved in the construction industry. Similarly Europe is consuming 47% of cement via RMC plants. In developed nations RMC is manufactured well by following stringent national and international codes with better verification processes.   The National Ready Mixed Concrete Association (NRMCA) is the certification body for technical audits. It also does regularity framework in USA. In Europe the ERMCO – European Ready Mixed Concrete Organization has 21 – nation members for the certification/audit of RMC. Similarly Canada has separate plan to deal with plant RMC plant certification process.

Indian Scenario

In India, usage of RMC was started in the year 1950 for only large-scale projects. Urbanization was increasing and hence building and infrastructure construction was growing very fast. This has led to reinvent itself to address its main future challenges like productivity, quality and sustainability. Meeting these requirements was possible only through RMC.

In India, the first commercial RMC plant was set up in Pune in 1992 [14]. The rapid growth of construction industry and the infrastructure sectors placed heavy demand on speed as well as quality in concrete construction which helped for the growth of RMC industry.

RMC growth is measured as the proportion of cement consumed in commercial RMC to total cement consumption in India, and currently it is around 10 per cent compared to 7 percent in 2019. Penetration of RMC in India has gradually risen with increasing awareness and usage of higher grade of concrete; however, compare to the world developed nations we are

at lower side by huge margin of around 50-55%.

In India, a nonprofit industry called RMCMA – Ready Mixed Concrete Manufacturers' Association was established in 2002 for the significant growth of RMC [15]. The important area of work of RMCMA was to evolve a self-regulatory framework by setting Quality Standards. It had introduced audit-based Quality Scheme for RMC in December 2008 and the same is available in the two Manual published by RMCMA. The scheme is operated through third-party certification and it is not owned by the RMCMA alone. But it is jointly operated with Quality Council of India (QCI) and Building Materials & Technology Promotion Council (BMTPC) under the Ministry of Housing and Urban Poverty Alleviation, Government of India.

In last 20 years Bangalore city has systematically modernized its concrete production process with the help of RMC facility. In Bangalore, according to the field survey conducted there are 122 captive and 154 commercial RMC plants, and the concrete consumption per month is approximately 0.5 to 0.7 Mi Cum. Further, in RMC plants, only 25 to 30% of GGBS is used for manufacturing up to M30 grade concrete, and this reduces to only 15 to 20% for manufacturing up to M40 grade concrete, respectively.

Typical Rmc Plat

Materials used:
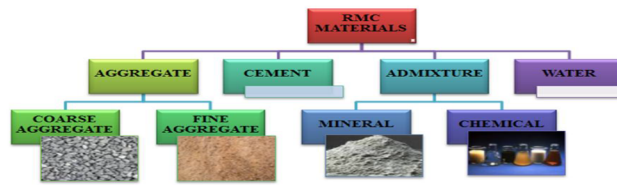
Tests carried out:

The raw materials used for the manufacturing of RMC as per Indian Standard Code of practice.

Typical Mix design:

Name of the project and Supply Details:

Customer Details	:Costing Purpose	
Project Name	:	
Location	:	
Grade	:	
Marketing Incharge	:	
Date of Submission	:	

Basic Data:

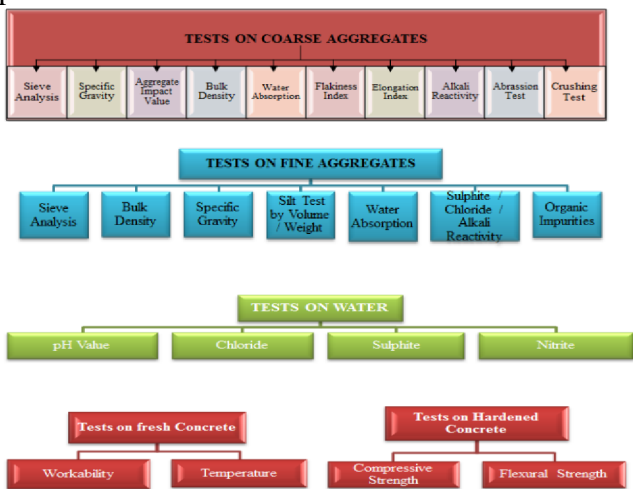|		
1	Type of Cement	: OPC 53 Grade
2	Specific Gravity of Cement	: 3.15
3	Source of GGBS	: Bellary
4	Specific Gravity of GGBS	: 2.86
5	Desired workability at site	: 110±25mm
6	Minimum Cement Content	: As per IS 456-2000
7	Nominal Size of Aggregate	: 20mm
8	Type of Fine aggregate	: M.Sand(zone II)
9	Source of Fine aggregate	: Chikkaballapur
10	Specific gravity of Fine aggregate(MS)	: 2.67
11	Water Absorption of Fine Aggregate(MS)	: 3.84%
12	Type of Coarse Aggregate	: Crushed Granite Rock(Angular)
13	Source of coarse aggregate	: Chikkaballapur
14	Size of Coarse Aggregate(Type I)	: 20mm
15	Specific gravity of coarse aggregate(20mm)	: 2.67
16	Water Absorption of Coarse Aggregate (Type I)	: 0.28%
17	Size of Coarse Aggregate(Type II)	: 12.5mm
18	Specific gravity of coarse aggregate(12.5mm)	: 2.66
19	Water Absorption of Coarse Aggregate (Type II)	: 0.40%
20	Type of Exposure	: Mild,Moderate
21	Degree of Quality control	: Good
22	Admixture	: Cflow 151
23	Make of Admixture	: CBS
24	Chloride Content in Admixture	: Nil

Grade→ Ingredients↓	M7.5	M10	M15	M20	M25	M30	M35	M40	Tolerance%
Units→	In Kg	In Kg	In Kg	In Kg	In Kg	In Kg	In Kg	In Kg	
Cement	80	110	136	160	192	262	280	380	
GGBS	80	110	136	160	128	108	120	60	
20mm	544	550	637	658	662	668	666	668	
12.5mm	544	550	425	439	441	409	408	409	
Fine Aggregate	1008	979	908	866	836	816	781	752	
Free Water	139	132	157	150	154	158	160	158	As per IS 4926-2003
Total Water	181	173	195	187	189	193	193	191	
Admixture %	0.4 to 0.9	0.4 to 0.9	0.4 to 0.9	0.4 to 0.9	0.4 to 0.9	0.4 to 0.9	0.4 to 0.9	0.4 to 0.9	
Density	2415	2431	2397	2413	2413	2411	2415	2427	
Mineral Additive %	50.00	50.00	50.00	50.00	40.00	30.00	30.00	13.64	
W/CM Ratio	0.77	0.60	0.58	0.50	0.48	0.44	0.40	0.36	
Target Mean Strength(MPA)	-	-	20.78	26.60	31.60	38.25	43.25	48.25	

Remarks 1.Water correction is adopted for aggregate accordingly.

2.The sources of materials given above relate to current production.Aggregate proportions may vary based on the performance, observation in mix design.

3.Admixture dosage can be varied according to site conditions.

4.Quanatity of concrete is measured by yield test only .

5.As per IS 456:2000 (Page 29 clause 16.1.1) 28 days compressive strength shall alone be the

criterion for acceptance or rejection of the concrete.

6 The practises and methods of transporting,placing, compacting, finishing and curing of concrete adopted at site significantly influence the quality of in-situ concrete. Therefore it is imperative that proper procedures,methods and controls are excersised while handling the concrete.

For Aparna Enterprises Limited

Low Relative cost, least energy consumption so environmental friendly.
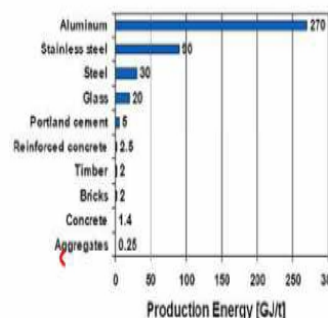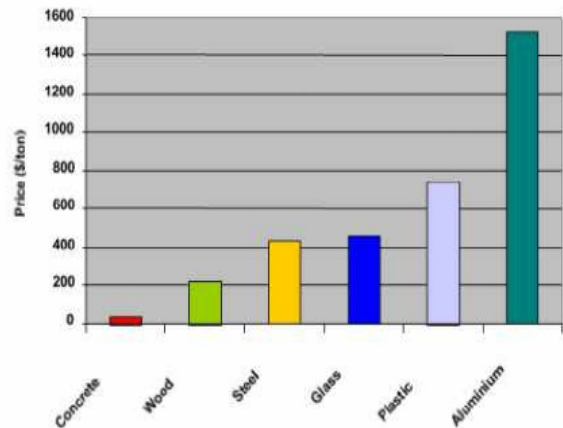
Concrete, the most commonly used construction material in the world because of its versatility. Concrete is the most popular building material because of various benefits. The main advantages are: a) its low cost compared to other building materials. : b) it's mould ability to any desired shape, d) the robustness e) versatile in terms of strength, b) As a finished product the cost of concrete is much lower compared to other materials.

Conclusions

Ready Mix Concrete is an innovative method of producing at remote locations far away from project sites, conveying and placing of concrete with ease without any compromise in the quality standards. It is very useful in completing projects on time where the volumes of concrete are very high and construction sites which are in located in congested areas, where mixing on site is not possible due to lack of storage place. RMC is ready to use material. It is gaining high importance and is widely adopted throughout the world. With the state of art production facilities , It enables to execute projects with high strength mixes to the structure and it also assures the durability to the structure. Compared with SMC It greatly reduces noise pollution as well as air pollution and reduces manpower. The supervisory and labour costs associated with the production of RMC is less. It is suitable for huge industrial, marine, infrastructure and residential projects where time plays a vital role. So ultimately it provides economy in the construction and better finish to the structure. Hence the advantages of RMC are realized by engineers and contractors in the construction industry. The combination of GGBS and fly ash can partially replace cement in the production of eco friendly concrete mixes. The cost of GGBS and Fly ash is much lower than the ordinary Portland cement therefore the concrete mix is economical.

Conflict of Interest

The authors do not have any conflict of interest.

References

1. Wang, Q., Wang, D., & Chen, H. (2017). The role of fly ash microsphere in the microstructure and macroscopic properties of high-strength concrete. Cement and Concrete Composites, 83, 125-137.
2. Mohamed, O. A., & Najm, O. F. (2017). Compressive strength and stability of sustainable self-consolidating concrete containing fly ash, silica fume, and GGBS. Frontiers of Structural and Civil Engineering, 11(4), 406-411.
3. Ting, L., Qiang, W., & Yuqi, Z. (2020). Influence of ultra-fine slag and silica fume on properties of high-strength concrete. Magazine of Concrete Research, 72(12), 610-621.
4. Lim, T. Y. D., Teng, S., Bahador, S. D., & Gjørv, O. E. (2016). Durability of Very-High-Strength Concrete with Supplementary Cementitious Materials for Marine Environments. ACI Materials Journal, 113(1).
5. Higgins, D. (2007). Briefing: GGBS and sustainability.
6. Feng, X. Z., Lugovoy, O., & Qin, H. (2018). Co-controlling CO_2 and NO_x emission in China's cement industry: An optimal development pathway study. Advances in Climate Change Research, 9(1), 34-42.
7. Brouwers HJH, Radix HJ. Self-compacting concrete: theoretical and experimental study. Cem Concr Res 2005; 35(11):2116–36.
8. Uysal, M., & Sumer, M. (2011). Performance of self-compacting concrete containing different mineral admixtures. Construction and Building materials, 25(11), 4112-4120.
9. Y.B. Raghavendra, Y. Ramalinga Reddy, (2019). Optimum usage of GGBS in ready mix concrete industry. International Journal of Engineering and Advanced Technology, vol.8, pp. 4542-4553,
10. Medina, E., Medina, J. M., Cobo, A., & Bastidas, D. M. (2015). Evaluation of mechanical and structural behavior of austenitic and duplex stainless steel reinforcements. Construction and building materials, 78, 1-7.

11. Oner, A. D. N. A. N., & Akyuz, S. (2007). An experimental study on optimum usage of GGBS for the compressive strength of concrete. Cement and concrete composites, 29(6), 505-514.

12. Elchalakani, M., Aly, T., & Abu-Aisheh, E. (2014). Sustainable concrete with high volume GGBFS to build Masdar City in the UAE. Case Studies in Construction Materials, 1, 10-24.

13. Ranjeeth, S., & Latchoumi, T. P. (2020). Predicting Kids Malnutrition Using Multilayer Perceptron with Stochastic Gradient Descent. Rev. d'Intelligence Artif., 34(5), 631-636.

14. Prasath, D. S., & Selvakumar, A. (2015). A Novel Iris Image Retrieval with Boundary Based Feature Using Manhattan Distance Classifier. International Journal Of Innovative Technology And Creative Engineering (Issn: 2045-8711) Vol, 5.

15. Balamurugan, K. (2021). Fracture analysis of fuselage wing joint developed by aerodynamic structural materials. Materials Today: Proceedings, 38, 2555-2562.

16. Joshi, A. M., & Bharadwaj, N. (2021). An Experimental Study In Developing Self-Compacting Concrete As Per Is: 10262 (2019) By Utilising The Marginal Materials As Fines. Indian Concrete Journal.

17. Rajesh, K. N., Raju, P. M., Mishra, K., & Madisetti, P. K. (2021). A review on sustainable concrete mix proportions. In IOP Conference Series: Materials Science and Engineering (Vol. 1025, No. 1, p. 012019). IOP Publishing.

18. Sharma, D. M. (2013). Management (Doctoral dissertation, Ganpat University).

19. Karakule, F., Akakın, T., & Ucar, S. (2004, June). Ready-mixed concrete industry in Turkey and in the world. In Proceedings of concrete congress.

20. Kulkarni, V. R. (2012, June). Evolution of RMC in India. In 16th International ERMCO Congress on RMC, Verona, Italy (pp. 1-31to).

21. Hossiney, N., & HT, D. (2021). Properties of high strength concrete with reduced amount of Portland cement–a case study. Cogent Engineering, 8(1), 1938369.

ECO-FRIENDLY MASONARY UNIT USING INDUSTRIAL WASTE

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ABSTRACT

The life of environment and ecosystem is of great importance. Concrete being the most used material on earth, next to water. Cement industries are the major contributor to carbon dioxide in the world. The demand of cement is increasing day by day due to the increase in infrastructure facilities. Geopolymer concrete can be used as an alternative material which is eco-friendly with reduced CO2 emissions. In order to overcome these problems, study is conducted by replacing cement with flyash, and fine aggregates by copper slag (copper slag is a by-product of copper extraction by smelting) waste with special focus on its mechanical properties and performance in comparison with conventional concrete blocks. The blocks were casted with an increasing percentage of copper slag (20%,40%,60%,80%,100%). Various experimental works such as shear test, prism test, water absorption test, crushing test on mortar, flow test and crack propagation of wall on application of UDL to evaluate the effect of various parameters affecting it's compressive strength in order to enhance its overall performance. The block with maximum compressive strength is adapted for further casting. Walls were constructed to investigate the crack propagation after 28 days. The paper briefly reviews the constituents of geopolymer concrete block, it's strength, and potential application as a wall.

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Keywords: *Geopolymer concrete blocks, Fly ash, Copper slag, Strength, Waste management*

Introduction

The geopolymer materials represent an innovative technology generating considerable interest in the construction industry, particularly in light of the ongoing emphasis on sustainability. The demand of concrete is increasing day by day and cement is used for satisfying the need of development of infrastructure facilities, 1 tone cement production generates 1 tone CO_2, which adversely affect the environment. In order to reduce the use of OPC and CO_2 generation, the new generation concrete has been developed such as Geopolymer concrete. The demand for concrete as a construction material increases exponentially and thereby, there is an increase in the demand for the production of OPC. The environmental issues associated with the production of cement are well known. The production of one ton cement releases around one ton of carbon dioxide to the atmosphere due to the calcinations of lime stone and combustion of fossil fuel and causes the global warming condition. In addition, the production of cement is highly energy intensive and it consumes a large amount of natural resources. To reduce these problems, it is necessary to find out an alternative material for cement. Many researches were carried out to find a replacement for cement. Partial replacement and high volume replacement of OPC with materials having binding property were studied .In 1978, Davidovits proposed that binders can be produced by polymeric reaction of alkaline liquid with alumino-silicate materials such as fly ash, rice husk ash, blast furnace slag etc and termed these binders as Geopolymers. Geopolymers can be considered as a green material, because it relies on minimally processed natural materials or industrial byproducts, thus reducing its carbon foot print. Geopolymers have gained considerable attention for their rapid strength attainment, corrosion resistance, chemical stability, low rate of shrinkage and freeze thaw resistance. Two main constituents of geopolymers are, source materials and alkaline liquids. The source materials should be alumino-silicate based and rich in both silicon (Si) and aluminium (Al). They could be by-product materials such as fly ash, silica fume, slag, rice-husk ash, red mud, etc. Geopolymers are also unique in comparison to other alumino silicate materials (e.g. alumino silicate gels, glasses, and zeolites).

For every ton of copper production, about 2.2 tons of copper slag is generated. Therefore, in India 8 lakhs tons of copper slag is generated every year and in worldwide generation of

annually about 24.6 million tonnes of slag. Copper slag has physical properties similar to the fine aggregate, so it can be used as a replacement of fine aggregate in concrete. Copper slag has lower absorption and higher strength properties than fine aggregate.

Experimental Program

As the impact of construction on environment is increasing Geopolymer concrete block is eco - friendly block with copper slag as Fine aggregate. The size of Block was 400x200x100MM.

Objectives

- To study the physical properties of materials of geopolymer block
- To produce geopolymer mortar cube with copper slag as replacement of fine aggregate at different proportion
- To produce the Geopolymer block and to investigate the strength of block with different proportion of copper slag as fine aggregate.
- To compare the strength of geopolymer block with conventional concrete block.

Methodology

One of the oldest building techniques is block masonry. Masonry units and mortar make up the structure. Burnt brick and concrete blocks are the most common masonry units. These traditional masonry bricks and blocks are not known to be long-lasting. While geopolymer Blocks are eco- friendly.

Material of Geopolymer block

- Fly ash
- Sodium silicate
- Sodium Hydroxide
- Copper Slag
- Coarse aggregate
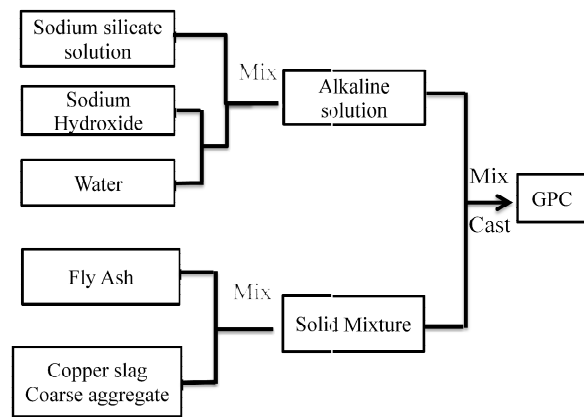
FIGURE 1: Flow chart of GPC

Fly Ash
Raichur thermal power plant provided Class-F fly ash. Fly ash is a byproduct of pulverised coal combustion in electric power plants.

Fine Aggregate
Copper slag is a by-product of the smelting of copper. Impurities transform into slag, which floats on top of the molten metal during the smelting process. Slag that has been quenched in water creates angular granules that are discarded..
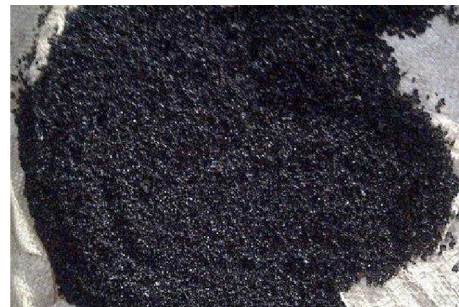
FIGURE 2: Copper Slag

Coarse Aggregate
Locally available crushed stones conforming to graded aggregate of nominal size 10 mm as per IS 383 – 1970 with the specific gravity of 2.77.

Sodium Hydroxide
Sodium hydroxides are commonly available as pellets or flakes in the solid state. The price of sodium hydroxide is mostly determined by the purity of the substance.

FIGURE 3: Sodium Hydroxide

Sodium silicate

Also known as water glass or liquid glass, available in liquid (gel). The silicates which is supplied to the detergent company and textile industry as bonding agent, same sodium silicate is used for the making of geopolymer concrete.
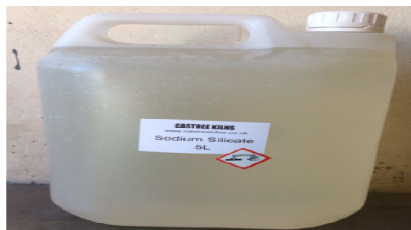
FIGURE 4: Sodium Silicate

Results and discussion
Workability
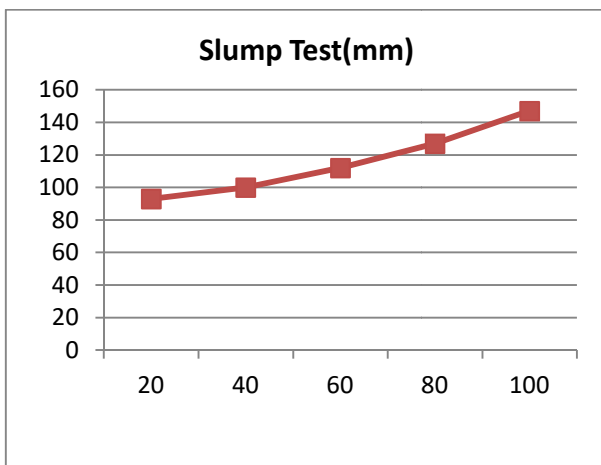
Chart 1: Slump test with different proportion of copper slag

The workability of geopolymer concrete was tested by doing slump test. The slump was done for different proportion of copper slag as a replacement of coarse aggregate. Copper slag added in different proportion as 20,40,60,80 and 100%. with the increase in copper slag proportion the slump value also increase as 93,100,112,127 and 147 mm.

Mechanical Property of Mortar cube

The mechanical property of mortar cube is determined by conducting the compressive strength test on cubes for 3,7,14 and 28 days at different proportion of copper slag. The ratio of mortar was 1:4 as part of Fly ash and 4 part of fine aggregate. The size of cube was 70x70x70MM.
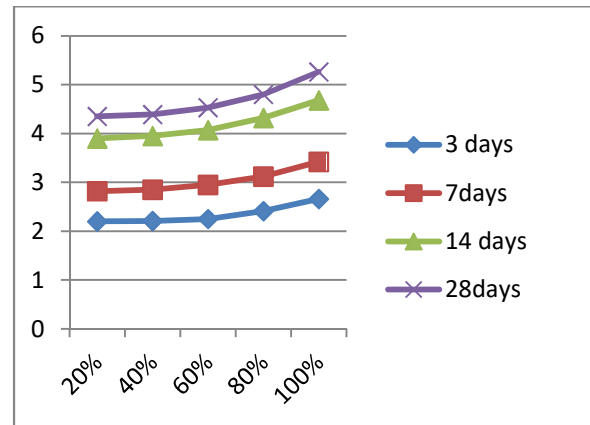
Chart 2: Compressive Strength of Mortar cube

With the given results it is observed that the compressive strength of mortar cube increases with increase in copper slag content. The strength of cube of at 3 days varies from 5.7Mpa to 16.2Mpa. The cube achieves maximum strength at 28 days at 100% copper slag as 27.05Mpa.

Compressive strength of Geopolymer Concrete block
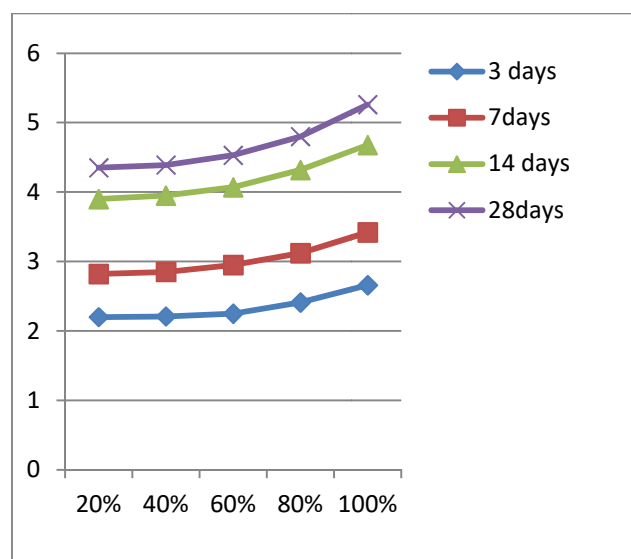
Chart 3: Compressive Strength of GPC block

The Compressive strength of Geopolymer concrete block is determined by conducting the

test on cubes for 3,7,14 and 28 days at different proportion of copper slag. The strength or 3 days at 20,40,60,80 and 100% of copper slag is 2.2, 2.21, 2.25, 2.41 and 2.66. Similarly the specimen was tested for different days and best results were achieved at 100% of copper slag used in GPC block with a strength of 5.26Mpa at 28 days of ambient curing.

Comparison between GPC block and conventional block
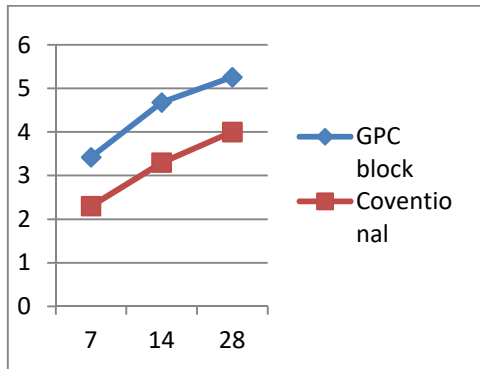
Chart 4: Comparison of GPC and Conventional

Above result shows the comparison between GPC and conventional bock. The compressive strength of GPC block at 7,14 and 28 days with copper slag used as fine aggregate is 3.42,4.68 and 5.26Mpa and for conventional block is 2.2,3.3 and 4 MPA.

Conclusion

- From the results obtained Geopolymer block with copper slag gives more strength than conventional concrete block.
- The workability of GPC increases with increase in copper slag.
- Geopolymer block with complete replacement of fine aggregate with copper slag has more strength.
- The water absorption of GPC block is 2.85%.
- The compressive strength of GPC block for 7, 14 and 28 days is 3.42, 4.68 and 5.26 respectively.
- The strength of mortar cube increases with the increase in Copper slag content

As the impact on environment is increasing by construction activity Geopolymer concrete can reduce the effects by using by products.

References

1. Bellum, R. R., Muniraj, K., Indukuri, C. S. R., & Madduru, S. R. C. (2020). Investigation on performance enhancement of fly ash-GGBFS based graphene geopolymer concrete. Journal of Building Engineering, 32, 101659.
2. Zhang, P., Zheng, Y., Wang, K., & Zhang, J. (2018). A review on properties of fresh and hardened geopolymer mortar. Composites Part B: Engineering, 152, 79-95.
3. Subharajit Roy, Sanjith J,Jagath H R, Chethan G(2018) "Experimental Investigation on Geopolymer Bricks "Volume: 05 Issue: 08 Aug 2018.
4. Sasalatti Vinod Marutia, Radhakrishnab, Mounesh Ma (2018) "Properties of Geopolymer cement mortar and blocks". Volume 24, Part 2, 2020, Pages 1518-1524, Material today.
5. Dwivedi, V. K., & Bharosh, R. (2018). A study on development of concrete using copper slag with silica fume.
6. S.C. Devia R.A. KhanEffect of graphene oxide on mechanical and durability performance of concrete . Journal Of Materials And Engineering Structures 6 (2019) 201–214 .
7. Maruti, S. V., & Mounesh, M. (2020). Properties of geopolymer cement mortar and blocks with calcium carbonate. Materials Today: Proceedings, 24, 1518-1524.
8. Ranjeeth, S., & Latchoumi, T. P. (2020). Predicting Kids Malnutrition Using Multilayer Perceptron with Stochastic Gradient Descent. Rev. d'Intelligence Artif., 34(5), 631-636.
9. Prasath, D. S., & Selvakumar, A. (2015). A Novel Iris Image Retrieval with Boundary Based Feature Using Manhattan Distance Classifier. International Journal Of Innovative Technology And Creative Engineering (Issn: 2045-8711) Vol, 5.

10. Balamurugan, K. (2021). Fracture analysis of fuselage wing joint developed by aerodynamic structural materials. Materials Today: Proceedings, 38, 2555-2562.

11. Ma, C. K., Awang, A. Z., & Omar, W. (2018). Structural and material performance of geopolymer concrete: A review. Construction and Building Materials, 186, 90-102.

12. Jawahar, J. G., & Mounika, G. (2016). Strength properties of fly ash and GGBS based geopolymer concrete. Asian J. Civ. Eng.(BHRC), 17(1), 127-135.

13. Aswani, E., & Karthi, L. (2017). A literature review on fiber reinforced geopolymer concrete. Int. J. Sci. Eng. Res, 8(2), 408.

14. Nanda, R. P., Das, A. K., & Moharana, N. C. (2010). Stone crusher dust as a fine aggregate in concrete for paving blocks. International Journal of Civil & Structural Engineering, 1(3), 613-620.

EFFECT OF PARTIAL REPLACEMENT OF FINE AGGREGATES BY SLAG SAND IN POLYPROPYLENE FIBER REINFORCED SELF-CURING CONCRETE

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ABSTRACT

Sand is one of the key components in concrete. Natural sand is a non-renewable resource and will soon be exhausted. Henceit is important to switch to some equivalent alternatives. It is of most importance to keep in mind the environmental impact while switching to alternatives in the presentscenario. One such alternative which is also environmental friendly can be slag sang, which is a byproduct of metal smelting processes. Slag sand has been made commercially available for use in construction, but in this project work, the strength properties of concrete, when the fine aggregates are partially replaced with slag sand along with polypropylene fiber reinforced concrete subjected to internal curing using self-curing agent PEG-400 is studied. In this experimental study, M25 concrete mixes for 0%, 10%, 20%, 30%, 40% and 50% replacement of slag sand with M sand are prepared with 1.5% of polypropylene fibers and 1% PEG-400 by weight of cement. The mixes were exposed to air curing at room temperature in order to achieve internal curing. Compressive and split tensile strength of the mix specimens were conducted at 7, 14 and 28 days of curing and the results are compared with conventional concrete. It was seen that addition of fibers decreased the workability so super plasticizer has been used. When tested for compressive and split tensile strength, specimen with 30% replacement showed maximum strength. Through this study we concluded that up to 30% replacement of Slag Sand with M sand can be done when compared to conventional concrete.

Keywords: Slag Sand, Fiber Reinforced Concrete, Self-Curing Concrete, Polypropylene Fiber Reinforced Concrete, Internal Curing, Environmental Friendly

1. Introduction

1.1. Overview

Natural sand is one of the key components and also the world's most extracted material. It's growing demand due to rapid increase in urbanization and infrastructure, causing severe damages to the ecosystems and environment. In order to keep up the demand of sand supply, the quality is being compromised. This has led to a rise in various social hazards like smuggling, illegal sand mining and black markets. sand mining can lead to losing water retaining soil strata, deepening of the river beds and causing bank slides, loss of vegetation on the bank of rivers. These issues call for a more sustainable approach. Slag sand can be considered as one such sustainable alternative because Slag sand is a non-metallic product, consisting essentially of glass containing silicates and alumino-silicates of lime, slag is a byproduct of metal smelting process, manufactured under controlled conditions. One of the most common problems

encountered in plain cement concrete is the development of early cracks due to plastic and drying shrinkage, leading to brittle failure and reduces the durability and life of the structure. Even though it's a common problem, it cannot be ignored. These shrinkage cracks can be prevented by various methods like using temporary windbreaks and sunshades, placing concrete in a cool place etc.One of the most effective methods is using fibers. The concrete made by the addition of fibers is called fiber reinforced concrete (FRC). FRCs can bridge the gap between the small cracks due to their thin tread like structure. In this study, the behavior of polypropylene fibers incorporated in plain cement concrete is studied.

Water is another global issue without which the construction industry cannot function. Especially for curing during which the concrete attains the desired strength. It is believed that nothing can replace water. But recent studies have shown that curing of concrete can be done effectively with some special materials like Light weight aggregates (LWA), Super-

absorbent polymers (SAP) and Shrinkage Reducing Admixture (SRA) where the curing takes place internally. This phenomenon is known as self-curing or internal curing. These self-curing agents help to reduce theevaporation of water from the surface of the concrete and helps in water retention that is consistently needed in the concrete, by forming a thin layer around the aggregates resulting in a matrix. The strength of self-curing concrete has proven to be on par with conventional curing.

1.2 Manufacture of Slag Sand

Slag Sand is a non-metallic product without any delirious material. It is produced from blast furnace slag, which is produced as a byproduct of metal smelting processes so it's often referred to as Granulated Blast Furnace Slag (GBS). GBS is obtained by rapid chilling or quenching of molten slag at 1500°C improvement of shape and size of GBS is required in order to convert into fine aggregates. This is done in 2 stages.

i. Altering Granulation Parameters

Slag granulation is done by rapid cooling by means of water and pressure. This achieved by maintaining optimum water temperature and flow. The molten slag hardens and becomes dense under such optimum conditions and needle or flaky shape particles are produced.

ii. Shaping and Screening

Figure 1: Slag Sand

1.4 Fiber Reinforced Concrete

Fiber reinforced concrete is the concrete containing short, discrete, thin thread like fibrous material that are uniformly distributed in the concrete. FRC can improve the structural strength of the concrete and may even reduce the need of steel reinforcements. Some types of fibers can provide resistance to abrasion and shatter. They also reduce bleeding of water and permeability. Fibers are classified into two categories i.e. Natural and Man-made fibers. The most important factor to be considered for the selection of fibers is the length to diameter ratio known as Aspect Ratio. FRC is greatly affected by volume of fibers, orientation and aspect ratio.

1.5 Advantages of Polypropylene Fibers

- Improves durability by controlling the crack width very tightly
- Improves impact resistance and plastic shrinkage
- Prevents absorption of water due to its hydro-phobic nature.
- Resistant to acids, alkalis and corrosion
- Improves structural strength
- Economic, ecofriendly and easily available

Figure 2: Polypropylene Fibers

1.6 Self Curing

The ACI-308 code states that "Internal curing refers to the process by which the hydration of cement occurs because of the availability of additional internal water that is not part of the mixing water." Self curing or internal curing is a technique in which concrete can cure by itself by retaining the moisture content in it without letting it evaporate. This technique involves providing additional moisture in the concrete during mixing for more effective hydration of cement and to reduce self-desiccation and autogenous shrinkage. Currently there are various materials that promote the internal curing.

1.7 Mechanism of Self Curing

During normal curing, there is a difference in chemical potential between the vapor and liquid phases during evaporation. Due to this continuous evaporation of moisture takes place from external surface of concrete. In the case of water soluble chemicals like SAP and SRA which are polymers added to the concrete mix form hydrogen bonds with water molecules and reduce the chemical potential of the molecules which results in reduction of the vapor pressure, thus reducing the rate of evaporation from the surface. Whereas the saturated lightweight aggregates contains saturated pores which acts as an internal reservoir and allows water for curing to pass from inside to outside.
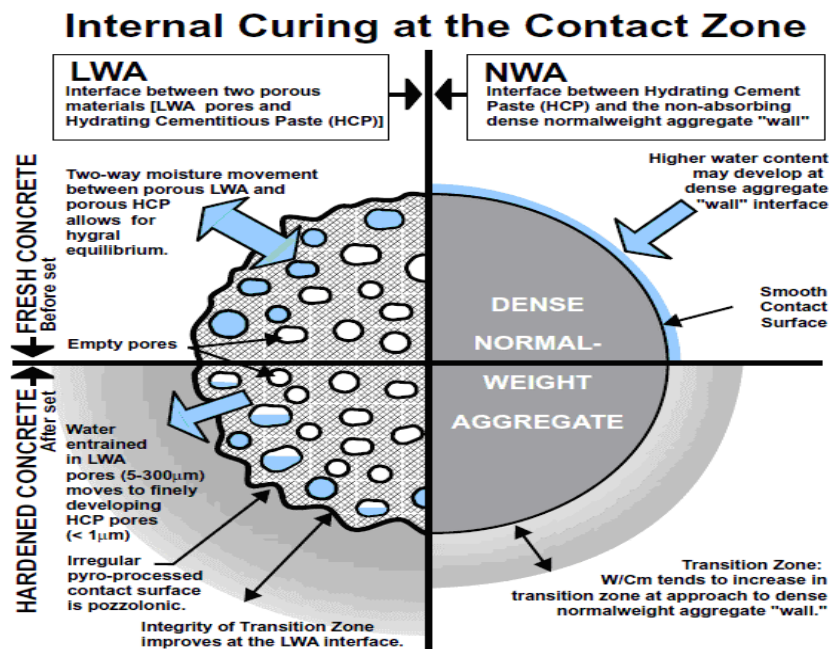
Figure 3: Self Curing Mechanism with LWA.
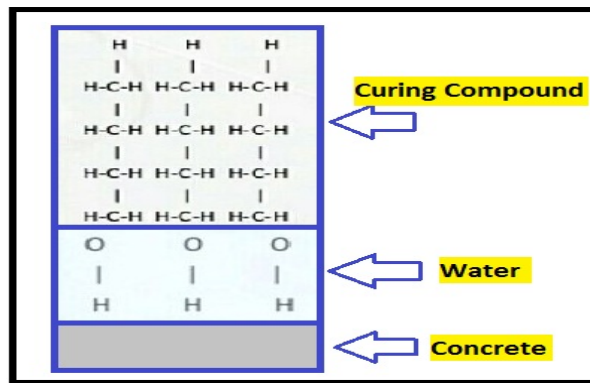
Figure 4: Self Curing Mechanism with Polymers

1.8 Advantages of Self Curing

- Provides water to keep the relative humidity (RH) high, keeping self-desiccation from occurring.
- Increases strength and hardness to some extent
- Reduces autogenous shrinkage and avoids micro-cracks in the concrete which increases strength and permeability.

2. Objectives of the Study

- To obtain an ideal percentage for replacement of fine aggregates by slag sand with replacement percentages of 0%, 10%, 20%, 30%, 40% and 50%
- To study the strength properties of the concrete when reinforced with 1.5% by weight of cement of polypropylene fibers and 1% by weight of cement of self-curing agent.
- To conduct a comparative study of strengths obtained with conventional concrete when fibers are added along with self-curing.

3. Methodology

Upon reviewing of various existing research papers and literatures, the materials were procured from local vendors. Initial tests were conducted to determine its basic properties. Then mix proportions were calculated as per IS 10262:2019 to carry out the mixing and casted into moulds. On successful casting, the specimens were kept in air dry condition in a cool place for internal curing without water for 7, 14 and 28 days. After the curing period the specimens were tested to determine the compressive and split tensile strengths using CTM. The strengths were then compared with conventional concrete.
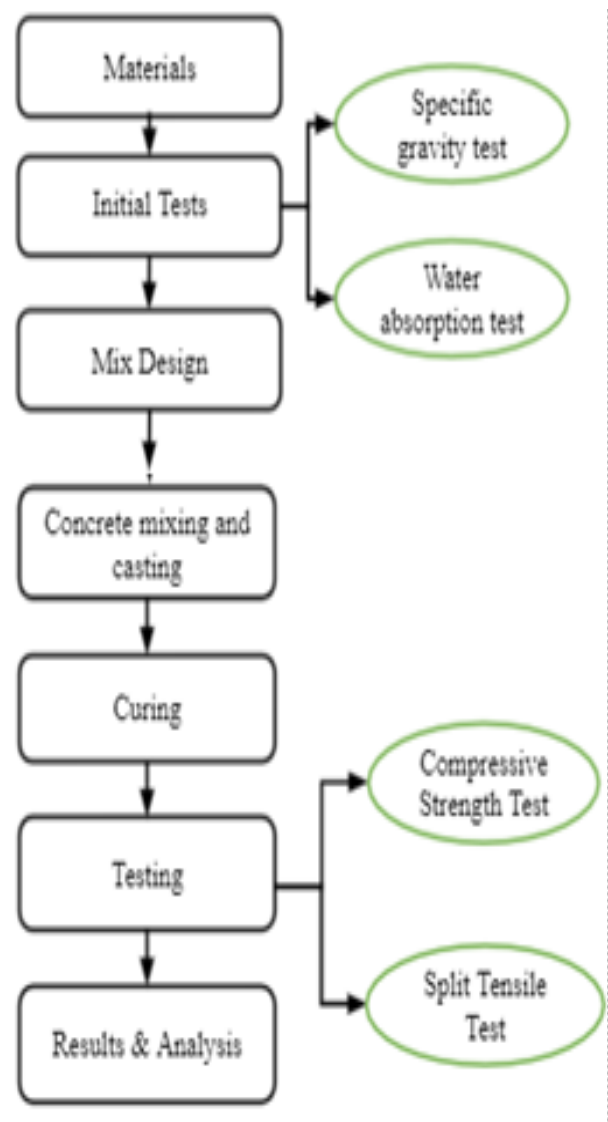
Figure 5: Methodology.

3.1 Materials Used

Cement: In this study, Birla's Ordinary Portland Cement of 53 Grade conforming to IS 12269-1987 was used

Course Aggregates: Aggregates of maximum size 20mm, as per IS 383-2016, was used procured from local quarries.

Fine Aggregates: Locally available M-sand as per IS 383-2016 was used in this project.

Slag Sand: JSW slag sand which is available in 50kg bags was used.

Polypropylene Fibers: Fibers of length 12mm was used which is oriented randomly during mixing and added in 1.5% by weightof cement.

Polyethylene Glycol-400 (PEG-400): It is a shrinkage reducing admixture. The dosage was taken as 1% by weight of cement while mixing.

Super plasticizer: For this study, Sulphonated Naphthalene Formaldehyde (SNF). 1% admixture dosage by weight of cement was used for all mixes except for conventional specimens.

Water: Potable water was used for mixing

Table 1: Material properties			
	Material	**Property**	**Value**
1	Cement (OPC 53)	Specific Gravity	3.15
		Initial setting time	32 mins
		Final setting time	500 mins
2	Course aggregate	Specific Gravity	2.65
		Water Absorption	0.30%
3	M-Sand	Specific Gravity	2.67
4	Slag Sand	Specific Gravity	2.65
5	Polypropylene Fibers	Specific Gravity	0.91
		Length	12mm
		Aspect Ratio	500

3.2 Mix Proportion

For this study, design mix of M25 grade of concrete was calculated as perIS 10262:2019. A total of 7 mixes were prepared including the conventional mix to obtain an optimum replacement dosage. Table 2 indicates the mix proportion for (kg/m^3) of design mix of M25 grade with a mix ratio of 1:1.49:2.61and water cement ratio of 0.45.

Table 2: Mix Proportion of concrete							
Mix		**Cement**	**Course Aggregate**	**M-sand**	**Slag Sand**	**PPF**	**PEG-400**
M1	0%	341	1112	636	-	-	-
M2	0%	341	1112	636	-	5.1	3.4
M3	10%	341	1112	572	64	5.1	3.4
M4	20%	341	1112	508	127	5.1	3.4
M5	30%	341	1112	445	191	5.1	3.4
M6	40%	341	1112	381	254	5.1	3.4
M7	50%	341	1112	318	318	5.1	3.4

3.3 Test Procedure

The concrete specimens were prepared for compressive and split tensile tests. Cubes and cylinders containing polypropylene fibers, self-curing agent of 1.5% and 1% respectively by weight of cement. The M-sand replacement by slag sand in 0%, 10%, 20%, 30%, 40% and 50% percentages.

Conventional concrete specimens without slag sand i.e. with only M-sand, fibers and self-curing agent were also casted.

First the dry mixing was done by adding all dry materials followed by mixing water, self-curing agent and super plasticizer.

After adding water, mixing is done for about 5 minutes and casted into the respective moulds. It was observed that the workability of the trial mixes was reduced due to the addition of fibers. Hence 1% by weight of super plasticizer was added to reduce the water for mixing and to obtain better workability. Since the curing is doneinternally, specimens were kept in air dry condition in a cool place for internal curing without water for 7, 14 and 28 days. After the curing period the specimens were tested to determine the compressive and split tensile strengths using CTM. The strengths were then compared with conventional concrete.

4. Results and Discussion

4.1 Compressive Strength

This test was performed on cubes of size 150mm x 150mm x 150mm as per IS: 516-1959, in compression testing machine where the load is applied gradually at a constant rate on the surface of the cube till it fails orcracks develop. From the test results we can observe that the compressive strength increases with increase in percentage of slag sand up to 30% .The maximum strength attained was 31.52 MPa after 28 days of curing at 30% replacement. There is anincrement of strength by 20.31%with respect to the conventional concrete mix. At 40% replacement, there is a gradual decrease in strength. At 50% there is further decrease in strength. The test results are as represented below.

Table 3: Compressive Strength (MPa)			
Samples	7 Days	14 Days	28 days
M1	2.26	2.59	3.07
M2	2.26	2.64	3.11
M3	2.28	2.69	3.14
M4	2.36	2.74	3.22
M5	2.52	2.91	3.37
M6	2.38	2.75	3.19
M7	2.26	2.7	3.08
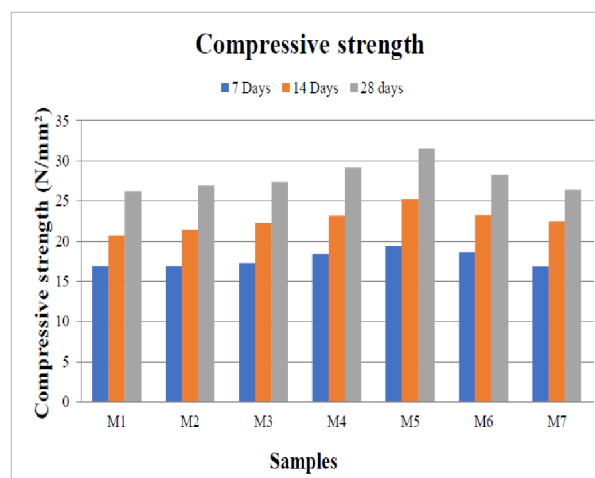
Figure 6: Graph showing Compressive Strength.

Figure 7: Compression Testing of Cube in CTM

4.2 Split Tensile Strength

This test is performed on cylinders of size 300mm x 150mm in compression testing machine. The load is applied axially on the specimen without any shock at a constant rate until it fails. From the test results we can observe that the split tensile strength increases with increase in percentage of slag sand up to 30% .The maximum strength attained was 3.37 MPa after 28 days of curing at 30% replacement. There is an increment of strength by 9.68% with respect to the conventional concrete mix. At 40% replacement, there is a gradual decrease in strength. At 50% there is further there is further decrease in strength. The test results are as represented below.

Table 4: Split Tensile Strength (MPa)			
Samples	**7 Days**	**14 Days**	**28 days**
M1	2.26	2.59	3.07
M2	2.26	2.64	3.11
M3	2.28	2.69	3.14
M4	2.36	2.74	3.22
M5	2.52	2.91	3.37
M6	2.38	2.75	3.19
M7	2.26	2.7	3.08
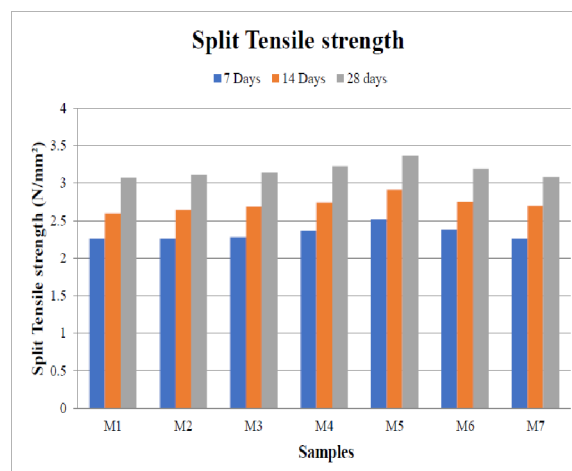
Figure 8: Graph showing Split Tensile Strength.

Figure 9: Split Tensile Testing of Cylinder in CTM.

The % variation of compressive and split tensile strengths in comparison with the conventional concrete is given below. The comparison indicates the maximum % variation in M5 sample which contains 30% slag sand from both the tests.

Table 5: % variation with respect to conventional mix					
Compressive Strength (Mpa)			Split Tensile Strength (Mpa)		
Samples	Strength at 28 days	% variation	Samples	Strength at 28 days	% variation
M1	26.2	0.00%	M1	3.07	0.00%
M2	26.92	2.75%	M2	3.11	1.36%
M3	27.4	4.58%	M3	3.14	2.26%
M4	29.15	11.26%	M4	3.22	4.99%
M5	31.52	20.31%	M5	3.37	9.68%
M6	28.23	7.75%	M6	3.19	3.80%
M7	26.4	0.76%	M7	3.08	0.38%

5. Conclusions

After conducting the strength tests on the concrete specimens the following conclusions can be drawn:

- Both compressive and split tensile tests have shown increase in strength with increase of replacement percentage for all mixes at each curing period, up to 30% where maximum strength is obtained.
- Increase in replacement percentage beyond 30% will give lower strength

- Finally based on the study, it can be concluded that M-sand can be replaced by slag sand up to 30% where it yields maximum strength when compared to conventional concrete.
- Self-curing concrete can be employed in areas with scarcity of water.
- Serves as an effective waste disposal method for industrial byproducts.
- Can be used for tunnel linings, pavements, flooring etc.

References

1. Aziz, F. N. A. A., Elhibir, M. M. O., Bakar, N. A., & Safiee, N. A. (2018, October). Compressive Strength and Water Absorption Behavior of Self-Curing Fiber Reinforced Concrete. In IOP Conference Series: Materials Science and Engineering (Vol. 431, No. 4, p. 042008). IOP Publishing.

2. Arun A, Madhan M B, SagarGotur, Sethupathy G, Divya Nair (2018). Comparison of River Sand and Iron Ore Slag Sand.International Research Journal of Engineering and Technology (IRJET) Volume: 05 Issue: 05 | May-2018.

3. Arya S, Biju Mathew (2017). An investigation on the properties of self-curing polypropylene fiber reinforced concrete. International Research Journal of Engineering and Technology (IRJET) Volume: 04 Issue: 06 | June -2017.

4. Archana, P., Nayak, A. N., Nayak, S. R., & Vaddar, H. (2017). Study of strength of polypropylene fiber reinforced concrete. International Journal of Engineering & Technical Research, 6(6), 8-11.

5. Divya S D, AswathyLal (2015). Study the Effect of Polypropylene Fiber with Steel Slag Aggregate in Concrete. International Journal of Science and Research (IJSR) ISSN (Online): 2319-7064.

6. Kumar, D. S., Kumar, P., Sah, R., Kaza, M., & Prasad, S. M. R. (2016). Converting granulated blast furnace slag into fine aggregate. Int J Civil Eng Res, 7(2), 91-103.

7. Kumar, P. R., & Kumar, P. (2015). Use of blast furnace slag as an alternative of natural sand in mortar and concrete. Int J Innov Res Sci Eng Technol, 4(2).

8. Ahmed SeragFaried ,Taher A. Tawfiq and Magdy A. Abd- ElAziz (2017). The exploitation of Blast furnace Slag as Sand Replacement in Concrete.International Journal of Engineering Research and Technology (IJERT) Vol. 6 Issue 04, April-2017.

9. Mohammed Shafeeque.V, Sanofar.P.B, Praveen.K.P, Jithin Raj, Nikhil.V.PGopikrishna.P.M (2016) Strength Comparison of Self-Curing Concrete and Normal Curing Concrete. SSRG International Journal of Civil Engineering (SSRG – IJCE) – Volume 3 Issue 3–March 2016.

10. Dahyabhai, P. M., & Pitroda, J. R. (2014). Introducing the self-curing concrete in construction industry. International Journal of Engineering Research & Technology (IJERT), 3(3), 1286-1289.

11. Ramujee, K. (2013). Strength properties of polypropylene fiber reinforced concrete. International journal of innovative research in science, engineering and technology, 2(8), 3409-3413.

EFFECT OF PEDESTRIAN CROSSING BEHAVIOR AT MID-BLOCK SECTION OF URBAN ROADS ON TRAFFIC FLOW CHARACTERISTICS

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ABSTRACT

In general, there are two types of crossings i.e. at-grade and grade separated. If the pedestrians are completely segregated (grade-separated) with vehicular traffic, then there is no effect of pedestrian crossings on vehicular flow characteristics. If such grade separated crosswalks are too apart from each other, then pedestrians either change their road crossing choice according to their destination which will result in more travel time or pedestrian will use forced gaps to cross the roads. Also, due to poor construction of grade separated facilities and roadside development, pedestrians usually cross the road at unprotected mid-block locations under mixed traffic conditions. However, in mixed traffic condition, it is very rare to get adequate vehicular gaps to cross the road. Hence, pedestrians will exhibit non-complaint road crossing behavior, causing more interference with vehicles. It leads to a rigorous change in vehicular flow characteristics such as speed and flow. The present study is carried out with the objective to study traffic flow characteristics at such sections.The present study has analyzed the effect of pedestrian crossing on the characteristics of vehicular flow at mid-block location under mixed traffic conditions. The study results may be useful for decreasing the travel time for vehicular drivers by controlling usage of pedestrian forced gaps.

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Introduction

Traffic has grown in recent years with urbanization and hence became major consent for the developing nations. The un-protected mid-block location is one of the important components in the urban transportation system for pedestrian activities under mixed traffic conditions especially in countries like India. The number of such un-protected mid-block pedestrian road crossing activities has been increasing in Indian context and growth of these activities may also result in pedestrian accidents. The increase in un-protected midblock pedestrian road crossings has been a significant effect on vehicular characteristics such as an increase in travel times and a decrease in vehicle speed. At signalized midblock and intersection, there is the complete right-of-way to pedestrians and vehicles as it results a decrease in pedestrian and vehicle conflicts as well as the severity of conflicts.

There are numerous studies which deal with the pedestrian road crossing behavior at intersection and mid-block locations. The importance of these crossing studies is related to the evaluation of pedestrian facilities, traffic control features and road safety treatments by means of before and after crossing studies on pedestrians' behavior as well as safety. Pedestrians need to cross the road at some location during the course of travel and crosswalks are important for pedestrians to cross the road. The crosswalk locations should provide safe and comfortable movement.

In this context, the objective of present study is to investigate the effect of pedestrian crossing on vehicular characteristics. More precisely, this research aims to study the vehicular flow characteristics with and without pedestrian crossings along the same roadway section with same geometry properties. Hence we study the effect of pedestrian crossing on unprotected midblock without crosswalk available for pedestrians.

Literature Review

The designing of pedestrian crossing facilities at proper location is a complex problem under mixed traffic conditions in countries like India. The choice of a particular type of pedestrian crossing facilities (at grade or grade separated) influences the safety of pedestrian and results in change of vehicular flow characteristics. It is very important to avoid the sudden change of vehicular flow characteristics caused by

unexpected pedestrian crossings by improving typical crossing locations usually by implementing refuge median islands or signalized crossings or complete segregation (grade separated) by considerations of both vehicle as well as pedestrian volume. In this line, Bak and Kiec (2012) studied the influence of mid-block pedestrian crossings on roadway capacity by the simulation model. The results indicate that the vehicular driver willingness to give a right of way to pedestrians on urban roads results in decrease in capacity reduction and increase in delays and it is also observed that there is significant reduction in roadway capacity at zebra crossing locations. Schroeder et al. (2012) found that effect of pedestrian non-complaint behavior on vehicular capacity at the multilane roundabout as a function of the driver yields behavior. Duran and Cheu (2012) studied the effect of crosswalk location as well as pedestrian volume on roundabout capacity by the simulation model. From the results, they concluded that if the crosswalk is placed further upstream from the yield line then the entry capacity of roundabout approach increases. But, there is no significant change in the entry capacity when the crosswalk is beyond three car-length upstream from the yield line.

The yielding behavior is affected by various aspects of the roadway and driving environment, including vehicle dynamics, pedestrian's behavior, roadway function and design. The driver yield behavior is rarely observed (those pedestrian waiting at curb location) at un-signalized intersection under mixed traffic conditions. The non-complaint behavior of pedestrian and non- driver yield behavior the interaction between pedestrian-vehicle increases at un-signalized mid-block crosswalk locations. Dulaski and Liu (2013) studied the interaction between the pedestrian and vehicular driver at un-signalized mid-block locations when pedestrian is waiting at curb and stepping off the curb. From the results, it was concluded that, the driver yield behavior is more when the pedestrian steps off from the curb and it is more during morning peak hours. Safety at mid-block crosswalks depend on the ability of drivers and pedestrians to recognize potential conflicts. Some of the researchers explored pedestrian safety at mid-block crosswalk location and they concluded that pedestrian safety is governed by driver yield behavior (Brumfield et al., 2013) and some researchers have carried pedestrian road crossing behavior comparative study between signalized and un-signalized midblock locations (Khatoon et al., 2013). But, there is trade-off between pedestrian safety and vehicular flow characteristics (speed, vehicular flow etc.) at un-protected midblock locations due to non-complaint road crossing behavior of pedestrian.

In summary, a midblock path provides pedestrians a safer and a lot of visible thanks to cross a street than crossing at a random and infrequently dangerous location. Midblock crosswalks are most helpful in suburbs and areas wherever it's common to seek out long stretches while not intersections. Midblock crosswalks ought to be settled wherever there's significant traffic and major destinations, like faculties, looking centers, or transit stops. whereas all midblock crosswalks should be marked, they will even be increased with medians, refuge islands, signals, signs, lighting and curb extensions.In the urban transportation system at some locations (school zone and residential areas) the effect of vehicular traffic is reduced by implementing raised pedestrian crosswalks. Some research studies were carried on effect of raised pedestrian crosswalks on urban vehicular traffic. However, the improper midblock crosswalk location was deliberating the pedestrian crossing behavior. Moreover, this crossing behavior leaves a deleterious impact on traffic stream. Few research studies address the effect of pedestrian. The present research work is directed to the improvement and development of mid-block section and road intersection and to regulate the traffic volume and its downside by traffic style in urban areas in the developing nations like Indian. The objectives of the current study area formulated to study the pedestrian crossing characteristics and behavior in urban roads and to study the effect of pedestrian crossing behavior on traffic flow characteristics.

Study Location

Following are the factors considered for selection of study section:

- The midblock section should be free from the effect of any kind of side frictions like speed breakers, bus stops, signals etc. other than pedestrian crossing.
- The midblock section should be free from the effect of intersection gradient, horizontal and vertical curve with uniform geometry.
- The midblock section should have good traffic and pedestrian flow.
- The midblock section should not have any crosswalks available for pedestrian to cross.

By considering all the above criteria, the sections selected were NagavaraandYelahankaNew Town, Bengaluru. Nagavara is in north Bengaluru and has a population of 35264according to 2011 census (conducted by BBMP). The main cause of traffic and its congestion in this area is Manyata Tech Park (also called Manyata Embassy Business Park),which is a software technology park in Bangalore. The park is situated in Nagavara (near Hebbal) on Outer Ring Road, and has a building area of 9.8 million square feet.

First midblock section was located near outer ring road of Nagavara which has mixed traffic in immense amount and second midblock section was located 80m away from first location and had vast amount of vehicle traffic and reduced pedestrian traffic. Figure 1 shows the Google Maps Image of Nagavara.

Yelahanka New Town is a suburb of Bengaluru and has population of 30,000 according to 2011 census (conducted by BBMP). YelahankaNew Town is connected with downtown Bangalore through Yelahanka Old Town which is in turn connected to a network of roads and a six lane dual carriageway highway. The same highway connects Yelahankawith Kempegowda International Airport and other villages near Devenahalli.

A midblock section was located near dairy circle of Yelahanka which had ample amount of pedestrian and vehicle traffic and the second

midblock section was located 125m away from first location which had low pedestrian traffic and moderate amount of vehicle traffic. Figure 2shows the Google Maps Image of Yelahanka New Town area
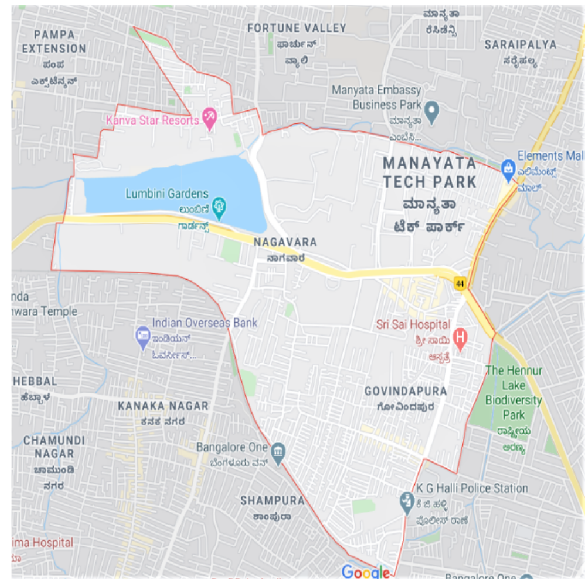
Figure 1. Google Maps Image of Nagavara
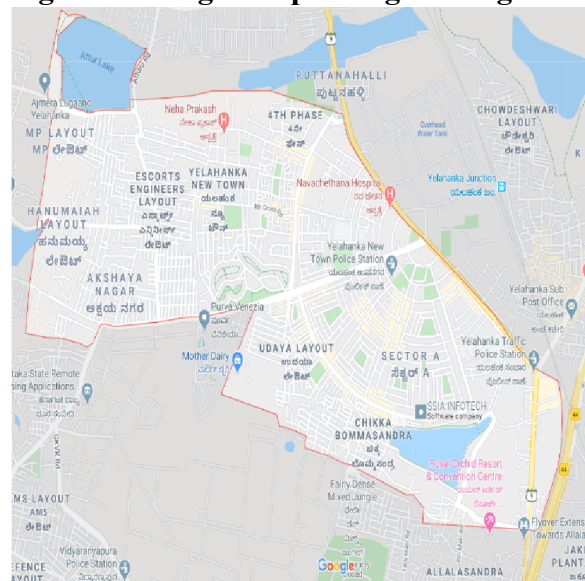
Figure 2. Google Maps Image of Yelahanka New Town

Data Collection

Videotaping survey was conducted at both locations during a normal weather working day condition. The survey was conducted during peak flow condition in morning (8:00-10:00AM). The video camera was located at the side of the road/ on the footpath. Figure 3 shows the video camera setup for capturing the

vehicular and pedestrian traffic at the study locations.

Data that was collected includes pedestrian and traffic characteristics. In particular, to study the individual vehicular effect by pedestrian crossing, data was collected for 2 hours. The collected data includes a number of pedestrians, vehicular flow, and vehicle speed. The video-graphic data was captured with the help of high-resolution cameras to capture vehicular characteristics.

Figure 3. Video Camera Setup

Data was collected in time step of 5 minutes. From each time step (5 min), data was collected which includespedestrian and traffic characteristics.In particular, to study the individual vehicular effect by pedestrian crossing, data was collected every 5 min and it is approximated to hourly traffic in order to get each hour traffic flow characteristics. Data collected consists of mean speed of vehicles, density and flow of vehicles, total number of vehicles traversing and number of pedestrians crossing the road.

Analysis

Preliminary observation

- From the preliminary survey, it is observed that there is significant difference between speeds of different class of vehicles at selected locations (with and without pedestrian crossing).
- It was observed that, the higher jaywalking or higher multiple stage of road crossing behavior, parked vehicles and pedestrians waiting for bus or auto rickshaw further increases the

interaction between vehicles and pedestrian.
- It was observed that pedestrians neglected the sidewalk or footpath which was in perfect condition, and often used walk on the road.
- Few vehicles were parked on the sidewalk often.

Figure 4 and 5 shows the vehicles parked on the foot path and pedestrians walking on road adjacent to a fairly usable sidewalk respectively.

Figure 4. Vehicle parked on footpath

Figure 5. Pedestrians walking on road adjacent to a good sidewalk

The effects of pedestrian crossing on individual vehicles were studied by considering the

variation of individual vehicle flow characteristics. Vehicle Flow characteristics consist of the following parameters (i) volume count (ii) Speed (iii) density of vehicle on road (iv) Flow and various relationship between various traffic flow characteristics.

From the field survey, it is observed that vehicles such as car, two wheelers were more compared to heavy vehicles and auto rickshaw and cars at the selected site. Hence, individual variation analysis was only carried out for car and two wheelers. The following figures show the variation of both midblock section (i.e. unprotected and protected) from theoretical curves.

5.2 Volume count

Road user volume count data was extracted by using VLC Media player software. The road users classified into five different categories for both sites as shown in following tables. Total number of vehicles recorded in Nagavara are 9390 and Yelahanka New Town are 5823, during 2-hour time period at both protected and unprotected midblock sections. Table 1 and table 2 shows the volume count at unprotected midblock section and protected midblock section at Nagavara and Yelahanka New Town, Bengaluru, respectively.

Table 1 Volume Count at Unprotected Midblock Section and Protected Midblock Section at Nagavara

Road user type	Road users included	Volume Count at unprotected midblock section	Volume Count at protected midblock section
Pedestrian	Pedestrians crossing the road	96	0
2 Wheeler	Scooter, Motorcycle, Bicycle	3343	3002
3 Wheeler	Auto rickshaw, Garbage rickshaw	757	612
4 Wheeler	Cars	809	535
Heavy Vehicle	Buses, Trucks, Big Utility Vehicles	178	154

Table 2 Volume Count at Unprotected Midblock Section and Protected Midblock Section at Yelahanka New Town

Road user type	Road users included	Volume Count at unprotected midblock section	Volume Count at protected midblock section
Pedestrian	Pedestrians crossing the road	110	0
2 Wheeler	Scooter, Motorcycle, Bicycle	1902	2008
3 Wheeler	Auto rickshaw, Garbage rickshaw	375	486
4 Wheeler	Cars	310	514
Heavy Vehicle	Buses, Trucks, Big Utility Vehicles	107	121

Speed Measurement

From the play back videos in theVLC Media player software, the entry and exit timings of vehicles on marked lines for every 5 minutes are noted. The distance between the two lines was known (30m) and the speed extracted are average speeds or mean speeds using the equation 1. Table 3 shows the speed data for the study locations.

$$Speed\ of\ Vehicle = \frac{\text{distance between marked lines(d=30m)}}{\text{time taken to traverse between marked line(t)}} \quad \text{eq (1)}$$

Table 3 Speed data in kmph at Nagavara and Yelahanka New Town.

	Type of Road User	Speed in kmph at Nagavara			Speed in kmph at Yelahanka New Town		
		Minimum	Maximum	Mean	Minimum	Maximum	Mean
Midblock with pedestrian crossing	All Vehicles	12.00	40.00	26.00	12.00	36.00	24.00
	2 Wheelers	21.16	40.00	30.58	19.60	36.00	27.80
	3 wheelers	20.16	36.00	28.08	19.60	31.76	25.68
	Cars	17.60	32.70	25.15	16.61	29.18	22.80
	Heavy vehicles	12.00	27.00	19.50	12.00	27.00	19.50
Midblock without pedestrian crossing	All Vehicles	15.40	51.40	33.40	19.60	54.00	36.80
	2 Wheelers	30.80	51.40	41.10	27.00	54.00	40.50
	3 Wheelers	27.00	41.50	34.25	27.00	41.53	34.26
	Cars	26.30	45.00	35.65	26.34	41.53	33.94
	Heavy Vehicles	15.40	36.00	25.70	19.60	36.00	27.80

Traffic Flow and Density

Density (k) is calculated as the ratio of number vehicles traversed between two marked on lines on a lane in a specified time to distance between the two marked lines on the lane. Here average or mean density has been calculated using the equation 2:

$$Density\ (k) = \frac{Number\ of\ vehicles\ traversed\ between\ two\ marked\ lines\ on\ a\ lane\ \ in\ a\ specified\ time}{distance\ between\ the\ two\ marked\ lines\ on\ the\ lane}\ \ eq\ (2)$$

Flow is the number of vehicles passing a reference point per unit of time, vehicles per hour. Here it is calculated as the product of average or mean speed of vehicles (v) and density (k). Equation 3 showa the relation between traffic flow (q), density (k) and speed (v)

$$Flow\ (q)\ =\ speed\ of\ vehicles\ (v)\ *\ density\ (k)\ \ eq\ (3)$$

Table 4 shows the density (k) and flow (q) at the Nagavara and Yelahanka New Town

Crossing condition	Traffic type	Nagavara		Yelahanka New Town	
		Density (k) in veh/km	Flow(q=v*k) in veh/hour	Density (k) in veh/km	Flow(q=v*k) in veh/hour
Midblock section with pedestrian crossing	2 Wheelers	15	459	9	250
	3 Wheelers	4	112	5	129
	Cars	5	126	5	114
	Heavy vehicle	3	59	3	58.5
	All Vehicles	28	728	23	552
Midblock section without pedestrian crossing	2 Wheelers	15	617	10	405
	3 Wheelers	9	308	3	103
	Cars	7	250	4	136
	Heavy vehicle	2	52	3	83
	All Vehicles	35	1169	20	736

The speed (v) – Density (k) – Flow (v) relations are developed for the traffic flows with and without pedestrian crossings and are shown in figure 6.
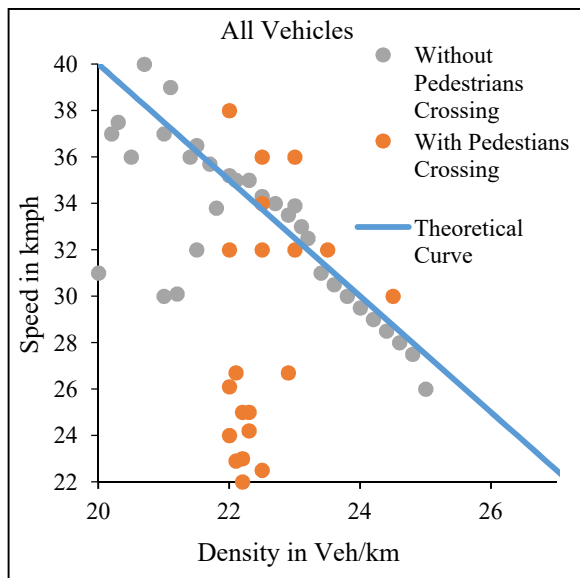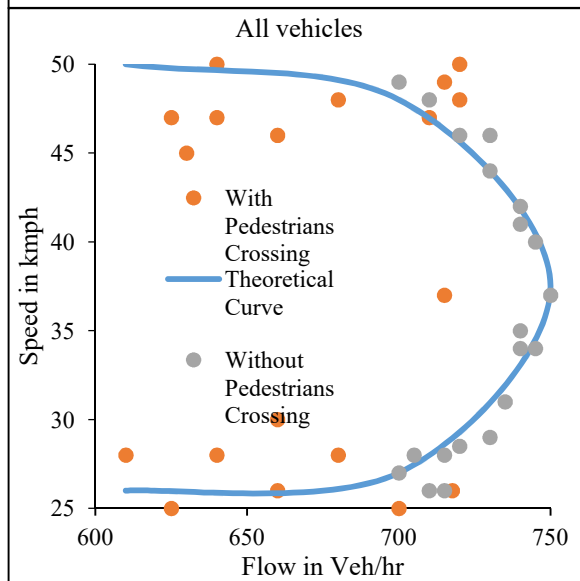
(a) Traffic Speed (v) – Density (k)
(b) Traffic Speed (v) – Flow (q)
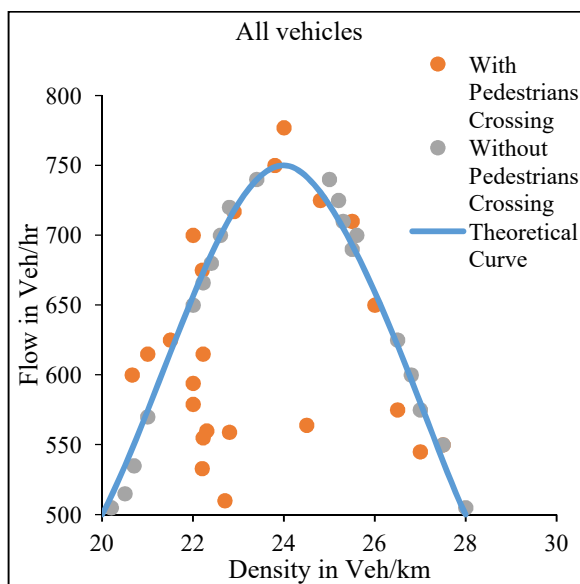
(c) Traffic Flow (q) – Density (k)

Figure 6 Traffic Speed (v) – Density (k) – Flow (q) Relationship

The Speed -Density relationship of all the vehicles is approximately equal to theoretical one for midblock section without pedestrian crossing. But irregular variation is recorded for midblock section with pedestrians crossing the road. This variation is due to various reasons including driver and pedestrian behavior.

Results and Discussion

In this study, data was analyzed and the result shows the fundamental relation between the speed-density and speed-flow and flow-density. The study also shows how the pedestrians' crossing at midblock effects the speed, density and flow of different categories of vehicles and how behavior of driver changes from one section to another.Speed characteristics of unprotected and protected midblock section show that there is a significant difference in speed in all categories of vehicles. The pedestrians' crossings negatively affect the capacity of the section.

From the manual count method pedestrians' crossing the section was calculated for every 5minutes. From this, it is noted down that the pedestrians'crossing varies from section to section and from place to place also. The size of the data collection depends on the length of the counting period, the type of count being performed, crosswalks being observed and the road conditions.

The Vehicle count in Yelahanka New Town is lesser than Nagavara region, but pedestrians' crossing the section is higher than Nagavara region, due to less vehicle activity in the suburb. The Vehicles drive slowly at unprotected midblock section and have slightly higher speeds in protected midblock section.

Irrespective of the midblock section, two wheelers are present in higher count than any other vehicles and they also have higher speeds than any other category of vehicle with an average of 29 kmph and 40 kmph at unprotected and protected midblock sections, respectively.Two wheeler tend to change the vehicle path slightly to compensate for the interference of pedestrians.

Cars have higher interaction time with pedestrians' crossing the section as they have to yield and decrease their speed, with an average of 24 kmph and 35 kmph at unprotected and protected midblock sections, respectively. The relation between speed and density and flow are affected by pedestrians' crossing and have greater variation in unprotected midblock section than in protected midblock section.

Heavy Vehicle are not much affected by pedestrians' crossing as they are driven at low speed in District Roads and Urban Roads. But the speed and flow values vary only slightly and they also cause delay to other vehicles in smaller midblock sections with an average speed of 20 kmph and 26 kmph at unprotected and protected midblock sections, respectively. The Density and Flow values do not vary highly as in case of two wheelers and cars.

Three Wheelers tend to be affected by standing pedestrians rather than pedestrians crossing the road as they are anticipating fareswith an average speed of 28 kmph and 32 kmph at unprotected and protected midblock sections, respectively. The Density and Flow values do not vary highly as in case of two wheelers and cars.

Conclusions

The vehicular speeds were implicitly affected with pedestrian crossing when compared to without pedestrian crossing location under mixed traffic conditions. The theoretical capacity is significantly reduced with pedestrian crossings for car. However, increase in capacity is observed with pedestrian crossings in case of two-wheeler. The underlying fact is the variation of the speed of the car and two-wheeler.

The increase in reduction of vehicle speed significantly affects the travel time of vehicular drivers and it further has influence on the fuel consumption. However, the driver yield behavior is the tradeoff between pedestrian safety and vehicular flow characteristics. This study clearly indicates that the importance of pedestrian crossing facilities and the barrier effect on the vehicular flow characteristics.

Reduce pedestrian exposure to vehicular traffic. Better and easy way for pedestrian crossing is implementing pedestrian safety interventions for road geometry and grade separated crossing rather than using at-grade crossing. This judgment of segregating pedestrians from vehicular traffic should be based on the number of pedestrian accidents, illegal pedestrian crossing and demand of pedestrian as well as vehicular flow.

This study has few limitations, in this study the effect of pedestrian crossing on the heavy vehicle is not addressed because of less heavy vehicle flow at selected location.

Jaywalking should be considered a legal offense, at least at some roads where vehicular traffic and pedestrian volume is high.People need to be educated about crossing behavior and the delays and effect it has on day to day traffic.Various vehicles park at or near sidewalks. This should be prohibited in order to keep pedestrian and vehicular traffic separate

References

1. Bak, R., &Kiec, M. (2012). Influence of midblock pedestrian crossings on urban street capacity. *Transportation research record*, *2316*(1), 76-83.
2. Bang, K. L. (1995). Impact of side friction on speed-flow relationships for rural and urban highways. *SWEROAD, Indonesia*, 27.
3. Kadali, B. R., Chiranjeevi, T., & Rajesh, R. (2015). Effect Of Pedestrians Un-Signalized Mid-Block Crossing On Vehicular Speed. *International Journal for Traffic & Transport Engineering*, 5(2).
4. To Study Traffic Characteristics of Urban Midblock Section Influenced by Crossing Pedestrians under Mixed Traffic Conditions, HareshkumarDhayabhai.

5. Ranjeeth, S., &Latchoumi, T. P. (2020). Predicting Kids Malnutrition Using Multilayer Perceptron with Stochastic Gradient Descent. Rev. d'IntelligenceArtif., 34(5), 631-636.

6. Google, Wikipedia, YouTube etc.

7. Prasath, D. S., &Selvakumar, A. (2015). A Novel Iris Image Retrieval with Boundary Based Feature Using Manhattan Distance Classifier. International Journal Of Innovative Technology And Creative Engineering (Issn: 2045-8711) Vol, 5.

8. Balamurugan, K. (2021). Fracture analysis of fuselage wing joint developed by aerodynamic structural materials. Materials Today: Proceedings, 38, 2555-2562.

9. Chandra, S., Rao, G. S., &Dhamaniya, A. (2014). Effect of pedestrian cross-flow on capacity of urban arterials. *Indian Highways*, *42*(1).

10. Varhelyi, A. (1998). Drivers' speed behaviour at a zebra crossing: a case study. *Accident Analysis & Prevention*, *30*(6), 731-743.

11. Yagar, S., & Van Aerde, M. (1983). Geometric and environmental effects on speeds of 2-lane highways. *Transportation Research Part A: General*, *17*(4), 315-325.

12. Ashalatha, R., & Chandra, S. (2011). Critical gap through clearing behavior of drivers at unsignalised intersections. *KSCE Journal of Civil Engineering*, *15*(8), 1427-1434.

EFFECT OF REJUVENATORS ON BITUMEN MIXES

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ABSTRACT

The road network of 33 lakh kilometres in India is the second largest in the world. Despite much significance to national economy, the road network lacks quality in several aspects. The road construction exposes various concerns pertaining to the availability of natural resources such as soil, binders, aggregates, fuel etc. India consumes about 5 million tons of viscous bitumen per year and the quality of the binder used is required to comply with the specified standards. The rapid depletion of natural materials has led the asphalt industry to find other sources to build sustainable and economical roads without compromising the quality of the material. The Hot mix asphalt roads are rehabilitated by milling and replenishing with new HMA. As a result, 100 million tons of milled materials are generated annually. This may cause environmental damages if not properly disposed and landfills required is of large area. Pavement performance decreases considerably after years of exposure to traffic loads and climate changes. The pavement structure at the end of its life design can be crushed and recycled and used in construction in varying amounts with the addition of rejuvenators to obtain desired properties. There is need to adopt to the rejuvenation technique more reliable with the recycled materials in large traffic volume roads that needs to be maintained. This paper highlights the use of recycled asphalt pavement for the construction of new roads with the addition of rejuvenators with cost analysis.

Keywords: Asphalt Pavement, Rejuvenators.

Introduction

The road network of 33 lakh kilometres in India is the second largest in the world and accounts for 65% of goods and 80% of passenger transportation and comprises of expressways, national highways, state highways, major district roads n other district roads. India consumes about 5 million tons of viscous bitumen per year and the quality of the binder used is required to comply with the specified standards. These four grades of bitumen such as VG10, VG20, VG30 and VG40 are used in the construction of the pavement. Indian refineries produce only two grades of viscous bitumen grade VG 30, VG10 and are not adequate for traffic and climatic conditions in India. The rapid depletion of natural materials has led the asphalt industry to find other sources to build sustainable and economical roads without compromising the quality of the material.

The most common failures in the pavements are the Map cracking or alligator cracking, Pavement layers consolidation, Shear failure cracking and Longitudinal cracking

Material Characteristics

Bitumen is a nonrenewable material which is obtained by distillation of crude oil. This complex organic material is strongly recommended for the construction of the pavement structure. The consistency of the binder varies with temperature. Temperature sensitivity is considered to be the measure at which consistency of binder fluctuates with temperature variation and is an important property of the binder.

Binder Rheology

Binder changes it properties to climatic and environmental factors, where rheological properties of asphalt binder affects pavement performance. The age hardening is the first hardening process that starts from drum mixer or through pug mill to laying and through its design life. Rheology changes such as reduction of penetration and increase of the viscosity of bituminous binder takes place during the mixing period of two oxidation processes in the air and losing of the more resilient components. The main factors contributing to the age hardening of the asphalt during the mix/ in the service of it age:

a) Oxidation: This is the oxygen process and the reaction with the oxidation rate according to the variation in binder and the bonding temperature

b) Polymerization: The combination of molecules to form larger molecules, thus producing a progressive hardening.

c) Volatilization: This depends on the temperature change and the process of the lighter components evaporate.

d) Thixotropic: This hardening of asphalt is anticipated to the gradual emergence of structure on the asphalt over a duration of time. This may be checked to an extent by reheating the material.

e) Separation: The process of removing resins, the oily constituents of binder that the absorption of a part caused by porous aggregates.

Reclaimed Asphalt Pavement (RAP)

The Hot asphalt roads are rehabilitated by milling and replenishing with new HMA. As a result, 100 million tons of milled materials are generated annually. This may cause environmental damages if not properly disposed and landfills required is of large area. Pavement performance decreases considerably after years of exposure to traffic loads and climate change. The pavement structure at the end of its design life can be crushed and recycled and used in construction in varying amounts. Therefore, through rehabilitation process, the properties of old asphalt can be improved to restore the original properties. Hence the use of recycled materials (RAP) has reached high interest due to fewer waste.

Rejuvenators

The availability of desired asphalt properties such as viscosity, penetration and ductility may not be possible at all instances for a particular project. However, changing the available asphalt is possible by adding softer or harder hydrocarbon materials. Aged asphalt in RAP should be softened or rejuvenated to reduce stiffness through the use of recycling agents. On the other hand, some of the asphalt must be hardened by adding hardening agents used in HMA in high stress areas such as toll booths and intersections. Typically rejuvenators should reinstate the recovered binder to a level of consistency characteristics suitable for pavement construction and operation.

ASTM Requirements for Penetration and Viscous Grade Asphalt

Table 1

Test	Penetration Grade	Viscosity Grade
Penetration, 25°C, 5 s	60-70	50
Ductility, 25°C, cm	100	100
Solubility in trichloroethylene,%	99	99
Retained penetration and viscosity respectively after thin film oven test%	52+	15000
Ductility, after thin film oven test	50	40
Flash point	232	232

Methodology

The pavement construction, maintenance and rehabilitation is an important consideration for the infrastructure development of the country. Hence, the material requirement for construction is enormous and as the availability of binder is proven to be costlier, road construction agencies have found alternatives of using RAP materials to a certain proportion with the addition of rejuvenating agents to maintain original binder properties.

The experimental procedure included in this study as aimed t checking the consistency of original binder and the RAP extracted binder by the Brookfield viscometer test. The main aim of the study is to replace the original binder content with the RAP binder by adding rejuvenating agents such as waste cooking oil, waste engine oil and plastic are varying percentages and determining the optimum dose. This chapter gives a detailed information regarding the materials used such as RAP, virgin binder and rejuvenating agents used in the study. In addition it also highlights on the various laboratory tests performed such as dynamic shear rheometer. Fourier transform Infrared Spectroscopy and the test procedure involved in this study is carried out as per the codal structure.
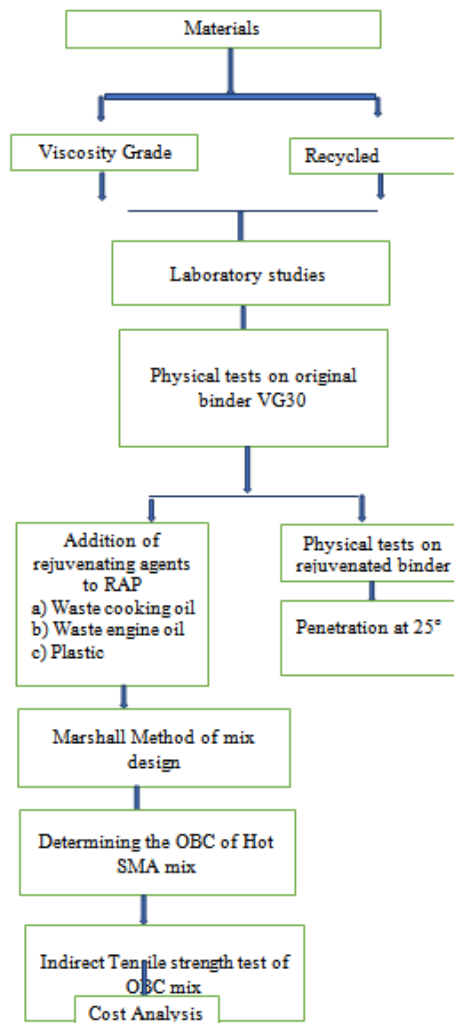
Figure 1

Selection of Materials

For the present study, RAP material was collected from selected sections, NICE expressway and the other sample from SH 17 (Gulbarga region) which is 8 years aged and 15 years aged, respectively. The characterization of obtained RAP material is done by detailed laboratory studies. Furthermore, the virgin binder VG30 is procured and further evaluation is done. The rejuvenators in this study were waste cooking oil obtained from nearby hotel, waste engine oil from automobile shop and shredded plastic.

Recycled Materials

The basic properties of binder in RAP is investigated as per IS 73-2006 and further investigation of the binder is done with addition of rejuvenating agents at varying percentages to examine the behavior. The consistency test on original VG30 binder was carried out using Brookfield viscometer at 135 deg C. the asphalt separation from reclaimed asphalt pavement material is done by extraction process.

Bitumen Extraction

The recycled asphalt pavement material samples were immersed in benzene solution and extraction method was conducted by using centrifugal bitumen extractor according to IRC-SP 11. The centrifugal extractor is used to extract bitumen which consists of a bowl rotating at a controlled speed up to 3600 rpm, it also consists of a drain pipe to remove solvent from the mixture collected in a separate collected container

Standard Requirements for VG30 Asphalt
Table 2

Tests	Specification As per IS-73 2006
Absolute viscosity(60) poise	2400, min
Kinematic viscosity(135),cst	350 min
Penetration at 25 C, 5 sec,0.1 mm	50-70
Softening point (ring and ball)	47

For the residue obtained from thin film oven test, the ductility at 25o c should be a minimum of 40 cm and the typical quality requires a ductility of 150 cm. the evaluation of binder in RAP is examined by the penetration value before and after the extraction process. When the amount of reclaimed asphalt materials to be used exceeds 10 % the penetration value of the recovered asphalt from RAP before mixing shall exceed 15 and after the asphalt recovery, the penetration value should not be less than 39 for VG30 grade binder as per Ministry of Roads Transport and Highways, clause 517.2.6

Mix Design

The method for characterization of bituminous mixes recommended is Marshall Mix design. The Marshall compaction is slowly being replaced by gyratory compaction as it obtains similar degree of aggregate reorientation caused by shear action imparted to mix in the field. The compaction is done using Marshall Hammer providing 50 no's of blows on either side of the specimen and test is conducted as per ASTM D1559-96. The optimum binder content is determined on the ability of mix to relate to stability volume changes and flow

Virgin Aggregate Mix Design
For the present study the aggregate gradation adopted is stone Mastic Asphalt (SMA) recommended by IRC SP-79 2008. The midpoint gradation of aggregates is considered which are used in bituminous mixes.

Mix Design for RAP Material

The mid gradation method is adopted for aggregates blend RAP material for varying percentages of 30%, 50% and 70% respectively and as per guidelines the layer gradation requirement is considered.

Gradation of Aggregates for SMA Mix
Table 3

IS Sieve	%Passing	Mid Gradation	%Weight	Weight Retained
26.5	100	100	-	
19	90-100	95	5	60
13.2	45-70	57.5	37.5	450
9.5	25-60	42.5	15	180
4.75	20-28	24	18.5	222
2.36	16-24	20	4	48
1.18	13-21	17	3	36
0.60	12-18	15	3	36
0.30	10-20	15	3	36
0.075	8-12	10	4	48

Results and Discussion
The preliminary results from the tests on virgin binder, RAP materials used for study was evaluated and it satisfied the limits s per IS-73:2006. The Brookfield viscosity test was carried out as per ASTM D4402 on virgin binder (VG30), RFO aged binder and RAP extracted binder which was 8 and 15 years aged.

The experimental procedure was aimed at testing basic properties of fresh binder and RAP binder with addition of waste cooking oil and waste engine oil a rejuvenators to the binder at 2%, 4% and 6%. The Marshall stability was carried out considering hot SMA mix using Polymer Modified Binder and further analysis included the blending of recycled asphalt pavement material (RAP) of varying proportions 30%, 50% and 70% with

bitumen content of 5%, 5.5% and 6% for the mix. The stability and strength for the SMA

Mix is performed for hot mix temperature.

Percentage of Binder Content in RAP
Table 4

Sl No	Binder content	Sample 1	Sample 2
1	Initial weight of aggregate W1	1000	1000
2	Initial weight of filter paper X3	6.2	6
3	Aggregate weight after extraction W2	962.4	961.9
4	Filter paper weight after extraction Y	6.6	6.3
5	Bitumen content (%)	3.72	3.78

Results of Original Binder VG30
Table 5

Binder Properties	Permissible Limits	Obtained Values	Codal Specification
Penetration at 25 C,5 sec	68	60-70	IS 1203-1978
Ductility , cm	86	75 min	IS 1203-1978
Flash point	270	175 min	IS 1448-1969
Softening point	52	45-55	IS 1205-1978

Properties at Optimum Binder Content for SMA Mix
Table 6

Sl No	Properties	RAP 30%	RAP 50%	RAP 70%	Virgin Mix
1	Stability	15.0	15.75	15.25	14.8
2	Flow	4.25	6.73	5.1	5.2
3	Air voids (%)	4.3	4.4	4.1	3.8
4	VFB (%)	76.2	75.5	75.3	77.9
5	Bulk Density	2.360	2.364	2.322	2.320
6	OBC (%)	5.75	5.82	5.86	6.08

Conclusions

The laboratory evaluation of RAP binder with the conventional binder was carried out and involved aging behavior of binder. Two RAP samples 8 and 15 years aged were used for ascertaining various properties of binder's along with addition of rejuvenators at varying percentages. From the detailed study, the important conclusions that can be drawn are;

1. The percentage of rejuvenators allowable in the RAP Mix with the conventional aggregates is 4 to 6%.
2. The Dynamic shear test for classifying the visco elastic behavior of binder indicated that the increase in rejuvenator content affected the binder's resistance to rutting.
3. The Marshall Stability test for SMA Mix with 30%, 50% and 70% indicated higher stability value when compared with that of the conventional mix.
4. Based on the cost analysis, it was observed that utilization of RAP reduces the overall construction cost with reference to the conventional practice by 17.5%, 29%,40% for 30%, 50% an 70% of RAP respectively

Scope for Future Study

1. The addition of rejuvenators to RAP binder can be increased above 10% and evaluated for the Brookfield viscosity classification and compared with the original properties.
2. In the study, the rejuvenators used are waste cooking oil, waste engine oil and plastic. However, by using various other rejuvenators' detailed study can be carried out for determining the aging behavior.
3. The FTIR analysis can be performed in detail considering various other rejuvenators and the effects of each compounds in the Mix may be determined

4. The conventional materials can be replaced with RAP materials and performance can be evaluated for various mixes.

References

1. IRC: 120. (2015). Recommended practice for recycling of bituminous pavements. Indian Roads Congress.
2. Gawande, A., Zamare, G., Renge, V. C., Tayde, S., & Bharsakale, G. (2012). An overview on waste plastic utilization in asphalting of roads. Journal of Engineering Research and Studies, 3(2), 1-5.
3. Abbas BooshehrianWalaa S Mogaver, PhD, PE nd Ramon Bonaquist, Ph D, PE How to construct an Asphalt Binder Maser Curve and Assess the Degree of Blending between RAP and Virgin Binders.
4. Jia, X., Huang, B., Moore, J. A., & Zhao, S. (2015). Influence of waste engine oil on asphalt mixtures containing reclaimed asphalt pavement. Journal of Materials in Civil Engineering, 27(12), 04015042.

ESTIMATION OF EQUIVALENCY UNITS OF DIFFERENT VEHICLE TYPE UNDER MIXED TRAFFIC CONDITIONS

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ABSTRACT

PUC is equivalency unit and acts converting factor that is used to convert different vehicle type in traffic stream into equivalent vehicle type exclusively in terms of passenger cars. There are several methods of estimating the PCU values . This study carried out estimating of PCU using few of method as mentioned in literature only based on data collected from field and it mainly concentrate on the on static characteristics of vehicle .This paper discuss the accuracy of methodology used in studies.

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Keywords: PCU, Equivalency Units

Introduction

In developing country traffic flow is generally heterogenous in nature, however implementing degree of heterogeneity varies. Heterogenous traffic shows complication in implementing traffic operations and designing roads. Measuring traffic volume as veh/hr. is inappropriate because of heterogenous traffic comprising different types of vehicles with different static and dynamic characteristics .due to this heterogeneity traffic studies becomes critical. PCU or PCE is a common approach used to convert the heterogenous traffic into equivalent homogenous units. In analyzing the traffic facilities and controlling and managing the traffic PCU estimation plays crucial role .

The highway research board in 1965 highway capacity manual first defined PCU as "the number of passenger cars displaced in traffic flow by a truck or a bus under prevailing roadway and traffic conditions". Later its redefined by Transportation Research Broad in 2010 as "the number of passenger car which will result in the same operational condition as a single heavy traffic vehicle of a particular section of road under particular traffic type under specified roadway, traffic and controlled conditions. Many different methods came to existence in this mean period of time . This led to confusion between user in terms of accuracy of PCU

Use of appropriate PCU for different vehicle categories will lead to correct volume of heterogenous traffic in mixed traffic conditions holding the desired level of services .In present studies ,videography is used to collect data and different method like dynamic PCU method , modified approach to dynamic method   and multiple non- linear approach method are used and estimated the equivalency units .this paper also compare and discuss accuracy of results obtained from each method

Methodology

1.1 Dynamic Method

According to this method, PCU is directly proportional to speed ratio and inversely proportional to the projected area ratio with respect to the standard vehicle

$$PCU=(V_c/V_i)/ (A_c/A_i)$$

where V_i and V_c = mean speeds of vehicle type 'i' and car respectively; A_i and A_c = respective projected rectangular areas of vehicle type 'i' and car; on the road.

1.2 Modified Approach Method

This method is modification of dynamic method where headway is extra factor which is used to estimate PCU.In this method speed factor, area factor, headway is considered. the product of speed factor, area factor, and

headway factor gives PCU values and calculation of each factor is as shown.

1.2.1 Speed factor (F_v): Its ratio of speed of standard car i.e., small car to that of speed of subject vehicle. Let's consider two-wheeler as subject vehicle.

1.2.2 Area factor (F_a): It is a ratio of area of subject vehicle to that of area of standard car.

Then $F_a = \dfrac{Ai}{Ac}$

Where: F_a- Area factor of subject vehicle.

    A_i- area of subject vehicle.

A_c-area of standard car.

1.2.3 Headway factor F_t:

Its ratio of headway of subject vehicle to that of headway of standard car.

Then $F_t = \dfrac{Ti}{Tc}$

Where: F_t- headway factor of subject vehicle

T_i- mean time headway of subject vehicle

    T_c-mean time headway of standard car

1.2.4 PCU of subject vehicle (TW):

The product of speed factor, area factor, and headway factor gives the PCU of subject vehicle.as shown below.

$PCU_i = F_v * F_a * F_t$

Where:PCU_i-PCU of subject vehicle

F_v- speed factor of subject vehicle

    F_a- area factor of subject vehicle

    F_t- time headway factor of subject vehicle

1.3 Multiple non-linear method

To estimate PCU speed model are developed using independent variable in non-linear regression method. It considers the variable like proportion of all type of vehicle ,an average speed of vehicle types other than standard cars(CS),where CS is considered as standard vehicle and area ratio of CS to all other vehicle types. The product of the area ratio of CS to subject vehicle type ,proportion share of subject vehicle type and average speed of subject vehicles type are used as multiplicative component and proportional of car is used as additive component. This model is developed to predict the sped of standard vehicle type whose co-efficient are estimated as equivalency units of all subject vehicle type.

$$V_{CS} = \sum_{j=1}^{k} a_j \left(\frac{Acs}{Aj} * n_j * V_j \right) + a_i * n_{cs}$$

Where $V_{CS\,i}$=average speed of small car

$a_j \& a_{i\,=}$ regression co-efficient

$V_{j\,=}$ average speed of vehicle type j

$n_{j\,=}$ proportion of vehicle type j

n_{cs}= proportion of standard car

A_j= projected area of subject vehicle type j

A_{cs}= projected area of standard car

Field Data Collection and Analysis

To carry out of studies two different section of NH 16 is selected as site. section I is near Vijayawada and Guntur and second section is at Ongle. Data is collected by varying the time as peak and non -peak hours are considered. 3-4 hours of videography is collected from both sections. A stretch of 50 m is marked and video is recorded . From videography recorded entry and exit time of each vehicle in between stretches noted. Based on this volume of traffic, speed and time headway are collected and even observed traffic capacity and speed parameters like low median and design speed are extracted.

Table 1 Dimension of Vehicle Type

Vehicle type	Length in m	Width in m	Area in m^2
TW	1.97	0.74	1.46
LCV	4.3	1.56	6.71
CB	4.6	1.7	7.82
HCV	6.7	2.3	15.41
A	3.2	1.3	4.16
MAV	11.5	2.42	27.83
BUS	10.6	2.4	25.44
CS	3.6	1.6	6.12

Table 2 Average Speed and Average Headway of Different Vehicle Type at Both Sections

Section	I		II	
Vehicle Type	Average Speed in km/hr.	Average Headway in sec	Average Speed in km/hr.	Average Headway in Sec
TW	54.92	2.54	51.80	4.25
LCV	58.15	2.34	58.63	3.99
CS	84.19	2.68	76.46	4.08
CB	80.32	2.79	84.28	3.80
HCV	52.7	2.88	48.56	4.48
A	50.13	2.58	45.32	3.85
MAV	46.82	2.87	43.95	5.09
BUS	63	2.85	57.54	4.62

Table 3 Speed Parameters and Composition of Vehicle at Different Sections

Section	Vehicle Type	Maximum Speed in km/hr.	Minimum Speed in km/hr.	SD	V 15	V50	V85	Compositions of Vehicle in %
I	TW	90	22.5	14.95	45	60	60	50.10
	LCV	90	30	14	45	60	60	6.76
	CS	90	36	26.44	60	90	90	23.21
	CB	90	30	21.34	60	90	90	7.03
	HCV	90	30	15.83	36	45	60	3.82
	A	60	36	10.07	45	45	60	2.12
	MAV	60	30	10.07	36	45	60	2.59
	BUS	90	35	14.03	45	60	90	4.10
II	TW	90	25	13.29	36	45	60	32.29
	LCV	60	22.5	19.03	36	60	90	6.69
	CS	90	30	17.06	60	90	90	18.70
	CB	90	45	14.38	60	90	90	5.19
	HCV	90	25.8	15.75	36	45	60	4.98
	A	60	22.5	9.23	36	45	60	2.25
	MAV	90	28	10.13	36	45	60	6.69
	BUS	90	45	11.02	45	60	60	4.16
Section	Vehicle Type	Maximum Speed in km/hr.	Minimum Speed in km/hr.	SD	V 15	V50	V85	Compositions of Vehicle in %
I	TW	90	22.5	14.95	45	60	60	50.10
	LCV	90	30	14	45	60	60	6.76
	CS	90	36	26.44	60	90	90	23.21
	CB	90	30	21.34	60	90	90	7.03
	HCV	90	30	15.83	36	45	60	3.82
	A	60	36	10.07	45	45	60	2.12
	MAV	60	30	10.07	36	45	60	2.59
	BUS	90	35	14.03	45	60	90	4.10
II	TW	90	25	13.29	36	45	60	32.29
	LCV	60	22.5	19.03	36	60	90	6.69
	CS	90	30	17.06	60	90	90	18.70
	CB	90	45	14.38	60	90	90	5.19
	HCV	90	25.8	15.75	36	45	60	4.98
	A	60	22.5	9.23	36	45	60	2.25
	MAV	90	28	10.13	36	45	60	6.69
	BUS	90	45	11.02	45	60	60	4.16

Estimation of PCU Using the different method mentioned in literature review, the process of estimation of equivalency units is carried out. PCU is estimated by dynamic method, modified method and multiple non-linear regression method at both section after extracting average speed and average time headway from data collected

Table No. 4 PCU Value of Different Vehicle types by Dynamic Method at Section I and II

Section	Vehicle Type	Speed Ratio	Area Ratio	Dynamic PCU
I	TW	1.53	4.192	0.33
	LCV	1.45	0.912	1.5
	CS	1.00	1.00	1.00
	CB	1.03	0.783	1.23
	HCV	1.59	0.397	4.02
	A	1.67	1.471	1.14
	MAV	1.79	0.220	8.17
	BUS	1.34	0.241	5.5
II	TW	1.47	4.19	0.35
	LCV	1.30	0.91	1.43
	CS	1.00	1.00	1.00
	CB	0.91	0.78	1.6
	HCV	1.57	0.39	3.95
	A	1.68	1.47	1.14
	MAV	1.71	0.22	7.91
	BUS	1.33	0.24	5.52

Table No 5 PCU Value of Different Vehicle types by Modified Approach Method At

Vehicle types	Speed Factor	Area Factor	Headway Factor	Modified PCU
TW	1.53	0.239	0.95	0.35
LCV	1.44	1.09	0.87	1.36
CS	1.00	1.00	1.00	1.00
CB	1.03	1.28	1.04	1.37
HCV	1.59	2.52	1.07	4.28
A	1.67	0.68	1.08	1.3
MAV	1.79	4.55	1.07	8.71
BUS	1.34	4.15	1.06	5.89

Table No 6 PCU Value of different Vehicle types by Modified Approach Method at Section II

Vehicle Types	Speed Factor	Area Factor	Headway Factor	Modified PCU
TW	1.47	0.239	1.04	0.36
LCV	1.31	1.09	0.99	1.41
CS	1.00	1.00	1.00	1.00
CB	0.91	1.28	0.98	1.13
HCV	1.57	2.52	1.09	4.29
A	1.68	0.68	1.06	1.21
MAV	1.74	4.55	1.07	8.47
BUS	1.32	4.15	1.13	6.19

For MNLR method: Initially vehicle count and proportion of each vehicle is calculated for 5 min of time intervals. The traffic composition and average speed of all vehicle types on all sections are given in Table 7. Field data collected at Section-I was used for the development of multiple non-linear regression (MNLR) speed models and Section-II data was used for the validation of the developed model.

Table No 7 Average Speed and Proportional Share of Vehicle at both Section I and II

Section	I		II	
Vehicle Type	Average Speed in km/hr.	Proportion Share	Average Speed in km/hr.	Average Headway in Sec
TW	45.1	0.45	56.5	0.48
LCV	47.6	0.07	60.1	0.04
CS	64.5	0.20	83.3	0.23
CB	67.0	0.06	75.1	0.10
HCV	42.0	0.07	51.9	0.08
A	40.8	0.12	49.4	0.018
BUS	45.2	0.03	66.1	0.05

PCU values of different vehicle are considered as regression coefficient in proposed equation of regression method. The average speed of accuracy of model in determining speed.

$V_{cs}=$

$a_1*n_{cs}+a2*\left(\dfrac{Acs}{Acb}*n_{CB}*V_{CB}\right)+a3*\left(\dfrac{Acs}{Alcv}*n_{LCV}*V_{LCV}\right)+a4*\left(\dfrac{Acs}{Ahcv}*n_{HCV}*\right.$

standard car (cs) is considered as initial co-efficient as a_1 .73 km/hr. is taken as $a_1.R^2$ value obtained is 0.77. R^2 indicates the

$\left.V_{HCV}\right)+a5*\left(\dfrac{Acs}{Atw}*n_{TW}*V_{TW}\right)+a6*\left(\dfrac{Acs}{Aa}*n_A*V_A\right)+a7*\left(\dfrac{Acs}{Ab}*n_B*V_B\right)$

Table No 8

Vehicle Type	Co-Efficient	PCU Values
CB	a_2	1.56
LCV	a_3	2.69
HCV	a_4	3.83
TW	a_5	0.28
A	a_6	0.85
B	a_7	6.80

Comparison of Results

PCU is estimate dusing dynamic method, modified approach method at both Vijayawada - Guntur and Ongle sections is compared with their results .and it is observed that modified approach shows higher PCU values than dynamic method . These results compared with MNLR method it shows greater values of PCU than both methods for some vehicles.

Table No 9

Section	I		II	
Vehicle type	Dynamic PCU	Modified PCU	Dynamic PCU	Modified PCU
TW	0.33	0.35	0.35	0.36
LCV	1.5	1.36	1.43	1.41
CS	1.00	1.00	1.00	1.00
CB	1.23	1.37	1.6	1.13
HCV	4.02	4.28	3.95	4.29
A	1.14	1.3	1.14	1.21
MAV	8.17	8.71	7.91	8.47
BUS	5.5	5.89	5.52	6.19

Conclusion

- Different method mentioned in literature review used to estimate PCU are resulted realistic under mixed traffic condition .
- Modified approach method shows higher values of PCU when compared to dynamic method
- MNLR method is found to be more realistic and logical under heterogenous traffic and it is suitable for high heterogenous traffic conditions. Since MNLR method considered composition into consideration where other two method considered only relations of area and speed and headway.
- But the present studies have practical difficulties in collecting data under controlled conditions and the data has been collected at different section of same site , it would have improved if collected at different location and studies will be continued to observe variation of PCU with respect to different location and considering road characteristics for calculations of PCU

References

1. Chandra, S., Kumar, V., & Sikdar, P. K. (1995). Dynamic PCU and estimation of capacity of urban roads. *Indian Highways*, *23*(4).

2. Srikanth, S., &Mehar, A. (2017). A modified approach for estimation of Passenger Car Units on intercity divided multilane highways. Archives of transport, 42.

3. Ranjeeth, S., & Latchoumi, T. P. (2020). Predicting Kids Malnutrition Using Multilayer Perceptron with Stochastic Gradient Descent. Rev. d'Intelligence Artif., 34(5), 631-636.

4. Prasath, D. S., & Selvakumar, A. (2015). A Novel Iris Image Retrieval with Boundary Based Feature Using Manhattan Distance Classifier. International Journal Of Innovative Technology And Creative Engineering (Issn: 2045-8711) Vol, 5.

5. Balamurugan, K. (2021). Fracture analysis of fuselage wing joint developed by aerodynamic structural materials. Materials Today: Proceedings, 38, 2555-2562.

6. Srikanth, S., & Mehar, A. (2017). Estimation of equivalency units for vehicle types under mixed traffic conditions: multiple non-linear regression approach. *Civil Engineering*, *8*(5).

7. Pooja Raj , Kalaanidhi Sivagnanasundaram, Gowri Asaithambi ,and Ayyalasomayajula Udaya Ravi Shanka,2019.Review of Methods for Estimation of Passenger Car Unit Values of Vehicles , Transportation engineering journal of ASCE · June 2019

EVALUATION OF EFFECT OF ROAD SIDE FRICTION ON URBAN ROAD CAPACITY

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ABSTRACT

A good implementation of transportation facilities will helps in economic growth of the country, especially in case of urban areas these facilities are may not be properly designed or utilized or maintained which will affects in future development of city and economic of the system and sometimes endangers safety of road users. Urban road capacity is a very important factor in which in some urban roads are not able to capable for their design capacity due to the vehicular growth in the developing cities. In this context side friction factors are also one of the reasons for the speed reduction in urban roads. Side friction factors are activities which will affects for the moving traffic. In general, road side frictions can be in the form of vehicles stopping for pick up and drop of passengers, pedestrians crossing or moving along roadside, parking and un-parking activities, buses stopped at bus stops, exits and entries from approach roads etc. In this study side friction factors considered are busses stopping at curb side, pedestrians using traffic road and on-street parking to study and analyze these activities impact on moving traffic speed and flow capacity in urban roads of Bangalore city. Analysis was carried out to determine the speed reduction on such stretches and speed prediction models were modeled with the above friction parameters as independent variables.

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Introduction

The urban transportation is acting as a key to each economical communication in all urban over the world. The increase in urban population growth tends to increase vehicular growth and travel demand. Typical urban transportation facilities include railways, waterways, airways and roadways. Among all categories, the big proportion consists of roads. Logically, most planning and research techniques are focused on road system. Many urban roads exhibit worsen capacity and bad performance. Many researchers have studied about urban traffic problem in some developing countries and found that because of urbanization, there is often great deal activity on and along the roadsides which affects the performance of through traffic flow and capacity of the road network which is called as side friction.

1.1 Different types of Road Side Friction Parameters are as follows

- Vehicles stopping for passengers pick up and drop
- Pedestrians walking along or crossing the road
- Non-motorized and slow moving vehicles.
- On-street parking

- Improper coordination and lack of multimodal manoeuvres
- Pedestrian and non-motorized vehicles moving along shoulders
- Vehicles entering and leaving road
- Food stalls and vendors along the road side etc.

The urban roadway capacity is influenced by various factors like speed of the vehicles, width of road, structure of the road, construction work on roads, shoulder and roadway width, access points, terrain etc. However for urban roads, the impact of side friction i.e., bus stops, encroachments, on street parking, pedestrian crossing, entries and exit from major roads etc. are also much significant by reducing the side friction like improper bus stops can effectively enhances the capacity of roads. Transportation engineering plays some role in economic development so its application of technology in well manner to planning, designing, operation and maintenance of urban roads plays very important role in developing countries.

1.2 Objectives of Study

- Study on effect of improper bus stops, pedestrian crossings and on street parking on urban road capacity.

- Generate the model of effect of side friction on capacity of roads using MLR analysis
- To determine the speed reduction due to Road Side Friction

2. Area of Study

The area selected for effect of side friction on urban roads was Sampige road located in Malleswaram, Bangalore. In this project there are two sections of each about 200m were selected in Malleswaram shown in Fig 1 and 2 i.e. 8th cross section as non-ideal section and 18th cross section as ideal section. Since at 8th cross there is no bus bay facilities, presence of on street parking and people walking across

and along the road is creating speed reduction in through traffic speed. Even though there is a safe and well planned pedestrian facility some people are using traffic road due to the presence of vendors on the footpath. On street parking facility is creating manoeuvres and in terms affecting stream flow speed. Due to the absence of bus bay busses are stopping at curb side which is creating traffic jam and indirectly affecting on speeds of other vehicles.

In ideal section there is a bus bay facility and no on- street parking hence this section was chosen to determine the speed reduction in side friction section.

Figure 1 8th Cross, Malleswaram, Bangalore

Figure 2 18th Cross, Malleswaram, Bangalore

3. Methodology

The work carried out in this study in three phases:

- Site selection and field data collection

- Speed reduction model development
- Determining speed reduction due to road side friction

3.1 Selection of Study area

The study area should be such that it includes some problem so that a solution can be found with the knowledge of the problem, consequences in future and effects of the solution. The length of sections is selected based on the availability of vantage points as well as based on the length of the road section coming under the influence of the side friction. Traffic data collected in this study area as following two categories:

a) Base sections; section with the absence of side frictions like on street parking, pedestrian activities along the road side and bus stop at curb side.(18th cross Malleswaram)
b) Non-base sections; section with the presence of side friction parameters like on street parking, pedestrian activities along the road side and bus stops at curb side.(8th cross Malleswaram)

3.2 Traffic Characteristics and Side Friction Study

Side friction parameters and traffic volume data collected using videography technique. Data captured in the videos were traffic volume data, spot speed study, bus frequency and dwell time in seconds, number of parking manoeuvres and influence time of un-parking and parking vehicles in seconds and number of pedestrian walking along and over the road.

Extracted the traffic volume for every 5min interval over the entire observation period and also converted it into PCU/hr. Taken the traffic data in different vehicle category wise i.e. motorcycles, car, bus, auto, LCV and HCV. Spot speed study was taken by selecting the stretch according to the standard. Average speed of the section was obtained by taking the average speed of vehicles of each type of vehicles passed in the selected stretch for each 5 min interval over entire period of observation.

3.3 Parameters of Side Friction

Extract the Side friction activities data from the recorded videos at different sites over selected length. Identify the pedestrian movement, on street parking and buses stoppage at curbs in the selected section of area. Note down the frequency of each event type in the selected section.

a) On-street parking
- Extract the on street parking data for every 5 min. interval
- Note down the number of parking and un-parking vehicles in the study stretch
- Note down the influence time due to un-parking and parking of vehicles in the study stretch with the help of stopwatch

b) Pedestrian movement
- Extract the pedestrian volume count for every 5 min. interval
- Number of pedestrians walking along and over the street is counted on both sides of the road at each non-base section over the entire observation period

c) Bus stops at curb side
- Extract the bus stop at curb side data for every 5 min. interval
- Note down frequency of buses over the entire observation period
- Note down the dwell time of bus in seconds with the help of stopwatch

4. Data Collection and Extraction

Camera was mounted on a tripod and kept in certain height. All the movement were captured in sagittal plane. Standard badminton court was used which is available at Lakshmibai national institute of physical education (M.P.). Standard badminton racket and shuttle were used. Video was analyzed through Kinovea 0.8.27 software. One way ANOVA was used as a statistical tool. SPSS software was used for statistical result.
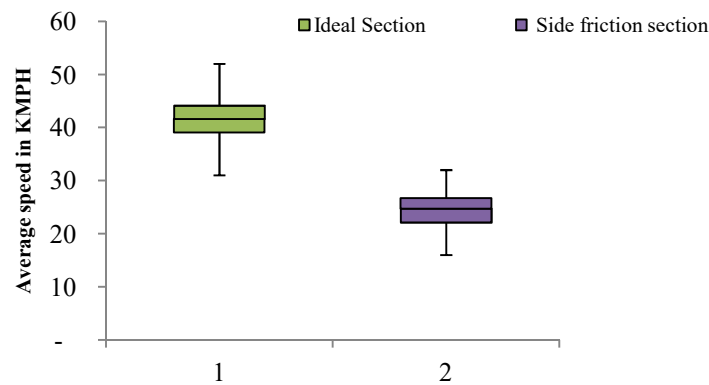
Figure 3: Box Plot for Ideal Sections and Section with Side Friction

4.1 Speed Prediction Model Development Multiple Linear Regression

Multiple linear regression (MLR) is a statistical technique used to predict the values dependent variable from the measurements of independent variable. The aim of MLR is to model the linear relationship between the dependent variable and independent variables.

Basically, multiple linear regression is the extension of linear regression and analysis done with one independent variable with dependent variable whereas in MLR more than two or more variables are considered to predict the model.

4.2 Calculation of Multiple Linear Regression

$Y = a_0 + a_1x_1 + a_2x_2 + a_3x_3 + \ldots\ldots a_mx_m$

Where,

Y is dependent variable, x_1, $x_2,\ldots x_m$ are independent variables , a_0 is regression constant, a_1, $a_2,\ldots a_m$, are regression coefficients of the respective m independent variables.

In this study average speeds of vehicles are considering as dependent variable and different categories of vehicles and its each average speed, number of pedestrians walking along and across the road, number of manoeuvres due to parking and un-parking, on street parking, bus dwell time and influence time due to parking facility as independent variable. This model gives the predicted average speed with respect to side friction parameters which are mentioned above.

4.3 Effect of Side Friction Factors on Speed of Traffic Stream

In order to check the effect of side friction factors and to handle variations in traffic flow and its influence on traffic speed, the data from chosen sections were categorized into various ranges of traffic flow. Graphs were plotted between side friction factors and average traffic speed in kmph for traffic flow values 2000-3000 PCU/hr. and 3000-4000 PCU/hr. The Figs 4-7 shows that the friction factors considered in this study has adverse effect on traffic flow. Hence these friction factors were considered for further speed prediction model study.
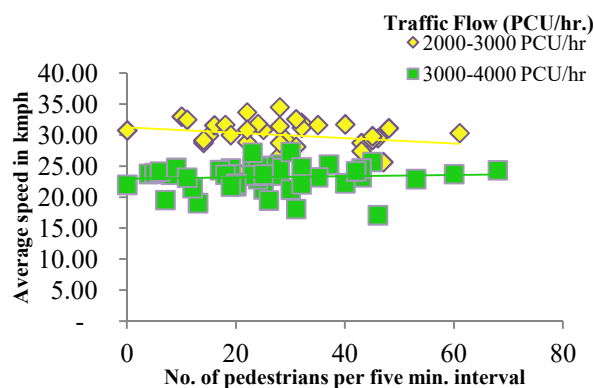

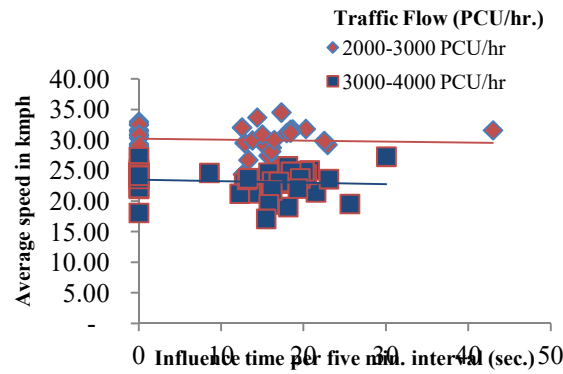**Figure 4 Variation of Traffic Speed with Pedestrian**

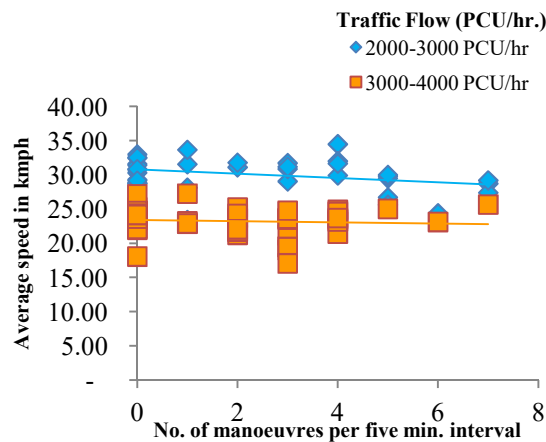**Figure 5 Variation of Traffic Speed with Influence Time**

Figure 7 Variation of Traffic Speed with Bus Dwell Time

4.4 Speed Prediction Model Summary Output

Speed prediction model was developed at non-base section with extracted data. In this model development average speed of the non-base section was considered as dependent variable whereas side friction factors considered in this study as independent variable. Speed prediction modelling was done using excel. The model obtained is shown in results and summary output of the model is given below.

Table 1 Regression Statistics

Regression Statistics	
Multiple R	0.927905765
R Square	0.86100911
Adjusted R Square	0.832808059
Standard Error	0.294987635
Observations	84

Table 2 Anova Analysis

ANOVA					
	df	*SS*	*MS*	*F*	*Significance F*
Regression	14	37.19	2.65	30.53	4.718E-24
Residual	69	6.00	0.08		
Total	83	43.19			

Table 3 Coefficients of Independent Variables

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	(0.16)	0.67	(0.24)	0.81
Motorcycles	0.00	0.00	0.97	0.33
Avg.speed m/s	0.06	0.02	2.68	0.01
Car	0.00	0.00	1.29	0.20
Avg.speed m/s	0.26	0.03	9.33	0.00
Auto	0.00	0.00	0.51	0.61
Avg.speed m/s	0.21	0.03	7.39	0.00
Lcv &Hcv	0.01	0.01	1.40	0.17
Avg.speed m/s	(0.08)	0.15	(0.53)	0.60
Bus	(0.00)	0.02	(0.14)	0.89
Avg.speed m/s	0.48	0.14	3.45	0.00
Bus dwell time (sec)	0.00	0.02	0.08	0.93
Manoeuvres	(0.04)	0.02	(1.82)	0.07
Influence time in sec.	0.00	0.00	0.53	0.60
No of Pedestrians	0.00	0.00	0.28	0.78

5. Results

1) Effect of Side Friction Factors on Speed of Traffic Stream

From the Figs 4-7 shows that there is some significant impact of side friction factors on the section with side friction area.

2). Speed Prediction Model for Non-Base Section is given below

$$V_{avg} = - 0.159 + 0.06*v_{2w} + 0.262*v_c + 0.21*v_a - 0.079*v_{lh} + 0.47*v_b$$

Where, V_{avg} is the average speed of vehicles at non-base section. $n_{2w}n_{2w}, n_c n_c, n_a n_a, n_{lh} n_{lh}, n_b n_b$, n_{man} and n_{man} and $n_{ped} n_{ped}$ is number of motorcycle, car, auto, lcv & hcv, bus, manoeuvre and pedestrians respectively. v_{2w}

v_{2w}, $v_c v_c$, $v_a v_a$, $v_{lh} v_{lh}$ and $v_b v_b$ is average speeds of motorcycle, car, auto, lcv & hcv and bus respectively., t_d and t_i are the bus dwell time in seconds and influence time of parking and un-parking vehicles (in seconds) respectively. This is the speed prediction model to determine the predicted average speed for the base section with 2-lane, one way direction road. The model is validated with F test and R^2 value is lies within the range of 0 to 1 and near to 1, so the model is best fit model.

3. Speed Reduction Due to Road Side Activities

Table 4 Average Speed at Ideal and Non Ideal Sections

Time	Ideal Section kmph	Side Friction Section kmph	Difference kmph
11:00-12:00	44	23	21
12:00-1:00	43	28	15
1:00-2:00	40	24	16
2:00-3:00	41	25	16
3:00-4:00	42	25	17
4:00-5:00	42	24	18
5:00-6:00	40	22	18

Difference between average speeds of vehicles in without side friction and average speeds of vehicles in with side friction gives the speed reduction due to road side friction. Here ideal section considered is at Malleswaram 18th cross and non- ideal section at Malleswaram 8th cross. Fig-8 shows the difference in average speed at base and non-base section.

6. 3D Modelling using Infraworks Software

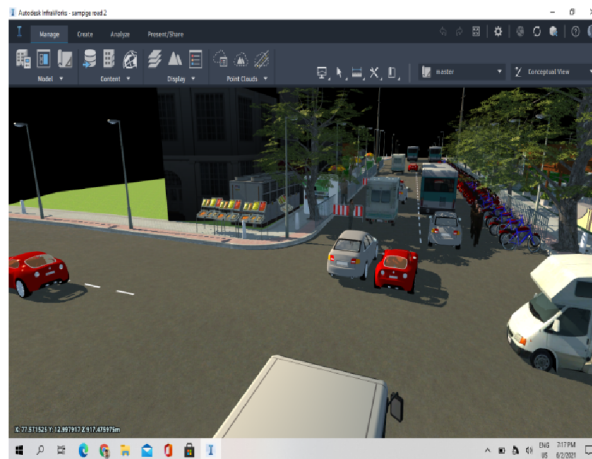3D model is developed at study area using Infrawork software.
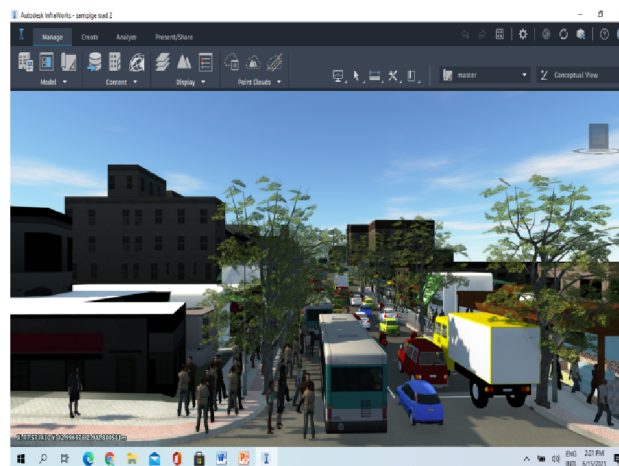
Figure 8 On Street Parking at Non-Ideal Section

Figure 9: Bus Stop at Curb Side

Figure 10 Pedestrians Walking Along Traffic Lane

7. Conclusion

- The study was conducted to determine the influence of the most prominent side friction factors on a typical urban road with 2-lane one way direction.
- From the graph of average speed versus dwell time of buses, pedestrian flow on sides of carriage ways, influence time and number of parking manoeuvres have adverse effect on speed of traffic stream.
- Traffic volume at non-base section and base section is varies from 2814 – 3729 PCU/hr. and 2961-4510 PCU/hr. respectively.
- Speed prediction model developed is having R^2 value of 0.86 within the range of 0 to 1 and model is validated with F test

where F value is more than critical value 1.83 so test is passed. Hence this model can be used to predict the average speed in side friction area with 2-lane one way direction road.

- Average speed at non-base section and base section varies from 22-28kmph and 40-44kmph respectively.

- Speed reduction graph shows that the speed reduction in side friction section varies between 15 to 21 kmph. Hence while planning and designing such type of urban roads, care should be taken to provide good facilities like pedestrian sidewalks and crossing facilities, off-street parking facilities and bus bays.

References

1. Salini, S., & Ashalatha, R. (2020). Analysis of traffic characteristics of urban roads under the influence of roadside frictions. *Case studies on transport policy*, *8*(1), 94-100.

2. Rita Bhanushali, Mayank Kanani, Prashant Lakkad, "Delay analysis due to Road side activities at Urban Arterial Road of Rajkot city", International Research Journal of Engineering and Technology (IRJET) , Volume: 06 Issue: 04 , pp-1754-1758, Apr 2019

3. Golakiya, H. D., & Dhamaniya, A. (2019). Modeling speed and capacity estimation at urban midblock sections under the influence of crossing pedestrians. *Journal of Transportation Engineering, Part A: Systems*, *145*(9), 04019036.

4. Subhadip Biswas , Satish Chandra, Indrajit Ghosh, "Side friction parameters and their influences on capacity of Indian undivided urban streets", International Journal of Transportation Science and Technology, PP- 1-19, 23 March 2020

5. Pal, S., & Roy, S. K. (2019). Impact of side friction on performance of rural highways in India. *Journal of infrastructure systems*, *25*(2), 04019006.

6. Rao, A. M., Velmurugan, S., & Lakshmi, K. M. V. N. (2017). Evaluation of influence of roadside frictions on the capacity of roads in Delhi, India. *Transportation research procedia*, *25*, 4771-4782.

7. Ranjeeth, S., & Latchoumi, T. P. (2020). Predicting Kids Malnutrition Using Multilayer Perceptron with Stochastic Gradient Descent. Rev. d'Intelligence Artif., 34(5), 631-636.

8. Prasath, D. S., & Selvakumar, A. (2015). A Novel Iris Image Retrieval with Boundary Based Feature Using Manhattan Distance Classifier. International Journal Of Innovative Technology And Creative Engineering (Issn: 2045-8711) Vol, 5.

9. Balamurugan, K. (2021). Fracture analysis of fuselage wing joint developed by aerodynamic structural materials. Materials Today: Proceedings, 38, 2555-2562.

10. Chauhan, R., Dhamaniya, A., Arkatkar, S., Sahu, P. K., & Vikram, D. (2019). Effect of side friction parameter on urban road traffic: under mixed traffic scenario. *Journal of the Eastern Asia Society for Transportation Studies*, *13*, 314-330.

11. Salini, S., George, S., & Ashalatha, R. (2016). Effect of side frictions on traffic characteristics of urban arterials. *Transportation research procedia*, *17*, 636-643.

12. Patkar, M., & Dhamaniya, A. (2020). Influence of nonmotorized vehicles on speed characteristics and capacity of mixed motorized traffic of urban arterial midblock sections. *Journal of transportation engineering, Part A: Systems*, *146*(4), 04020013.

EXPERIMENTAL INVESTIGATION ON THE BEHAVIOR OF EXPANSIVE SOIL BLENDED WITH INORGANIC CHEMICALS

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ABSTRACT

The problems of expansive soils remain a major challenge for geotechnical engineers and have been documented worldwide. There have been many attempts to control the swell-shrink nature of these soils. Use of chemical additives is one of the most effective and economical methods. In this paper an attempt was made to find the efficacy of inorganic chemicals such as Calcium Chloride ($CaCl_2$) and Sodium metasilicate (Na_2SiO_3) stabilized with varying percentages from 0% to 2.5% with an increment of 0.5% by dry weight of soil. An experimental program has evaluated to find the efficacy of additive contents on the Differential Free Swell Index (DFSI), and strength (by means of Unconfined Compressive Strength) (UCS) characteristics of expansive soil. The soil used in this investigation is classified as medium compressible soil as the DFSI is about 98.6%. The experimental results have been summed up in this paper is that the plasticity, swelling properties of the blends decreased and the strength increased with an increase in additive content.

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Keywords: *$CaCl_2$, DFSI, Expansive Soil, Na_2SiO_3, UCS*

Introduction

Expansive soils have a tendency to swell or shrink in response to changes in moisture levels. This peculiar property used to create numerous problems due to highly unpredictable upward movement of structures founded on them which results in severe cracking in case of buildings or pavements [1], [2], [3]. Because these are the major influencing factors for development of any place are country. In order to face the challenges caused by expansive soils, many different techniques have been developed such as under-reamed piles, granular pile anchors, drilled piers, belled piers, sand cushion technique, moisture barriers and cohesive non-swelling (CNS) layer.

In addition to the above special foundation techniques for stabilization of expansive soils with different additives such as lime, Calcium chloride, cement, fly ash, rice husk ash etc. has also been found as another potential option in controlling the volumetric changes in expansive soils [4], [5], [6], [7]. The use of $CaCl_2$ could be an effective alternative in place of lime treatment, because of its ready dissolvability and the ability to supply sufficient calcium ions for exchange reactions [7], [8], [9], [10]. In recent research, sodium metasilicate powder is using as the alkaline activator in stabilization of expansive soil to improve the strength properties [11].

Experimental Investigation

A detailed test programme was conducted to evaluate the individual effect of $CaCl_2$, Na_2SiO_3, and the combined effect of both ($CaCl_2$ + Na_2SiO_3) additives. on Differential Free Swell Index and strength characteristics.

Test Materials
Soil

The soil used in the present investigation is medium expansive nature which is collected from outskirts of Bangalore, Karnataka. The Differential Free Swell index (DFSI) of expansive soil is found as 98.6 %.

Calcium Chloride (CaCl2) and Sodium Metasilicate (Na2SiO3)

The CaCl2 and Na2SiO3 were purchased from chemical suppliers which were acquired in powder form.

Tests Performed and Variables Studied
Deferential Free Swell Index (DFSI)

It has been found that DFSI, which reflects the ability of soil to swell, and decreases with increasing CaCl2 and Na2SiO3 contents individually and also combined form. The

percentage of additives CaCl2, Na2SiO3 were varied as 0%, 0.5%, 1.0%, 1.5%,2.0% and 2.5% by dry weight of the expansive soil. The combination of two additives varied as0.5% + 0.5% of (CaCl2 + Na2SiO3) to 2.5% + 2.5%.

Unconfined Compressive Strength (UCS)
Stress-strain characteristics of soil+CaCl2, soil +Na2SiO3 and (soil + CaCl2 +Na2SiO3) blends were studied by conducting unconfined compression tests on cylindrical specimens. The percentage of individual additives CaCl2 and Na2SiO3 were varied as 0%, to 2.5% with an increase of 0.5%, whereas for the combination two additives (CaCl2 + Na2SiO3)

the proportion increases from 0% + 0% to 2.5% + 2.5%.

Discussion of Test Results

The Individual Effect of CaCl2, Na2SiO3 and the Combined effect of CaCl2 +Na2SiO3 of expansive soil on DFSI Characteristics.

Figure 1 and table.1 shows the variation in DFSI with the proportions of CaCl2, Na2SiO3, and the combined effect of both additives and it can be observed that when the percentage of additives goes from 0% to 2.5%, the DFSI decreases. The DFSI of virgin soil

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Table 1 Variation of Differential Free Swell Index with $CaCl_2$, Na_2SiO_3 and $CaCl_2 + Na_2SiO_3$ Contents

S No	$CaCl_2$	DFSI (%)	Na_2SiO_3	DFSI (%)	$CaCl_2 + Na_2SiO_3$	DFSI (%)
1	0	98.60	0	98.6	0+0	98.6
2	0.5	84.50	0.5	89.3	0.5+1.5	75.6
3	1.0	72.20	1.0	79.3	1.0+1.0	58.4
4	1.5	62.15	1.5	69.8	1.5+1.5	44.3
6	2.0	54.60	2.0	62.7	2.0+2.2	32.1
7	2.5	50.70	2.5	60.4	2.5+2.5	24.2

is 98.6% and the soil treated with 2.5% of CaCl2 is decreased as 50.7% which has become non expansive, because a soil with a DFSI of 50% or less is considered as non-expansive in nature. In case of CaCl2 the

resulting reduction in percentage of DFSI is 48.5. When it comes to Na2SiO3, as it is increased from 0% to2.5%, the DFSI has changed from 98.6% to 60.4% and the
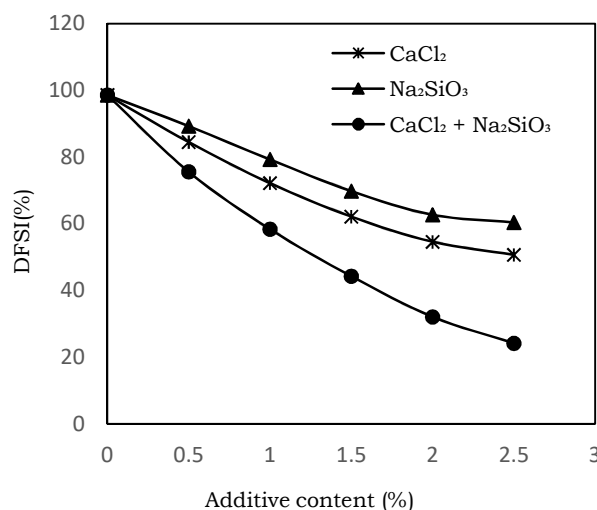

Figure 1 Influence of Additives ($CaCl_2$ andNa_2SiO_3) on DFSI

Esulting percentage reduction in DFSI is 38.7. For the combination of CaCl2 + Na2SiO3the DFSI has decreased from 98.6% percent to 24.2%, as the combined additives (0% + 0% to

2.5% + 2.5%) increased from 0 % to 2.5% and the resulting reduction in percentage in DFSI is 78.4. From the above data it shows that the combination of CaCl2 + Na2SiO3is the most

effective additive combination in reducing the swelling behavior of expansive soil when we compare with the individual effect of additives. **The Individual Effect of CaCl2, Na2SiO3 and the Combined Effect of CaCl2**

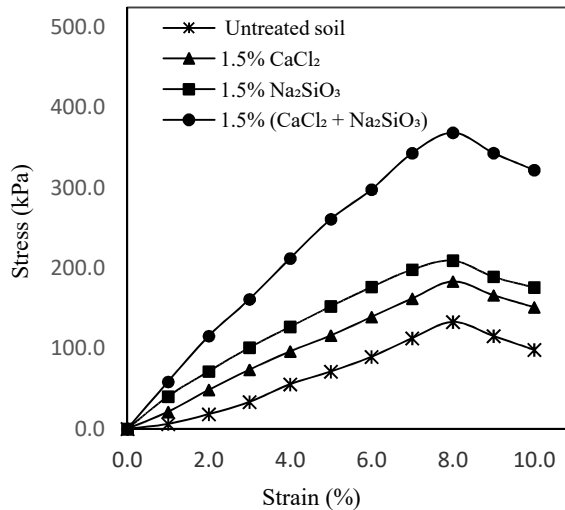**+Na2SiO3 of Expansive Soil on Strength Characteristics.**

Figure 2 Influence of Additives (CaCl$_2$ andNa$_2$SiO$_3$) on UCS

Unconfined Compressive Strength tests were performed on the samples of soil and soil with stabilizers. Figure 2&3 presents the improvement soil in UCS with CaCl2, Na2Sio3 and the combination of (CaCl2 + Na2SiO3)

treated soils. There is a considerable increase in the peak stress at 1.5% CaCl2, 1.5% at Na2SiO3 and the combination of 1.5% CaCl2 and 1.5% Na2SiO3.
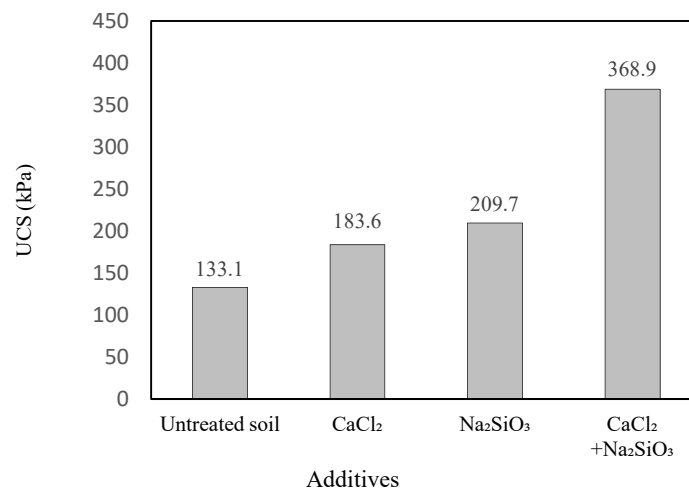

Figure 3 Improvement in UCS with Different Additives

The data reveals that the strength increases significantly (as shown in figure 3) at the chemical combination proportion of (1.5% + 1.5%) of (CaCl$_2$ + Na$_2$SiO$_3$)as compared to the untreated soil and other two individual additives like 1.5% of CaCl$_2$& 1.5% of Na$_2$SiO$_3$.

Conclusion

In this investigation the soil is representing as a clay of medium compressibility. The value of Differential Free Swell Index is 98.6% signifying the medium degree of expansion. The decrease in DFSI at 2.5% of CCaCl2 is observed as 48.5% and the decrease in DFSI at 2.5 Na2SiO3is noticed as 38.7%. When it

comes to the combined effect of CaCl2 and Na2SiO3 the decrease in DFSI at 2.5% of CaCl2 + 2.5% of Na2SiO3 is noticed as 78.4%. It is observed that at1.5 % of CaCl2 the decrease in DFSI is 62.15%, with the same percent of Na2SiO3 the decrease in DFSI is 68.9%. With the combined effect of both additives (1.5% + 1.5%) the decrease in DFSI is 44.3% which has become non- expansive soil. It is observed that when comparing the treated and untreated soils, the percentage increase in UCS at 1.5% CaCl2 for the soil is 44.1%.In case of Na2Sio3the percentage of increase in UCS at 1.5% Na2SiO3, it is observed as 63.8%. whereas the combined effect of CaCl2 + Na2SiO3, the percentage increase in UCS at 1.5% CaCl2 + 1.5% Na2SiO3 for the soil is 189.5%. This study revealed that the individual properties of Differential Free Swell Index and Unconfined Compressive Strength of expansive soil can be significantly modified with CaCl2 and Na2SiO3 and the combined influence of CaCl2 + Na2SiO3 is very impressive.

References

1. Nelson, J., & Miller, D. J. (1997). Expansive soils: problems and practice in foundation and pavement engineering. John Wiley & Sons.
2. Venkara Muthyalu, P., Ramu, K., & Prasada Raju, G. V. R. (2012). Study on performance of chemically stabilized expansive soil. International Journal of Advances in Engineering and Technology, 2(1), 139-148.
3. Ramana Murty, V. (1998). Study on swell pressure and the method of controlling swell of expansive soil (Doctoral dissertation, Ph. D. Thesis, Kakatiya University, REC, Warangal, AP).
4. Chakraborty, S., & Nair, S. (2020). Impact of curing time on moisture-induced damage in lime-treated soils. International Journal of Pavement Engineering, 21(2), 215-227.
5. Lajurkar, S., Golait, Y. S., & Khandeshwar, S. R. (2016). Effect of calcium chloride solution on engineering properties of black cotton soil. Int J Innov Res Sci Eng Technol, 5(2), 1766-1771.
6. Alex, AC, Menon, GG, Kurian JE, Jahan, R, Jamoh C. (2018). Stabilization of expansive soil with class Fly ash. International research journal of engineering and technology, 3005-3007.
7. Ranjeeth, S., & Latchoumi, T. P. (2020). Predicting Kids Malnutrition Using Multilayer Perceptron with Stochastic Gradient Descent. Rev. d'IntelligenceArtif., 34(5), 631-636.
8. Prasath, D. S., & Selvakumar, A. (2015). A Novel Iris Image Retrieval with Boundary Based Feature Using Manhattan Distance Classifier. International Journal Of Innovative Technology And Creative Engineering (Issn: 2045-8711) Vol, 5.
9. Balamurugan, K. (2021). Fracture analysis of fuselage wing joint developed by aerodynamic structural materials. Materials Today: Proceedings, 38, 2555-2562.
10. Raj, S., Rai, A. K., & Havanagi, V. G. (2018). Suitability of stabilized copper slag and fly ash mix for road construction. World Journal of Engineering.
11. Desai, I. D., & Oza, B. N. (1977). Influence of anhydrous calcium chloride on the shear strength of expansive soil. In Proc. of the 1st National Symposium on Expansive Soils, HBTI-Kanpur, India (pp. 4-1e4).
12. , T.M. and Armstrong, J.C. (1989), "Stabilization of Expansive Clay Soils", TRR-1219, TRB, pp. 103- 112.[13] Sani, J. E., Etim, R. K., & Joseph, A. (2019). Compaction behaviour of lateritic soil–calcium chloride mixtures. Geotechnical and Geological Engineering, 37(4), 2343-2362.

EXPLORATION OF STRENGTH AND PERMEABILITY CAPACITIES OF NO-FINES CONCRETE BY APPENDING WASTE MATERIALS

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ABSTRACT

Allow water to move downwards through the body of a pavement thereby allowing quick drainage of water off the road surface enhancing the safety while travelling on roads during the rains while at the same time allowing the absorption of water back into the surrounding soil strata, to recharge the groundwater and reduce the storm-water runoff simultaneously. Permeable concrete pavement is an effective means to meet growing environmental requirements due to various human and natural effects. A permeable concrete layer generally contains little or no sand. This creates the series of interconnected voids inside the permeable concrete layer that enables quick drainage. However, the absence of fine aggregates reduces the structural strength and makes it prone to quick failure making it unviable. This research aims to study the effects of addition of substitute materials in permeable concrete to determine if the addition alters the mechanical and hydrological properties of permeable concrete. Rubber crumbs and steel scrapings among other substitutes to fine aggregates have been used in this research work. Crumb Rubber due to its elasticity, lightweight, energy absorption, heat insulating property it is becoming a promising material in construction industry. Steel scrapings are a kind of industrial solid waste produced in the process of steel smelting. It can increase the compressive strength when used in permeable concrete. This study compares the flexural strength, compressive strength, permeability rate and porosity of permeable concrete by addition of waste materials (rubber crumbs & steel scrapings) in different proportions of 3%, 5%, and 7% of the weight of the coarse aggregates and further compared with no-fines permeable concrete and hopes to identify their applications based on the results generated.

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Keywords: Crumb Rubber, Permeability, Porous Concrete, Steel Wool, Strength.

Introduction

Over the years, human population has grown at exponential rates. With population growth, a rapid increase in infrastructure projects was seen, which resulted in many cities virtually being covered in concrete in residential and commercial areas, increasing the impermeability of the earth's surface. During rains, most of the water flows as surface run-off, overloading the drainage system. The pavement, not having the capacity to allow air circulation, gets heated up causing discomfort to the citizens and contributing to global warming as well (B. Han et al., 2017).

In pursuit to overcome this hassle, research scholars conceptualised the no-fine concrete, commonly known as the permeable pavement. No-fines concrete is similar to conventional concrete with very less or no fine aggregate content. Permeable pavement is a positive development in the practice of Low Impact Development (LID). Research works have positively indicated that the velocity and quantum of surface run-off reduced significantly with use of no-fines concrete (L.E. Abera et al., 2018).

Through years of research and development, various forms of permeable pavement systems have emerged. Interlocking concrete paver blocks are the most widely used throughout the world for parking area and walkways, although the quantity of water being led to percolate is relatively lesser than expected due to quick clogging of the gaps in between. Permeable concrete is used in locations with lower traffic volumes, while permeable asphalt is at times used in parking areas (A.A. Rowe et al., 2010; P.S. Patil, 2017).
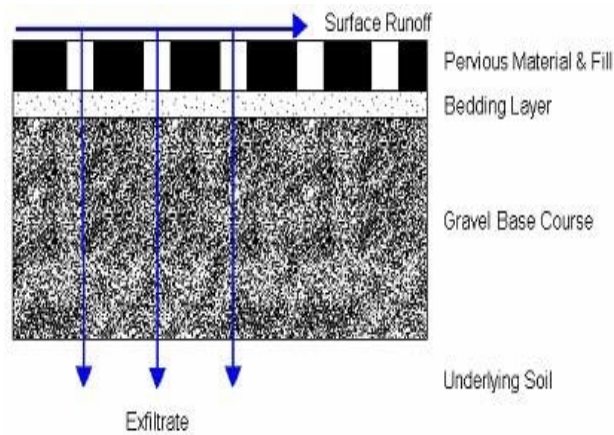
Figure 1: Schematic representation of Permeable Pavement

The predominant problem with widespread use of permeable concrete is the significant decrease in the mechanical strength (L.J. Hao et al., 2019) owing to the lack of fine aggregates in the concrete matrix. Admixtures such as silica fume, water reducing agents or polymer emulsions increases the load bearing capacity, but at the cost of reduced water permeability (S. Yang et al., 2019).

There have been many attempts by researchers to mitigate these structural defects of permeable concrete without compromising on the mechanical and water permeability aspects. One such area of research is the addition of waste materials as partial or complete replacement of fine aggregates in the permeable concrete mixture. This approach not only enhances the properties of permeable concrete, but also makes use of waste materials, thereby reducing the waste materials being accumulated on landfill which reduces the environmental and health hazards.

Figure 2: Water passing through the permeable concrete slab

In recent years, a big nuisance for many developed countries as well as some developing countries is during the disposal of waste products like plastic waste, rubber tyre waste, Rice Husk Ash (RHA), furnace slag and fly ash, among various other waste materials. Attempts have been made to replace different components of concrete with these waste materials in an attempt to minimise these disposal problems (S.K. Gosh et al., 2015). This path of research has led to the use of waste materials in permeable concrete as well to try and enhance the properties.

Further experimentation was done on permeable concrete with crumb rubber added to the composition in place of fine aggregates. Crumb rubber is readily available in different shapes and sizes with local rubber tyre dealers, as tyres need to be shredded before recycling them. Rubber crumbs was added in permeable concrete in various proportions (5%, 7.5%, 10%) with respect to the volume of concrete moulds. On performing strength tests on the permeable concrete moulds, it was concluded that the optimum crumb rubber content was 7.5%, with is gradual decline in both mechanical strength as well as water permeability thereafter (P. Sarala et al., 2019).

In a separate attempt (C.Y. Ng et al., 2019) to determine the ideal void content in permeable concrete, fine rubber crumbs were added in proportions of 2%, 4%, 6%, 8% along with fly ash as partial replacement of cement taken by volume. The study concluded that with an increase in crumb rubber content beyond the optimum dosage, lower was the compressive strength due to lesser quantity of coarse aggregate content per unit volume, and the permeability is significantly lowered as the crumb rubber fills the voids.

A study conducted on rubber crumb no-fines concrete (Y. Zhang, 2015) concluded that, adding rubber crumbs increased the strength properties of permeable concrete up to a optimum dosage of 15% crumb rubber. The strength parameters decreased with further increase in its content. However, crumb rubber did in fact improve the crack resistance, toughness and abrasion. The ability to resist frosting effect increased at first and then reduced significantly with increase in crumb rubber content.

With rubber crumbs added into permeable concrete, the results obtained were not satisfying. Taking cue from the use of steel reinforcement in concrete during RCC works, research work intended to determine the impact of using steel fibres of 30 – 50 mm length and 1 mm – 2 mm in diameter, along with the conventional constituents of permeable concrete (Channappa et al., 2019). Steel fibres were added in the mixture of no-fines concrete in various ratios by weight. However, it was found that the steel fibres in both straight as well as crimped form gave maximum strength at 2% content, and thereafter with increase in the content, there was a decrease in structural strength (Avishreshth et al., 2018). This imperfection was attributed to uneven distribution of the fibres and balling effect in concrete.

Steel crumbs are the scrapings or flakes produced in steel industries as a by-product during the steel processing and moulding processes. Since these scrapings are considerably smaller in size (1 mm – 2.5 mm in diameter) as compared to steel fibres, it is believed to mitigate the drawbacks of permeable concrete with addition of steel fibre. The use of steel crumbs to enhance the characteristics of permeable is expected to garner better results.

Methodology

On completion of reviewing the existing literature, materials to be used with finalised and procured from local sources. Primary tests were carried out to determine the quality of the materials. Once the materials procured were found to be of acceptable quality, mix proportions were calculated to carry out the mixing and casting into the various moulds. The moulds contained crumb rubber and steel crumbs in 3%, 5%, and 7% by weight of coarse aggregates, separately. Conventional no-fines concrete moulds without addition of waste crumb materials were used as a reference for comparison and analysis.

On successful casting, the moulds were then water cured for a period of 28 days using gunny bags. After the completion of the curing process, the test samples were tested to determine the compressive and flexural strength using the CTM and UTM respectively.

Percentage porosity and permeability rates were also determined to analyse the hydrological impact of no-fines concrete.
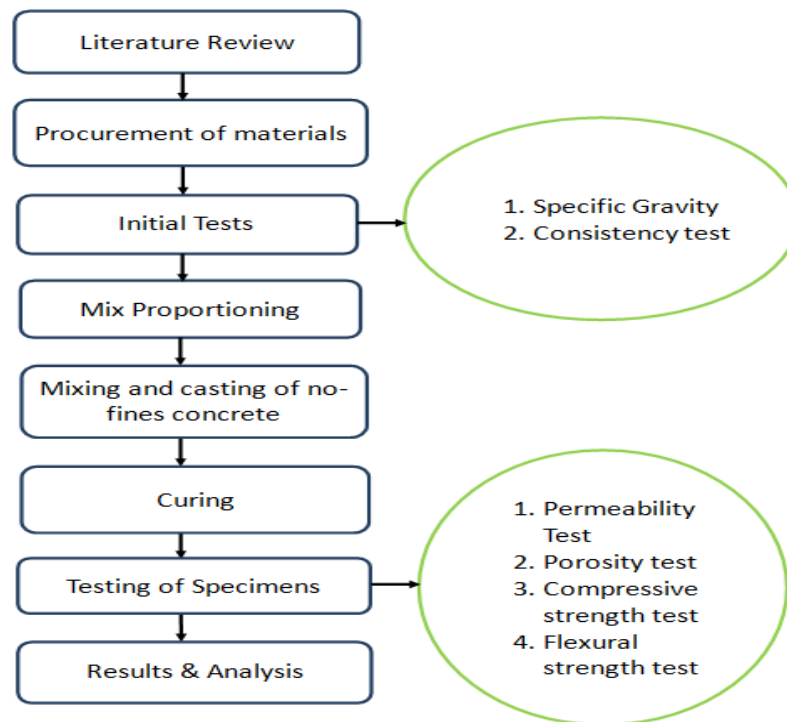

Figure 3: Flowchart explaining the research methodology

Materials Used

Cement: In this project Ordinary Portland Cement of 53 grade is used in the no-fines concrete mix for casting different specimens.

Coarse Aggregates: In this experimental study coarse aggregate retained on 12.5 mm sieve was used.

Water: A w/c ratio of 0.35 was used in the concrete mixture. Water used must be clean, fresh and free from any dirt, unwanted chemicals or rubbish that may affect concrete.

Crumb Rubber: Recycled rubber produced from automotive and truck scrap tyres. During the recycling process, steel and tyre cord are removed, leaving tyre rubber with a granular consistency. The particles are sized and classified based on various criteria including colour (black only or black and white). Crumb rubber retained on 2.36 mm sieve was used in this project.

Addition of crumb rubber into concrete has a positive effect to improve toughness and crack resistance. Rubber crumbs increases the abrasion & freezing thawing resistance.

Steel Crumbs: Steel fibres is a by product in steel industries. Steel crumbs are left behind during the process of moulding of steel. Some of the steel crumbs is reused, while a major portion is discarded due to quicker rusting process.

On addition of steel fibres, it is expected to significantly increase the compressive and flexural load bearing capacities of the blocks. There is also drastic decrease in the brittleness of the no-fines concrete moulds. The steel fibres help to convert the large cracks on failure to minute cracks on failure if used in permeable concrete. The steel crumbs aid in distribution of stresses evenly in the material.

Material Properties

	Table 1: Material Properties			
	Material	**Property**	**Value**	**Standard Range**
1	Cement (OPC 53)	Specific Gravity	3.11	3.1 - 3.2
		Consistency	30%	25% - 35%
2	Coarse Aggregates	Specific Gravity	2.63	2.4 - 3.0
3	Rubber Crumbs	Specific Gravity	1.11	1.10 - 1.15
4	Steel Fibres	Specific Gravity	6.92	6.5 - 7.7

Since the specific gravities of the various materials are well within the range, they are considered to be of good quality

Mix Proportion and Casting

i. The aggregates were taken in the ratio of 4:1 aggregate to cement ratio
ii. 0.35 w/c ratio was adopted for all the trials.
iii. Rubber crumb and steel crumb were taken in 3%, 5%, 7%, of coarse aggregates by weight.
iv. The quantity of mix components was calculated based on the volume of casting mould being used.
v. Compression test – 150*150*150 mm^3
a. Flexural mould – 100*100*500 mm^3
b. Slab mould – 200*200*75 mm^3
vi. The moulds were cured for duration of 28 days by the method of gunny bag curing.

Table 2: Mix Proportioning (IS 10262 : 2009)						
Mix		**Cement**	**CA**	**Crumb Rubber**	**Steel Crumbs**	**w/c**	**CA:Cement**
		kg/m3	kg/m3	kg/m3	kg/m3		
C1	-	360	1440	-	-	0.35	4:1
R1	3%	360	1440	43	-	0.35	4:1
R2	5%	360	1440	72	-	0.35	4:1
R3	7%	360	1440	101	-	0.35	4:1
S1	3%	360	1440	-	43	0.35	4:1
S2	5%	360	1440	-	72	0.35	4:1
S3	7%	360	1440	-	101	0.35	4:1

Testing
Compressive Strength Test

Compressive strength of concrete is the load bearing capacity of the block and its ability to withstand cracking and fissure.

In this test the test specimen is placed in the CTM (compression testing machine) is loaded at the rate of 140 kg/sq cm/min till the specimen fails (IS 516 : 1959).

Compressive strength is the load carried by the test specimen per unit surface area.

Figure 4: Compressive strength test moulds

Flexural Strength Test

This test measures tensile and flexural ability of the specimen under direct loading while the specimen behaves as a continuous member.

This test is conducted in the UTM (universal testing machine). The specimen is placed and

the load is applied as a one point load or as a two point load. The loading rate is 400 kg/min for 150 mm size mould and 180 kg/min for a 100 mm size mould (IS 516 : 1959).

Figure 5: Flexural strength test moulds

Porosity Test

This test is performed to determine the % of void spaces present in the sample. The porosity (n) of the sample helps us determine the seepage velocity (v_s) which indicates the speed of flow of water through the pores (F. Montes et al., 2005).

$$Porosity = \frac{(V - V_1)}{V} * 100$$

Where,

V – Volume of test mould

V_1 – Volume of water displaced in the tank

Figure 6: Test on porosity of No-Fines Concrete

Velocity of Discharge of water

The test mould is placed on top of a tank and water is poured on the surface of the mould. We then note down the time taken to drain the water container, as well as the time taken for 90% - 95% of the water to drain out from under the mould. Using Darcy's discharge equation we can calculate the rate of discharge and discharge velocity.

$$Q = A * V$$

Where,

Q – Rate of discharge of water

A – Cross Sectional area

V – Velocity of discharge

Figure 7: Permeability test on No-Fine Concrete slab

However, discharge velocity takes the entire surface area into consideration. In reality, the water flows through only the interconnected pores known as seepage velocity which depends on the porosity of the permeable concrete sample.

$$V_s = \frac{V}{n}$$

Where,
V – Discharge velocity.
n – Porosity of test block.
V_s – Seepage velocity through the pores.

Results and Discussion

Test Results
Compressive Strength Test

It was experimentally shown that the compressive strength of no-fines concrete increased with an increase in the crumb content of both rubber and steel in different proportions. The results of the compression strength test taking reference to a research study (P.S. Patil et al., 2017) are given below.

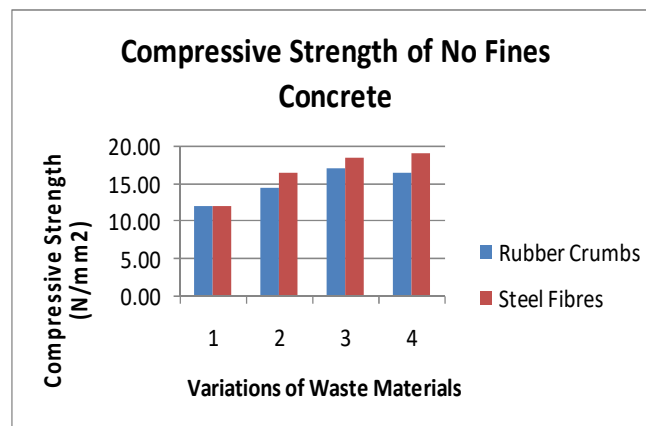| Table 3: Compressive Strength of No Fines Concrete					
	Rubber			Steel Fibres	
	% Content	Strength (MPa)	% Increase	% Content	Strength (MPa)	% Increase
1	0%	12.00		0%	12.00	
2	3%	14.50	20.83%	3%	16.50	37.50%
3	5%	17.00	41.67%	5%	18.50	54.17%
4	7%	16.50	37.50%	7%	19.00	58.33%

Figure 8: Compressive Strength of the test samples

It is prescribed that the compressive strength of the pavement be 20 – 40 MPa for use as pavement in roads. Since the test results show lower values, it is recommended that permeable concrete be used in locations with lower load bearing requirements, such as parking areas, cycle lanes and walkways.

Flexural Strength Test

It was experimentally shown that the flexural strength of no-fines concrete increased with an increase in the crumb content of both rubber and steel in different proportions. The results of the compression strength test taking reference to a research study (P.S. Patil et al., 2017) are given below.

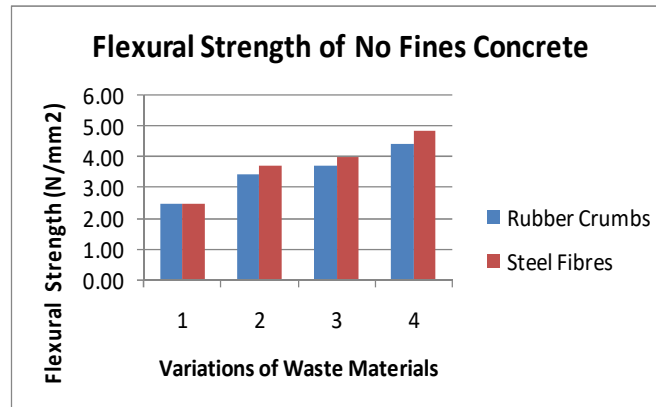| Table 4: Flexural Strength of No Fines Concrete					
	Rubber			Steel Fibres		
	% Content	Strength (MPa)	% Increase	% Content	Strength (MPa)	% Increase
1	0%	2.50		0%	2.50	
2	3%	3.45	38.00%	3%	3.75	50.00%
3	5%	3.75	50.00%	5%	4.00	60.00%
4	7%	4.45	78.00%	7%	4.85	94.00%

Figure 9: Flexural Strength of the test samples

For practical usage, a flexural strength of at least 4.5 MPa is recommended for use in roadways. Since the no-fines concrete is found not suitable for use in heavily loaded roadways, the flexural strength is not critical.

Porosity Test (n)

With increase in quantity of rubber or steel crumbs, the % porosity reduces. Determination of porosity % is a crucial step to determine the seepage velocity of water through the pores. The experimental test results are provided in the table below.

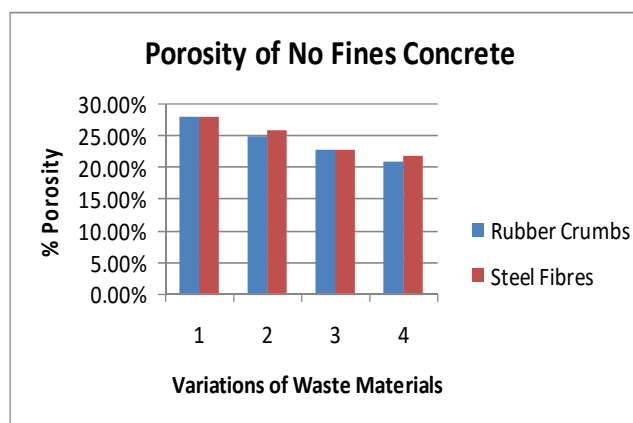| Table 5: Porosity of No Fines Concrete					
	Rubber			Steel Fibres		
	% Content	% Porosity	% Change	% Content	% Porosity	% Change
1	0%	28.00%		0%	28.00%	
2	3%	25.00%	-10.71%	3%	26.00%	-7.14%
3	5%	23.00%	-17.86%	5%	23.00%	-17.86%
4	7%	21.00%	-25.00%	7%	22.00%	-21.43%

Figure 10: Graphical representation of the variation of % porosity

Discharge Velocity (V)

The permeability test was conducted on the test samples and the results obtained are provided in the table below.

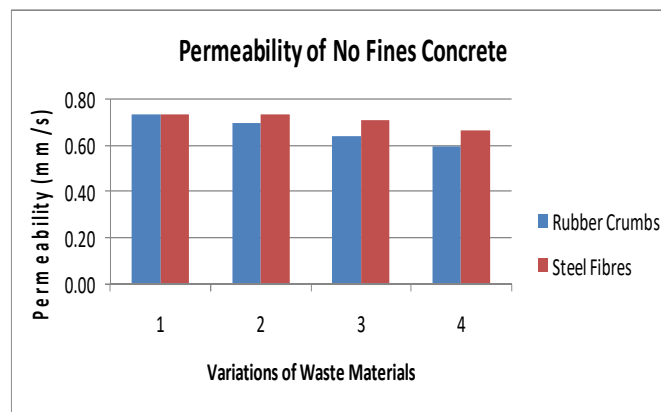|	Table 6: Dishcharge Velocity of No Fines Concrete							
	Rubber				Steel Fibres			
	% Content	Permeability (mm/s)	Permeability (mm/hr)	% Change	% Content	Permeability (mm/s)	Permeability (mm/hr)	% Change
1	0%	0.74	2,664		0%	0.74	2,664	
2	3%	0.70	2,520	-5.41%	3%	0.74	2,664	0.00%
3	5%	0.64	2,304	-13.51%	5%	0.71	2,556	-4.05%
4	7%	0.60	2,160	-18.92%	7%	0.67	2,412	-9.46%

Figure 11: Graph showing the variation permeability rates

We notice that the rate of apparent permeability marginally reduces with increase in crumb content. This can be attributed to the fact that the crumb content occupies the voids and provides resistance to flow of water through them.

Seepage Velocity Test (V_s):

The flow velocity **v** is also called the discharge velocity or the superficial velocity. It is different from the actual velocity through the soil pores, which is known as the seepage velocity, v_s as the water flows through the pores and not the entire surface area. Seepage velocity is always greater than the superficial velocity, and it is expressed as below:

$$V_s = \frac{V}{n}$$

Where,
V – Discharge velocity.
n – Porosity of sample.
V_s – Seepage velocity through the pores.

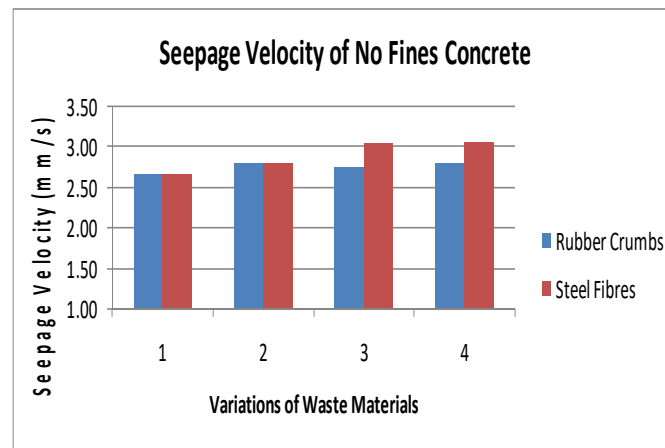|	Table 7: Seepage Velocity of No Fines Concrete							
	Rubber				Steel Fibres			
	% Content	Seepage (mm/s)	Seepage (mm/hr)	% Change	% Content	Seepage (mm/s)	Seepage (mm/hr)	% Change
1	0%	2.67	9,612		0%	2.67	9,612	
2	3%	2.81	10,116	5.24%	3%	2.80	10,080	4.87%
3	5%	2.75	9,900	3.00%	5%	3.05	10,980	14.23%
4	7%	2.80	10,080	4.87%	7%	3.07	11,052	14.98%

Figure 12: Graph showing the variation seepage velocity.

According to a research study (S. Priya, 2017) conducted in the urban areas of Bengaluru, the maximum rainfall intensity was in the range of 225 – 250 mm/hr. We have attained a seepage velocity of approximately 10,000 mm/hr which indicates that the pores have enough capacity to drain out all the water instantly.

Findings

- It was found that the maximum compressive strength for permeable concrete with rubber crumb was attained with 5% rubber crumb content at 17 MPa. For permeable concrete with steel crumbs, a maximum value of 19 MPa was attained at 7% content.
- While testing for the flexural strength, for both rubber crumb as well as crumb steel permeable concrete, maximum strength was attained with 7% content with a value of 4.45 MPa and 4.85 MPa, respectively.
- Due to the addition of rubber and steel crumbs, the percentage porosity reduced with increase in crumb content.
- The discharge velocity decreased marginally with increase in crumb content.
- Due to the porosity effect, there was a significant increase in the seepage velocity as compared to conventional no-fines concrete. However there was a significant difference in the seepage velocities between rubber crumb and steel crumb samples. We learnt that this effect is due to the increased affinity of rubber crumb to water when compared to steel crumbs.

Recommendations

- A 5% - 7% by weight of coarse aggregates gives the most preferred results in terms of structural strength and seepage velocity for quick drainage of water away from the surface.
- A 4:1 coarse aggregate to cement content ratio is ideal to obtain ideal results.
- With a w/c ratio of 0.35, the most workable mix of permeable concrete is obtained.
- As the strength parameters are low and unsuitable for use in roads with high traffic volumes and speeds, use of permeable concrete in parking areas, walking paths and other locations needing a rigid surface finish is advisable.

Conclusion

The test results are promising with regard to the use of no-fines concrete in real life application like parking lots, walkways and basements among others. However, in order to guarantee its proper performance, it is important to design it with good seepage rate while not compromising on the structural strength.

It is known that permeable concrete provides good skid resistance, reduces the heat island effect due to air circulation and also absorbs sound. However, the low compressive and flexural strength restrict the use to locations with low loads acting on the surface. The voids present further make the concrete layer prone to clogging which increases the maintenance cost due to the requirement of cleaning on a regular basis in dusty countries such as India.

On the brighter side, the use of waste materials such as rubber crumbs and steel crumbs in this research work indicates much higher structural integrity and load carrying capacity in comparison to the conventional no-fines concrete. With a lot more of research and development to improve the specific drawbacks of no-fines concrete, we will be able to arrive at a much stronger mix of permeable concrete, so that it can be used to a much greater extent.

ii. Use variations of aggregate size, along with a mixture of size grades.

iii. Use of cementitious materials as partial replacement to OPC.

iv. Mix rubber and steel to test the effect due to combination of the waste materials.

v. Check clogging of pores over 1 year time frame to determine cleaning frequency of the clogged pores and the cost implications.

vi. Check smoothness during travel & comfort over permeable concrete, with various aggregate sizes.

Future Scope of Study

i. To develop a standard code of practice for mix proportioning and usage of no-fines concrete in practical application.

References

1. Rowe, A. A., Borst, M., O'Connor, T. P., & Stander, E. K. (2010). Permeable pavement demonstration at the Edison Environmental Center. In Low Impact Development 2010: Redefining Water in the City (pp. 139-151).

2. Avishreshth, P.P. Bansal, T. Chopra, (2018) "Characterization of Steel Fibre Reinforced Pervious Concrete for Applications in Low Volume Traffic Roads", ASCE India conference, Pg. 93-102.

3. B. Han et al, (2017), "Permeable Concrete", Springer Nature Singapore, Pg. 359 – 368.

4. C.B. Patil, B.M. Mohite, P.S. Shinde, S.S. Ingale, (2017), "Experimental Evaluation of Compressive and Flexural Strength of Pervious Concrete by using Polypropylene Fibre", IJERT, 2278-0181, Vol. 6 Issue 04, Pg. 756-762.

5. Ng, C. Y., Narong, A. R., Zaman, A. B. K., Mustaffa, Z., Mohammed, B. S., & Ean, L. W. (2019). Properties of modified high permeable concrete with a crumb rubber. The Open Civil Engineering Journal, 13(1).

6. Channappa, P.K. Reddy, (2019) "Experimental study on steel fiber-reinforced pervious concrete", IRJET, 2395-0056, Vol. 06, Issue 08, Pg. 442- 447.

7. Montes, F., Valavala, S., & Haselbach, L. M. (2005). A new test method for porosity measurements of Portland cement pervious concrete. Journal of ASTM international, 2(1), 1-13.

8. IS 10262. (2009). Guidelines for concrete mix design proportioning. Bur. Indian Stand. Delhi, 1-21.

9. Standard, I. (1959). Method of tests for strength of concrete. Bureau of Indian Standards, Manak Bhavan, 9.

10. Abera, L. E., Surbeck, C. Q., & O'Reilly, A. M. (2018). Simulated performance of in-place pervious concrete under varying storms, surface areas, and infiltration rates. Journal of Sustainable Water in the Built Environment, 4(2), 04018003.

11. JiaHao, L., Lian, F. C., Hejazi, F., & Azline, N. (2019, November). Study of properties and strength of no-fines concrete. In IOP Conference Series: Earth and Environmental Science (Vol. 357, No. 1, p. 012009). IOP Publishing.

12. P. Sarala, E. Pavithra, E. Vanathu, S S Ujitha, (2019) "Crumb Rubber Concrete Blocks", IRJET, 2395-0056, Vol. 06(03), Pg.1503-1506

13. Ranjeeth, S., & Latchoumi, T. P. (2020). Predicting Kids Malnutrition Using Multilayer Perceptron with Stochastic Gradient Descent. Rev. d'Intelligence Artif., 34(5), 631-636.

14. Prasath, D. S., & Selvakumar, A. (2015). A Novel Iris Image Retrieval with Boundary Based Feature Using Manhattan Distance Classifier. International Journal Of Innovative Technology And Creative

Engineering (Issn: 2045-8711) Vol, 5.

15. Balamurugan, K. (2021). Fracture analysis of fuselage wing joint developed by aerodynamic structural materials. Materials Today: Proceedings, 38, 2555-2562.

16. Patil, P. S., Sonar, I. P., & Shinde, S. (2017). No fine concrete. Int. J. Concr. Technol, 3(2), 1-13.

17. Priya, S. (2017). A study on intensity of rainfall in urban bangalore areas. Int Res J Eng Technol, 4, 1462-7.

18. Yang, S., Guo, M., Duan, S., Liu, N., Wu, H., Du, E., & Liang, M. (2019). Study on strength variation of permeable concrete based on differential calorimetry method and multi-index test. Advances in Materials Science and Engineering, 2019.

19. S.K. Gosh, A. Chaudhury, R. Datta, D.K. Bera, (2015), "A Review on Performance of Pervious Concrete Using Waste Materials", IJRET, 2319-1163, Vol. 4 Issue 13, Pg. 105 – 115.

20. Zhang, Y., & Gao, L. (2015). Effect of Crumb Rubber Powder on the Pavement Performance of Cement Concrete. In ICTE 2015 (pp. 1253-1258).

GROUNDWATER MONITORING AND FLUCTUATION MAPPING USING RS AND GIS TECHNIQUES FOR BENGALURU NORTH TALUK, KARNATAKA, INDIA

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ABSTRACT

This paper presents the study the overexploitation of Groundwater leads to problem in water supply and ill effects to human health. Hence global awareness should be given to the community regarding recharge and recycle of water. The modern methods of groundwater monitoring and mapping helps for the recharge and Groundwater table management. The water quality and quantity analysis should be done for the management of sustainability of groundwater. In this study we analyzed water levels for past 19 years and mapped for every 5 years and analyzed the Groundwater changes and precautionary measures can be taken, Groundwater Level fluctuation changing in the study area during 2001, 2006, 2011, 2016 , from these maps we identified very good groundwater potential zones and poor groundwater zones, so we suggesting recharge structures for low groundwater potential zones like check dams, nala bunds, percolation ponds for cultivated land and roof top harvesting for urban areas.
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Introduction

India is the biggest groundwater consumer in the world. Groundwater plays a major role in the India's economy, condition and way of life. The Government has no immediate command over the Groundwater utilization of a large number of private bore well proprietors both in provincial and urban zones. [1,2,3]

Thus awareness should be given to the public people and hence in this study "observing and GIS mapping of Groundwater level" for that we are choosing Bengaluru North taluk, this zone continually experiencing water shortage, drinking water issue in each midyear season. And further more antagonistically consequences for yield of harvest, mechanical zone additionally confronting a similar issue of lack of water. It is need of the day to think about water level in bore well, this will be valuable to know the accessibility of water as per that we are arranging water the meet to beat the shortage of water.[4]

Study Area:

The area chosen geographically lies between 770 18' 30'' E and 770 46' 0'' E longitude and 120 56' 30'' N and 130 13' 0" N with an area of 795.49 sq.km which is covered in Survey of India (SOI) Topo sheet number: 57 G / 12 on 1:50000 scale.
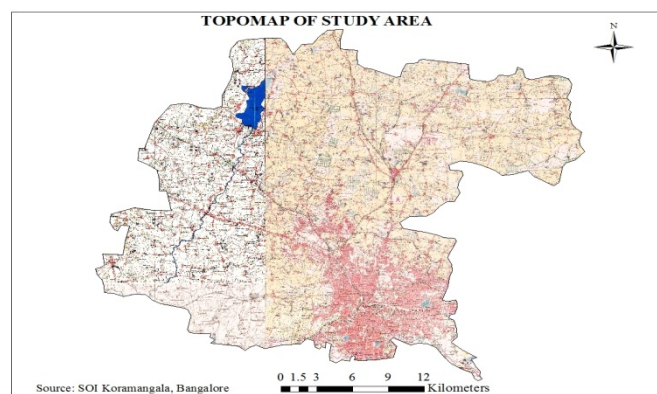

Figure 1: Topomap of Bengaluru North Taluk.

The maximum length and width of the command is approximately equal to 85.58 km and 114.29 km respectively. The following maps are prepared using GIS Software, Fig.1 shows the location map of the Bengaluru North, Fig.2 shows the Digital Elevation model of Bengaluru North Taluk
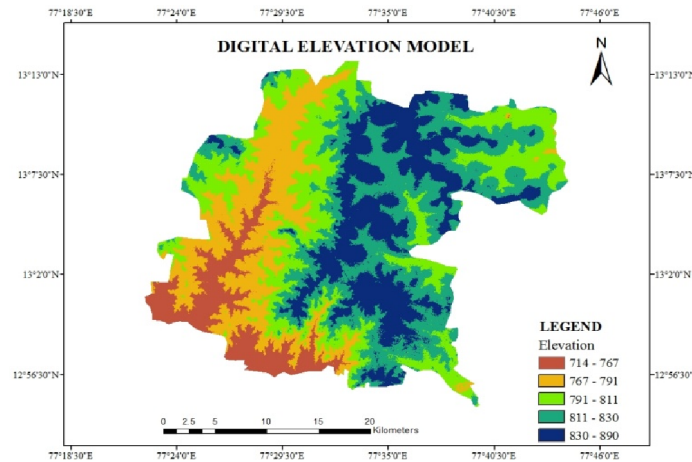
Figure 2: DEM of Bengaluru North watershed.

A. Land use/land cover map:

Land use refers to man's activities and various uses which are carried on land. Land cover refers to natural vegetation such as Water bodies, rock / soil, artificial cover and other resulted due to land transformation. Fig.3 Land use/Land cover map of Bengaluru North watershed.
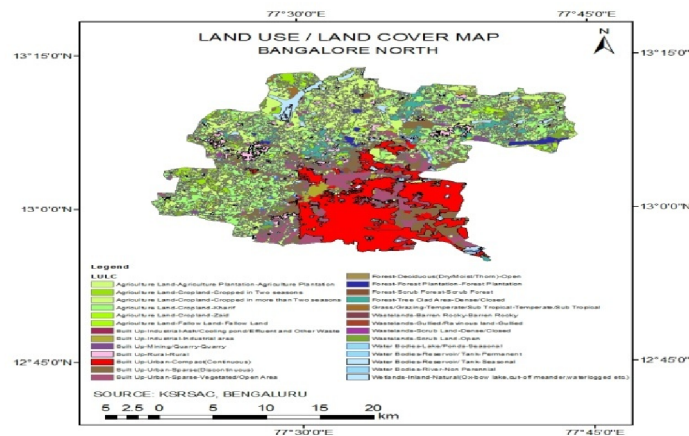
Figure 3: Land use/Land cover map of Bengaluru North watershed.

B. Drainage density map:

Behavior of drainage is essentially controlled by physiography, lithology and rainfall. Groundwater level behavior is analyzed based on influence of drainage density. Higher the drainage density lesser on influence of ground water and vice-versa. Fig.4 showing Drainage density map of Bengaluru North watershed

Figure 4: Drainage density map of Bengaluru North watershed.

C. Rainfall:

The principal source of all surface and groundwater in the study area is precipitation. 30 years annual rainfall data from 4 stations (Hebbala, Yelahanaka, 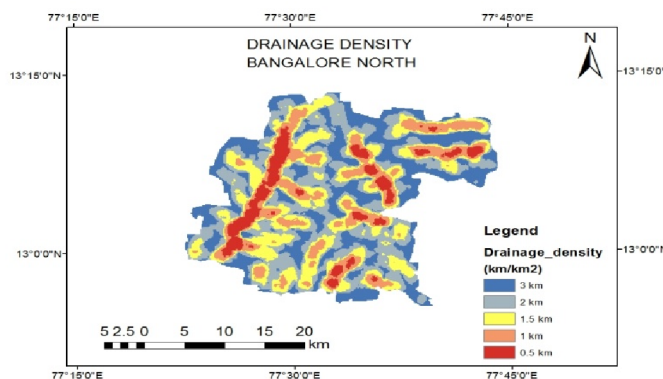Chikkajala, Yelahanaka (KSNDMC) situated within the watershed were collected and Isohyetal map has been prepared.Fig.5 shows the rainfall map of the study area.
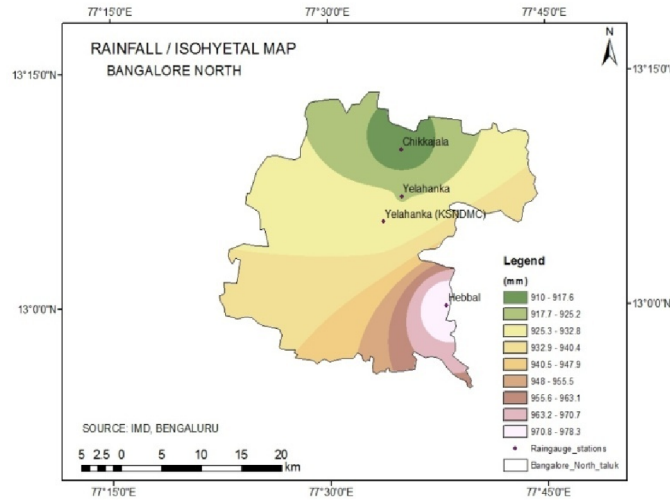

Figure 5: The rainfall map of the study area.

Methodology

The selected bore wells in all parts of the study area and covered each municipal ward. The positioning of wells interns of latitude and longitude are measured with the help of hand held GPS .the water levels are measured season wise they are monsoon and pre monsoon and post monsoon.

Depth to groundwater level was estimated in meter with the packaging of the well as reference indicates and afterward reasoned definite ground level. Google earth is utilized to enlist ground level profile of the examination region and ground level above mean sea level of the inspecting bore wells. The groundwater level in MSL was acquired by deducting groundwater profundity from the beginning in MSL. Table.1 to Table. 12 shows the Bore well and Dug well location and depth of water levels in the study area.

Table 1: Bore well and Dug well location and depth of water levels for the year 2016.

Sl. No.	Latitude	Longitude	Site-Name	Site-Type	Year	Monsoon	Post monsoon kharif	Post Monsoon Rabi	Pre Monsoon
1	13.041667	77.575	Hebbal-1	Bore Well	2016	39.45	38.3		
2	13.0975	77.609444	Rachenahalli	Bore Well	2016	1.16	9.3	4.07	8.26
3	13.095278	77.605833	Jakkur Pz	Bore Well	2016	1.84	2.77	1.33	2.1
4	13.059722	77.576944	Kodigehalli	Dug Well	2016	3.63	4.33	3.53	4.23
5	13.0275	77.569444	Indian Institute of Science	Bore Well	2016	27.86	34.67	24.84	32
6	13.004167	77.5725	Malleswaram	Dug Well	2016	3.45	5.45	3.15	2.87
7	12.992778	77.596111	Vasanthnagara	Dug Well	2016	0.65	1.1		0.37
8	12.981944	77.629167	Ulsoor	Dug Well	2016	2.87	2.27	2.87	2.27
9	12.981944	77.555556	Rajajinagara	Dug Well	2016	1.8	2.25	1.9	2.1
10	12.948889	77.596944	Wilson Garden	Dug Well	2016	1.62	2.75	1.15	3.79

11	12.948611	77.571944	Basavanagudi	Dug Well	2016	5.53	7.33	5.61	5.73
12	12.938611	77.592222	Nimhans	Bore Well	2016	13.93	9.33	7.43	
13	12.970833	77.6375	Indiranagar	Bore Well	2016		9.24		
14	12.951667	77.585556	Lalbagh garden	Bore Well	2016	3.58			
15	13.075	77.4375	Dasanapura	Bore Well	2016	24	30.44		
16	13.141667	77.458333	Hesaraghatta-1	Bore Well	2016	25.68	26.47		
17	12.944167	77.558333	Bengaluru-4	Dug Well	2016	2	3.3		2.44
18	13.108333	77.6	Yelahanka	Bore Well	2016	20.78	23.28		
19	13.041667	77.583333	Hebbal-2	Dug Well	2016	0.35	4		2.45
20	12.974167	77.593889	Cubbon Park	Bore Well	2016			3.06	

Table 2: Bore well and Dug well location and depth of water levels for the year 2015.

1	12.951667	77.585556	Lalbagh garden	Bore Well	2015	4.03		4.92	3.3
2	13.095278	77.605833	Jakkur Pz	Bore Well	2015	1.53	8.03	2.13	1.32
3	12.992778	77.596111	Vasanthnagara	Dug Well	2015	0.03		0.03	0.48
4	13.041667	77.575	Hebbal-1	Bore Well	2015	27.97		22.63	26.1
5	13.041667	77.583333	Hebbal-2	Dug Well	2015	2.38		2.3	2.38
6	13.108333	77.6	Yelahanka	Bore Well	2015	24.62		26.54	25.2
7	12.944167	77.558333	Bengaluru-4	Dug Well	2015	2.55	1.9	2.04	2.47
8	13.004167	77.5725	Malleswaram	Dug Well	2015	2.46	4.33	3.11	3.1
9	13.141667	77.458333	Hesaraghatta-1	Bore Well	2015	25.75		25.75	25.88
10	13.075	77.4375	Dasanapura	Bore Well	2015	31.38		29.88	30.37
11	13.0275	77.569444	Indian Institute Of Science	Bore Well	2015	27.62	26.23	24.98	30.59
12	12.981944	77.629167	Ulsoor	Dug Well	2015	2.8	2.55	2.65	2.5
13	12.981944	77.555556	Rajajinagara	Dug Well	2015		1.84	1.84	1.77
14	12.96	77.576944	Vijayanagar	Dug Well	2015			29.25	29.25
15	12.974167	77.593889	Cubbon Park	Bore Well	2015		20.84		
16	12.948889	77.596944	Wilson Garden	Dug Well	2015	0.88	1.2	4.9	0.8
17	13.059722	77.576944	Kodigehalli	Dug Well	2015	3.83	4.83	4.45	3.46
18	12.948611	77.571944	Basavanagudi	Dug Well	2015	4.73	3.68	4.32	3.62
19	12.938611	77.592222	Nimhans	Bore Well	2015	6.92	8.35		
20	13.0975	77.609444	Rachenahalli	Bore Well	2015	10.13	49.95		10.92
21	12.970833	77.6375	Indiranagar	Bore Well	2015	7.7		7.59	7.7
22	13.091667	77.6	Yelahanka1	Dug Well	2015	2.6	1.9	10.4	2.4

Table 3: Bore well and Dug well location and depth of water levels for the year 2014 and 2013.

1	13.0975	77.609444	Rachenahalli	Bore Well	2014				22.23
2	12.970833	77.6375	Indiranagar	Bore Well	2014	8.54	6.87	6.92	8.98
3	13.059722	77.576944	Kodigehalli	Dug Well	2014				4.24
4	13.108333	77.6	Yelahanka	Bore Well	2014	31.29	15.4	29.76	30.85
5	13.141667	77.458333	Hesaraghatta-1	Bore Well	2014	29.87	26.54	30.06	29.45
6	12.948889	77.596944	Wilson Garden	Dug Well	2014				1.28
7	13.095278	77.605833	Jakkur Pz	Bore Well	2014				3.19
8	12.992778	77.596111	Vasanthnagara	Dug Well	2014				0.14
9	12.948611	77.571944	Basavanagudi	Dug Well	2014				5.47
10	13.075	77.4375	Dasanapura	Bore Well	2014	32.18	29.28		19
11	13.004167	77.5725	Malleswaram	Dug Well	2014				4.27
12	13.0275	77.569444	Indian Institute Of Science	Bore Well	2014				33.01
13	13.041667	77.583333	Hebbal-2	Dug Well	2014	3.22	0.1	2.99	4.67
14	12.951667	77.585556	Lalbagh garden	Bore Well	2014	4.99	3	3.53	4.95
15	13.091667	77.6	Yelahanka1	Dug Well	2014		3.65	4.45	10.4
16	12.944167	77.558333	Bengaluru-4	Dug Well	2014	2.91	1.75	3.28	3.48
17	13.041667	77.575	Hebbal-1	Bore Well	2014	38.32	24.21	21.43	36.21
18	12.981944	77.555556	Rajajinagara	Dug Well	2014				2.02
19	13.041667	77.575	Hebbal-1	Bore Well	2013	35.27		26.4	36.6
20	13.041667	77.583333	Hebbal-2	Dug Well	2013	1.77	0.13	6.87	6.52

21	13.108333	77.6	Yelahanka	Bore Well	2013	30.35		30.5	31.7
22	12.944167	77.558333	Bengaluru-4	Dug Well	2013	2.8	2.76	3.4	6.6
23	13.141667	77.458333	Hesaraghatta-1	Bore Well	2013	34.98	32.09	33.25	35.9
24	13.141667	77.633333	Hunsemaranahalli	Dug Well	2013			1.2	
25	13.075	77.4375	Dasanapura	Bore Well	2013			31.3	31.48
26	12.951667	77.585556	Lalbagh garden	Bore Well	2013	3.1		3.3	3.5
27	12.970833	77.6375	Indiranagar	Bore Well	2013	7.82		8.45	8.72
28	13.166667	77.566667	Sonnenahalli	Dug Well	2013				12.02
29	13.081944	77.505556	Chikkabanavara	Dug Well	2013				7.8
30	13.091667	77.6	Yelahanka1	Dug Well	2013	10.4	4.32	10.4	10.4
31	12.9725	77.576667	Bengaluru-3	Dug Well	2013	10.45		1.95	
32	12.948611	77.571944	Basavanagudi	Dug Well	2013			2.43	2.73
33	12.948889	77.596944	Wilson Garden	Dug Well	2013			1.8	2.21
34	12.96	77.576944	Vijayanagar Hosahalli	Dug Well	2013			18.85	29.25
35	12.981944	77.555556	Rajajinagara	Dug Well	2013			2.6	2.38
36	12.981944	77.629167	Ulsoor	Dug Well	2013			3.27	3.35
37	12.992778	77.596111	Vasanthnagara	Dug Well	2013				1.01
38	13.004167	77.5725	Malleswaram	Dug Well	2013			3.75	3.85
39	13.059722	77.576944	Kodigehalli	Dug Well	2013			3.98	4.43

Table 4: Bore well and Dug well location and depth of water levels for the year 2012 and 2011.

1	12.9725	77.576667	Bengaluru-3	Dug Well	2012		2.37	2.25	1.48
2	12.944167	77.558333	Bengaluru-4	Dug Well	2012		2.99	3.35	1.23
3	12.948889	77.596944	Wilson Garden	Dug Well	2012		2.64		
4	12.96	77.576944	Vijayanagar	Dug Well	2012		7.6		
5	12.981944	77.555556	Rajajinagara	Dug Well	2012		2.35		
6	12.992778	77.596111	Vasanthnagara	Dug Well	2012		1.1		
7	13.004167	77.5725	Malleswaram	Dug Well	2012		4.9		
8	13.059722	77.576944	Kodigehalli	Dug Well	2012		4.25		
9	13.141667	77.458333	Hesaraghatta-1	Bore Well	2012		32.37	27.09	29.14
10	13.075	77.4375	Dasanapura	Bore Well	2012		40.6	29.69	28.55
11	12.951667	77.585556	Lalbagh garden	Bore Well	2012		3.47	3.3	3.09
12	12.970833	77.6375	Indiranagar	Bore Well	2012		8.8	6.76	8
13	13.091667	77.6	Yelahanka1	Dug Well	2012		1.74	3.1	4.22
14	13.041667	77.575	Hebbal-1	Bore Well	2012		23.18	15.39	21.3
15	13.041667	77.583333	Hebbal-2	Dug Well	2012		7.26	5.12	4.18
16	13.108333	77.6	Yelahanka	Bore Well	2012		30.07	29.02	29.35
17	12.948611	77.571944	Basavanagudi	Dug Well	2012		2.62		
18	12.9725	77.576667	Bengaluru-3	Dug Well	2011	1.82	2.15	2.25	2.1
19	13.141667	77.458333	Hesaraghatta-1	Bore Well	2011	25.93		23.75	25.35
20	13.075	77.4375	Dasanapura	Bore Well	2011	29.03	28.78	28.44	
21	12.951667	77.585556	Lalbagh garden	Bore Well	2011	2.14	2.42		2.6
22	12.944167	77.558333	Bengaluru-4	Dug Well	2011	1.82	2.45	2.7	2.25
23	13.091667	77.6	Yelahanka1	Dug Well	2011	2.82	3.58	3.85	4.26
24	13.041667	77.575	Hebbal-1	Bore Well	2011	19.93	14.38	12.91	20.91
25	13.041667	77.583333	Hebbal-2	Dug Well	2011	'0	1.93	4.87	5.87
26	13.108333	77.6	Yelahanka	Bore Well	2011	28.83	29.59	25	28.57
27	12.970833	77.6375	Indiranagar	Bore Well	2011	6.4	5.07	8.18	8.64

Table 5: Bore well and Dug well location and depth of water levels for the year 2008 and 2007.

1	12.9725	77.576667	Bengaluru-3	Dug Well	2008	2.09	2.84	3.7	1.45
2	13.141667	77.633333	Hunsemaranahalli	Dug Well	2008		1.17	2.5	8.56
3	13.075	77.4375	Dasanapura	Bore Well	2008	31.8	23.7	30.45	31.25
4	12.951667	77.585556	Lalbagh garden	Bore Well	2008	1.65	2.19	0.98	2.85
5	12.970833	77.6375	Indiranagar	Bore Well	2008	8.8	7.1	8.42	9.6
6	13.141667	77.458333	Hesaraghatta-1	Bore Well	2008	23.8	21.7	22.76	24.7
7	13.091667	77.6	Yelahanka1	Dug Well	2008	1.21	2.53	3.92	9.65
8	13.041667	77.575	Hebbal-1	Bore Well	2008	5.8	11.63	16.14	22.04
9	13.041667	77.583333	Hebbal-2	Dug Well	2008		0.54	4.1	6.47
10	13.1875	77.5	Doddakallasandra	Dug Well	2008		22.59		
11	12.944167	77.558333	Bengaluru-4	Dug Well	2008	2.45	2.11	2.56	1.22
12	13.166667	77.566667	Sonnenahalli	Dug Well	2008				12.02
13	12.9725	77.576667	Bengaluru-3	Dug Well	2007	2.45	2.87		2.66
14	13.141667	77.633333	Hunsemaranahalli	Dug Well	2007		0.85		
15	13.075	77.4375	Dasanapura	Bore Well	2007		28.77	34.2	
16	12.951667	77.585556	Lalbagh garden	Bore Well	2007	2	1.43	2.25	
17	12.970833	77.6375	Indiranagar	Bore Well	2007	9.4	8.08	9.76	
18	13.141667	77.458333	Hesaraghatta-1	Bore Well	2007	25.2	22.94	22.06	
19	13.091667	77.6	Yelahanka1	Dug Well	2007	10.4	2.65	5.06	9.9
20	13.041667	77.575	Hebbal-1	Bore Well	2007	20.7	15.89	16.7	
21	13.041667	77.583333	Hebbal-2	Dug Well	2007	2.57	0.47	5.62	6.97
22	13.108333	77.6	Yelahanka	Bore Well	2007	31.2	31.62	25.06	
23	12.944167	77.558333	Bengaluru-4	Dug Well	2007	2.15	2.15		1.88
24	13.166667	77.566667	Sonnenahalli	Dug Well	2007	12.02			

Table 6: Bore well and Dug well location and depth of water levels for the year 2006 and 2005.

1	12.9725	77.576667	Bengaluru-3	Dug Well	2006	2.41	2.7		2.65
2	13.075	77.4375	Dasanapura	Bore Well	2006	29.31	32.58	23.2	28.36
3	12.951667	77.585556	Lalbagh garden	Bore Well	2006	2.02	2.07	1.75	1.95
4	12.970833	77.6375	Indiranagar	Bore Well	2006	8.61	9.16	6.21	11.2
5	13.166667	77.566667	Sonnenahalli	Dug Well	2006	12.02	12.02	9.99	
6	13.141667	77.458333	Hesaraghatta-1	Bore Well	2006	28.37	21.75	21.78	21.8
7	13.041667	77.575	Hebbal-1	Bore Well	2006	13.71	14.21	7.67	9.45
8	13.041667	77.583333	Hebbal-2	Dug Well	2006	2.63	3.36	1.13	
9	13.108333	77.6	Yelahanka	Bore Well	2006	24.35	25	23.09	23.85
10	12.944167	77.558333	Bengaluru-4	Dug Well	2006	2.89	2.67	2.02	2.85
11	13.091667	77.6	Yelahanka1	Dug Well	2006	7.53			
12	12.9725	77.576667	Bengaluru-3	Dug Well	2005	2.4	2.4	2.81	2.56
13	13.075	77.4375	Dasanapura	Bore Well	2005	32.04	23.4	26.25	
14	12.951667	77.585556	Lalbagh garden	Bore Well	2005	1.08	1.64	2.18	
15	12.970833	77.6375	Indiranagar	Bore Well	2005	9.62	5.45	8.87	
16	13.141667	77.458333	Hesaraghatta-1	Bore Well	2005	25.75	23.3	23.42	24.02
17	13.041667	77.575	Hebbal-1	Bore Well	2005	15.95	9.45	14.9	6.5
18	13.041667	77.583333	Hebbal-2	Dug Well	2005	6.92	0.57	7.75	6.5
19	13.108333	77.6	Yelahanka	Bore Well	2005	27.99	23.4	26.43	
20	12.944167	77.558333	Bengaluru-4	Dug Well	2005	2.06	1.7	2.66	2.74
21	13.166667	77.566667	Sonnenahalli	Dug Well	2005	12.02	12.02		

Table 7: Bore well and Dug well location and depth of water levels for the year 2004 and 2003.

1	12.9725	77.576667	Bengaluru-3	Dug Well	2004	1.67	2.39	2.3	3.06
2	13.075	77.4375	Dasanapura	Bore Well	2004		26.44	32.76	35.8
3	12.951667	77.585556	Lalbagh garden	Bore Well	2004	1.83	1.67	2.34	1.87
4	12.970833	77.6375	Indiranagar	Bore Well	2004	8.23	7.8	10.17	9.8
5	13.041667	77.575	Hebbal-1	Bore Well	2004	15.25	10	21.87	15.6
6	13.1875	77.5	Doddakallasandra	Dug Well	2004		20.2		
7	13.108333	77.6	Yelahanka	Bore Well	2004	27.96	26.5	28.27	28.1
8	12.944167	77.558333	Bengaluru-4	Dug Well	2004	2.15	2.05	2.3	2.1
9	13.141667	77.458333	Hesaraghatta-1	Bore Well	2004		23.38	22.68	24.3
10	13.166667	77.566667	Sonnenahalli	Dug Well	2003	11.08			11.9
11	13.091667	77.6	Yelahanka1	Dug Well	2003			8.2	
12	12.9725	77.576667	Bengaluru-3	Dug Well	2003	1.8	1.46	2.4	2.1
13	13.108333	77.6	Yelahanka	Bore Well	2003			24.29	
14	12.951667	77.585556	Lalbagh garden	Bore Well	2003			2.28	
15	12.944167	77.558333	Bengaluru-4	Dug Well	2003	2.01	1.65	2.64	2.75
16	13.075	77.4375	Dasanapura	Bore Well	2003			26.91	
17	13.041667	77.575	Hebbal-1	Bore Well	2003	3.35	1.14	14.69	8.16
18	13.141667	77.458333	Hesaraghatta-1	Bore Well	2003			18.68	
19	13.1875	77.5	Doddakallasandra	Dug Well	2003			18.95	

Table 8: Bore well and Dug well location and depth of water levels for the year 2002 and 2001.

1	12.951667	77.585556	Lalbagh garden	Bore Well	2002		2.34		2.67
2	13.075	77.4375	Dasanapura	Bore Well	2002	22.21	23.54		22.9
3	12.9725	77.576667	Bengaluru-3	Dug Well	2002		2.25	3.4	3.5
4	13.141667	77.458333	Hesaraghatta-1	Bore Well	2002	17.85	18.27		7.46
5	12.944167	77.558333	Bengaluru-4	Dug Well	2002	2.35	2.2		2.35
6	13.125	77.477778	Hesaraghatta-2	Tube Well	2002				6.96
7	13.108333	77.6	Yelahanka	Bore Well	2002	21.44	24.5		22.53
8	13.1875	77.5	Doddakallasandra	Dug Well	2002	17.42	18.55	13.13	16.45
9	13.041667	77.575	Hebbal-1	Bore Well	2002	8.76	10.4	2.48	13.48
10	13.091667	77.6	Yelahanka1	Dug Well	2002	5.5	5		4.92
11	13.081944	77.505556	Chikkabanavara	Dug Well	2002	7.95			4.68
12	13.166667	77.566667	Sonnenahalli	Dug Well	2002			7.26	8.66
13	13.041667	77.575	Hebbal-1	Bore Well	2001	8.7	6.33	9.53	14.41
14	13.125	77.477778	Hesaraghatta-2	Tube Well	2001	20.59		14.79	
15	13.091667	77.6	Yelahanka1	Dug Well	2001	5.11	2.67	2.81	4.45
16	12.970833	77.6375	Indiranagar	Bore Well	2001		5.71	5.96	2.25
17	12.9725	77.576667	Bengaluru-3	Dug Well	2001	3.12	2.64	3.07	2.87
18	13.108333	77.6	Yelahanka	Bore Well	2001		20.99	21.54	23.11
19	13.075	77.4375	Dasanapura	Bore Well	2001			14.5	16.59
20	13.141667	77.458333	Hesaraghatta-1	Bore Well	2001	17.6	16.39	15.29	15.58
21	13.1875	77.5	Doddakallasandra	Dug Well	2001	16.35	14.07	12.77	15.88
22	12.951667	77.585556	Lalbagh garden	Bore Well	2001	2.1	1.42		2.41
23	13.166667	77.566667	Sonnenahalli	Dug Well	2001	9.4	6.9	6.88	
24	12.944167	77.558333	Bengaluru-4	Dug Well	2001	2.34	1.09	2.36	2.48

Table 9: Bore well and Dug well location and depth of water levels for the year 2000 and 1999.

1	13.091667	77.6	Yelahanka1	Dug Well	2000	2.38	2.08	2.75	4.18
2	13.108333	77.6	Yelahanka	Bore Well	2000		21.67		
3	13.166667	77.566667	Sonnenahalli	Dug Well	2000	9.15	5.64	9.88	
4	12.944167	77.558333	Bengaluru-4	Dug Well	2000	2.15	1.97	2.43	2.5
5	13.041667	77.575	Hebbal-1	Bore Well	2000	9.26	8.38	2.38	3.91
6	13.1875	77.5	Doddakallasandra	Dug Well	2000	15.55	13.35	12.96	
7	12.9725	77.576667	Bengaluru-3	Dug Well	2000	2.57	2.13	2.78	
8	13.075	77.4375	Dasanapura	Bore Well	2000				16.9
9	13.141667	77.458333	Hesaraghatta-1	Bore Well	2000	17.66	16.61		17.85
10	13.081944	77.505556	Chikkabanavara	Dug Well	2000		2.99		
11	13.091667	77.6	Yelahanka1	Dug Well	1999	4.08	2.05	3.82	3.45
12	12.944167	77.558333	Bengaluru-4	Dug Well	1999	2.91	2.22		2.24
13	13.081944	77.505556	Chikkabanavara	Dug Well	1999	6.7	4.25		6.15
14	12.9725	77.576667	Bengaluru-3	Dug Well	1999	3.27	2.83	3.22	2.15
15	13.108333	77.6	Yelahanka	Bore Well	1999	24.6			
16	13.1875	77.5	Doddakallasandra	Dug Well	1999		13.2	14.52	14.4
17	13.041667	77.575	Hebbal-1	Bore Well	1999	2.18	1.11	4.88	1.44
18	13.166667	77.566667	Sonnenahalli	Dug Well	1999	10.22	9.91	8.76	9.45

Table 10: Bore well and Dug well location and depth of water levels for the year 1998 and 1997.

1	12.944167	77.558333	Bengaluru-4	Dug Well	1998	1.94	2.08	2.36	2.59
2	13.125	77.477778	Hesaraghatta-2	Tube Well	1998			23.65	
3	13.1875	77.5	Doddakallasandra	Dug Well	1998	17.65	13.9	16.81	17.9
4	12.9725	77.576667	Bengaluru-3	Dug Well	1998	2.3	2.5	3.02	2.84
5	13.166667	77.566667	Sonnenahalli	Dug Well	1998	9.78	7.22	10.8	
6	13.136111	77.619444	Puttanahalli	Dug Well	1998			5.2	
7	13.091667	77.6	Yelahanka1	Dug Well	1998	2.54	1.72	3.51	4.45
8	13.081944	77.505556	Chikkabanavara	Dug Well	1998		3.07		2.44
9	13.041667	77.575	Hebbal-1	Bore Well	1998		0.92	2.36	3.99
10	13.166667	77.566667	Sonnenahalli	Dug Well	1997	11.68	10.62	9	11
11	13.136111	77.619444	Puttanahalli	Dug Well	1997		1.4	7.16	8.26
12	12.944167	77.558333	Bengaluru-4	Dug Well	1997	3.2	2.1	3.5	3.75
13	13.125	77.477778	Hesaraghatta-2	Tube Well	1997	25.1	23.35	18.3	23.3
14	13.1875	77.5	Doddakallasandra	Dug Well	1997	18.36	16.31	16.46	17.68
15	13.041667	77.575	Hebbal-1	Bore Well	1997	7.02	1.26	7.03	8.36
16	12.9725	77.576667	Bengaluru-3	Dug Well	1997	3.96	2.77	4.5	4.49
17	13.091667	77.6	Yelahanka1	Dug Well	1997	6.3	3.3	5.95	5.62
18	13.081944	77.505556	Chikkabanavara	Dug Well	1997			8.01	

Table 11: Bore well and Dug well location and depth of water levels for the year 1996.

1	13.091667	77.6	Yelahanka1	Dug Well	1996	5.08	3.57	5.68	6.36
2	13.041667	77.575	Hebbal-1	Bore Well	1996	4.36	3.64	8.51	8.48
3	13.125	77.477778	Hesaraghatta-2	Tube Well	1996	22.1			22.52
4	13.1875	77.5	Doddakallasandra	Dug Well	1996		17.17	20.04	21.68
5	12.944167	77.558333	Bengaluru-4	Dug Well	1996	2.7	3.29	3.56	3.37
6	13.136111	77.619444	Puttanahalli	Dug Well	1996	6.8	6.28	7.45	
7	12.9725	77.576667	Bengaluru-3	Dug Well	1996	3.43	3.92	4.26	
8	13.166667	77.566667	Sonnenahalli	Dug Well	1996	7.3	8.59	8.5	10.43

Results and Discussion

After careful observation of water levels in the bore wells are mapped with the help of GIS software, for this study we have collected the Groundwater levels for the past 19 years in the Central Groundwater Board, Bengaluru.

From the observed results the groundwater zones are good in the year 1996, in the map green portions are more compared to yellow and red areas it means groundwater conditions are good, Groundwater fluctuation map of 1996 is shown in the Fig.6.

Groundwater Level fluctuation changing in the study area during 2001, 2006, 2011, 2016 during these years how the groundwater potential zones are decreasing gradually shown in the Fig.7, Fig,8, Fig.9 and Fig.10.
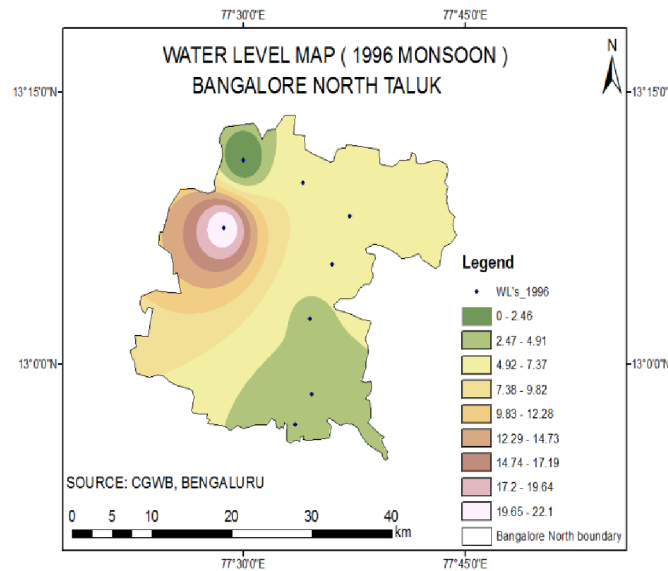
Figure 6: Water Level fluctuation Map for the year 1996.
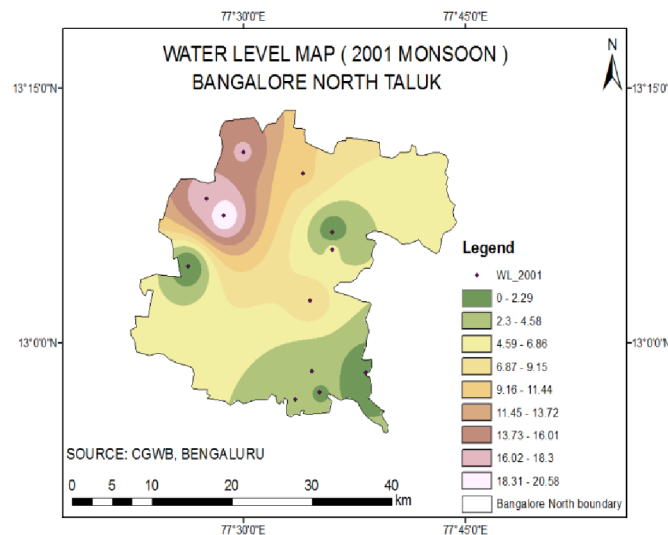
Figure 7: Water Level fluctuation Map for the year 2001.
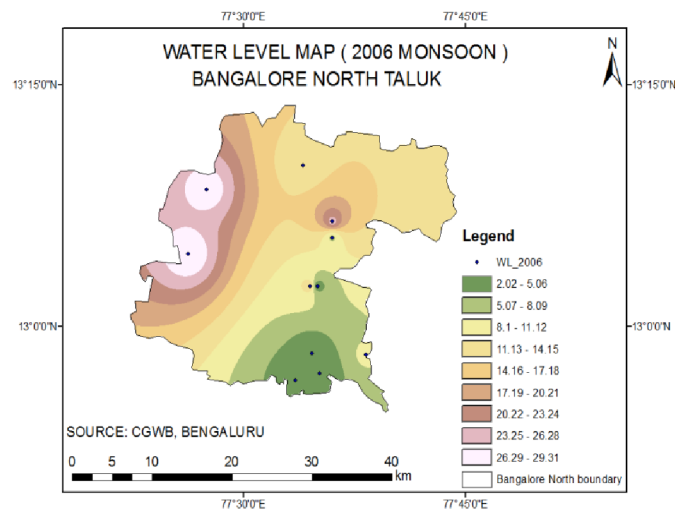
Figure 8: Water Level fluctuation Map for the year 2006.
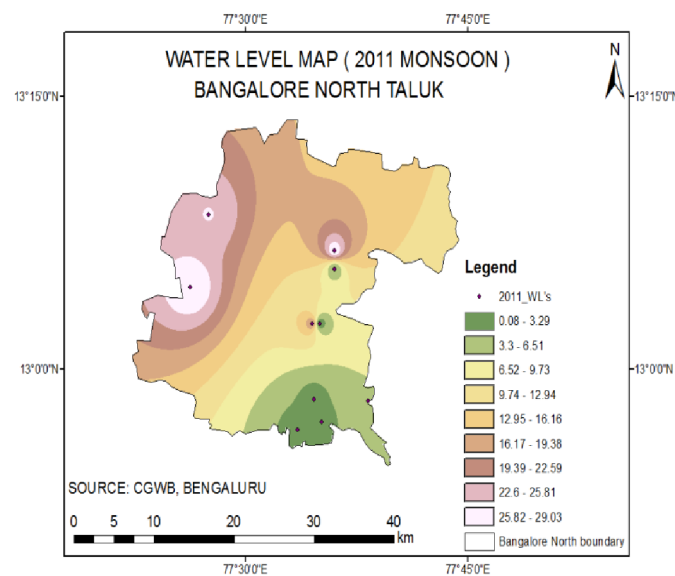
Figure 9: Water Level fluctuation Map for the year 2011.
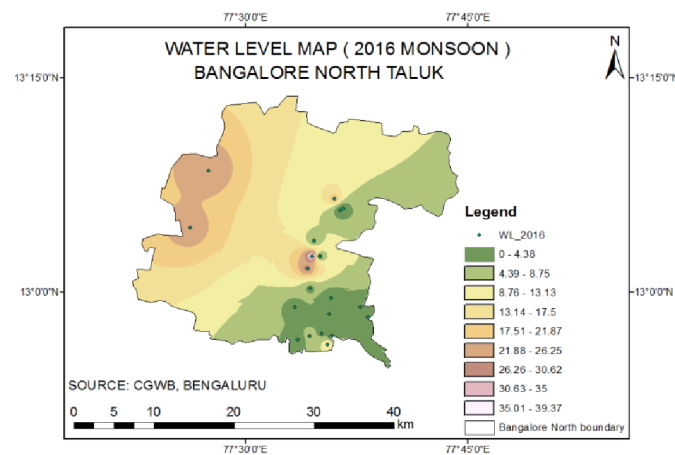
Figure 10: Water Level fluctuation Map for the year 2016.

Conclusion

For the Monsoon season mapping is being done with the help of GIS software. These observations were analyzed in detail, the changes which have occurred in water table level fluctuations are found and using GIS Mapping is done using QGIS software. In this study, plotted Digital elevation model mapping, slope mapping, land use land cover mapping, Geology of the study area, These gives the idea regarding terrine undulations and variations in Groundwater table how it changing. This analysis is important for comparative study of well inventory and planning various irrigation activities in the study area. In this study we analyzed the water levels for the year 1996, 2001, 2006, 2011, 2016, from these maps identified very good groundwater potential zones and poor groundwater zones, so we suggesting recharge structures for low groundwater potential zones like check dams, nala bunds, percolation ponds for cultivated land and roof top harvesting for urban areas.

References

1. Kumar, T. M., & Prabhu, N. Geochemical Modelling Of Kushawathi Watershed Area Chikkaballapur District, Karnataka.

2. Prabhu, N., & Inayathulla, M. A Groundwater Modeling on Hard Rock Terrain by using Visual Modflow Software for Bangalore North, Karnataka, India. *Genesis*, *3*(8), 7E-7.

3. Prabhu, N., & Inayathulla, M. (2019). Ground water quality analysis of hard rock terrain in Bangalore North taluk, Karnataka, India. *International journal of innovative technology and exploring engineering*, *8*(12).

4. Ranjeeth, S., & Latchoumi, T. P. (2020). Predicting Kids Malnutrition Using Multilayer Perceptron with Stochastic Gradient Descent. Rev. d'Intelligence Artif., 34(5), 631-636.

5. Prasath, D. S., & Selvakumar, A. (2015). A Novel Iris Image Retrieval with Boundary Based Feature Using Manhattan Distance Classifier. International Journal Of Innovative Technology And Creative Engineering (Issn: 2045-8711) Vol, 5.

6. Balamurugan, K. (2021). Fracture analysis of fuselage wing joint developed by aerodynamic structural materials. Materials Today: Proceedings, 38, 2555-2562.

7. Prabhu, N. (2019). Morphometric analysis for Bangalore north watersheds. *WATER And EnERGY InTERnATIOnAL*, *62*(7), 54-62.

8. H. Vijaya Kumar, S. Nagraj Patil, and Nanjundi Prabhu. "Analysis of Water Quality Parameters of Groundwater near Ranebennur industrial area, Haveri District, Karnataka, India", 2nd International Conference on Emerging Research in Civil, Aeronautical and Mechanical Engineering ERCAM-2019, "American Institute of Physics (AIP) Conference Proceedings", July 25-26, 2019.

9. Nanjundi Prabhu and M.Inayathulla. "Runoff Estimation by SCS Curve number method for Bangalore North Taluk, Karnataka, India", Journal of Advance Research in Dynamical systems, vol.11, No.1, 2019. ISSN 1943-023X. 24th Dec 2018.

STUDY ON EFFICIENT USAGE OF WATER IN PERMEABLE PAVEMENT SYSTEM

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ABSTRACT

This project is mainly enforced how to reduce storm water runoff using sustainable urban drainage system with permeable Asphalt pavement. This system provides proper drainage flow of water. By this approach we can recharge the groundwater table. Porous Asphalt pavements are built with 50% to 75% compacted subgrade layer to increase soil penetration. The following layer contains one or more layer of porous Asphalt compounds with interlocking spaces that allow a small amount water to flow through the pavement. Then we provide a recycled plastic sheet which has minute voids that allows little amount of water to pass through it and even water can be drained to drainage system by providing a slope of 2 to 3%. From this approach results recorded are the strength is 10 to 15% relatively lesser than traditional Asphalt pavement. Due to porous pavements it can absorb water in large amount and stop storm water runoff on road pavement. This method can allow water to recharge the ground water table and also allows it to flow through the drains. This project is mainly done in consideration of Sustainable Development. This approach can reduce large volumes of runoff and improve water quality of storm water runoff by allowing partially infiltrating through its structure and rest to drain through drainage system. By this, storm water reaches the ground water table and also reaches the drains to be used as rain harvesting. This even can be considered as sustainable urban drainage system.

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Keywords: *permeable asphalt pavement, sustainable urban drainage, recycled plastic sheet.*

Introduction

Sustainable Urban Drainage Systems has many other names such as drainage schemes and continuous drainage systems. Urban Drainage Systems challenge traditional wastewater management practices by improving resource utilization and the development of new and productive technologies.

There are many benefits to using Sustainable Urban Drainage Systems in our community but there are a few pluses mentioned below.

1. Flood management and better storm water management (resource management).
2. Pollution control.
3. Recharging of underground regimes and rivers.
4. Reduced construction and maintenance costs.
5. Improved environment.

There are a number of SUDS applications, if not all, ranging from reed wastewater treatment systems, sink ponds, simple swales and filtration canals.

However, the size of the stone bed and the depth should be designed so that the water level does not rise to the asphalt. in depth, it provides a lower base for making asphalt. While slightly stronger than conventional asphalt, advanced asphalt modes are acceptable.

In addition, porous asphalt mortar does not require related ingredients and does not require special polishing equipment. Due to the structure of the paved road, porous asphalt offers ways to fill tables with water instead of forcing rain into storm sewers, strong asphalt and helps reduce the demand for storm sewer systems.

It usually consists of a fine, coarse stone coated with a bituminous-based binder coarse. Asphalt passing over the combined storage bed will reduce storm water volume, scale, and pollution. Reduced fines leave air pockets stable on asphalt. The enclosed space allows storm water to flow through the asphalt and then enters the base layer of the crushed stone beds and the foundation that supports the asphalt while providing water conservation and management.

Properly constructed, perforated asphalt is a more cost-effective and more expensive means than conventional asphalt. The size of the asphalt depends on the road load, usually from 7.5 to 18 cm. There were problems in the past with the first perforated asphalt, as the bond was moving to empty empty spaces, blocking the flow of water. This is enhanced by the use of additional additives and additives.

Additional additives and additives are often used to enhance the characteristics of bold asphalt. Polymers keep the binder from moving to empty spaces. The natural benefits from perforated asphalt allow it to be incorporated into green municipal infrastructure and low impact development plans. Open asphalt has been used for decades. Pollution from road and car parks due to oil and gas leaks, leaks, tire wear and atmospheric dust. This type of pollution comes from a variety of sources and is widespread throughout urban areas also known as contagious pollution. Invisible areas have the potential to bring pollution to waterways.

Hydrocarbons can endanger soil and groundwater, if they are not removed sufficiently during intrusion into the upper layer. Many pollutants such as fragrant polycyclic hydrocarbons, metals, phosphorus and organic compounds are incorporated into solid solids. The models are designed to measure the fixed solid load and their strength during the rainy season, leading to a better understanding of finding water contaminated with hydrocarbons. Approved pellets can serve as efficient hydrocarbon traps and powerful in-situ bioreactors.

found that PPS vaccinated specifically for microorganisms reduces hydrocarbon energy does not effectively retain the number of organisms with the aim of increasing hydrocarbon degradation over many years. Naturally built communities effectively reduce oil efficiency. For the successful biodegradation of white-scented hydrocarbons, certain environmental conditions must be met. Extreme hydrocarbon emissions can be contained due to absorption processes within the water is sent to the installation of suits where they may have the opportunity to drain the soil or be temporarily stored rather than delivered directly to a sewer system or open sewer.

Permeable Pavement Systems are designed to achieve water quality and quantity benefits by allowing storm water flow across the roadway and into the base / ground pool, water passing through the paved material through a gap between the pavers and providing support to the building as a standard paved system. Stone-based rock delivery systems have been shown to improve storm water quality by reducing storm water temperatures, contaminants concentrated and polluted loads of fixed durability, heavy metals, high-odor hydrocarbons and other nutrients.

The rise of inaccessible areas and traditional plumbing systems, curbs and gutters connected directly to drainage networks, could lead to high-speed water flows that could compress existing infrastructure which has led to the risk of flooding. The paved area is an easy way to control and control the flow of water. Bold bitumen or solid asphalt is a binding material used by us that is more than just a paved road. In this paper we propose a better way to reduce these problems and a way to lay a more open road.

Bituminous permeable paving can play an important role in many of the designs of Sustainable Urban Drainage Systems, which provide an effective, long-term response to surface water floods that can be used quickly and costly. The new, faster bituminous pavement solution, quickly disperses excessive water away from the road.

you know. The results have shown that this system can store hydrocarbons, and therefore can provide improved water quality output. However, when there is a specific cleaner in the stone system, it can cause outflow of water, which may require a second treatment to improve water quality.

Kellems pointed out that improved filtration using biological resources was a different way to get rainwater treatment for storm water treatment. Filtering with a specific organic adsorbent can remove about 95% of the molten copper and zinc. Compared with asphalt corridors, concentrations of zinc, copper and lead were much lower in open structures. Otherwise, the metals will pass through them, and after that they can enter the groundwater wells.

Geotextiles usually separate small impurities such as cadmium, zinc and copper from the subsoil, thus preventing groundwater from being contaminated.

Objectives

1. To study the permeable asphalt pavement with proper planning and designing.

2. Develop a permeable asphalt pavement with effective drain out system.
3. To compare the marshall stability test and flow values of conventional bitumen and the bitumen mix with fly ash as filler.
4. To make use of optimum content of fly ash and minimize the cost of construction for a better pavement.

Methods

Methodology includes the overview on pavement layer which is a surface course & takes the vehicular wheel loads directly. For both porous (Open graded) asphalt pavement and flexible (Dense graded) pavement, preliminary tests were conducted on the materials used for the study. After completion of preliminary tests as per IS standards & specifications, bituminous mould were casted by varying the binder content for both dense (flexible) & open graded (porous) bituminous layer to conduct Marshall Stability test.

Materials Used

1. Coarse aggregates of pertaining sieve sizes as per IS standards.
2. Fly ash as a filler.
3. Recycled plastic sheet.
4. Polyester fiber.
5. Bitumen grade – 60/70.

Fly ashes as filling

- It saves a lot.
- The use of Fly Ash is harmful to the environment as industrial waste is effectively used to build quality building materials.
- Fly Ash asphalt is resistant to acid and sulphate attacks.
- The decrease in fly ash asphalt is very small.
- The use of fly ash asphalt provides good performance, durability and finish

Figure 1: Methodology

Recycled plastic sheet.

- Porous recycled plastic sheet are thick and can be moulded into any shape. Thermoplastics are used to make recycled plastic sheets.
- In these sheets there are minute pores through which water can pass.

Polyester fiber

- Polyester is a class of polymers that contain the active ester group throughout the repetition unit of their larger series. As a matter of fact, it is often referred to as polyethylene terephthalate.

- Features: Resistant to abrasion, dry quickly, firm, light weight, firm, resistant to wrinkles.

Tests conducted for aggregates.

- **Sieve analysis:** Particle size determinations on large samples of aggregate are necessary to ensure that aggregates perform as intended for their specified use. A sieve analysis or gradation test determines the distribution of aggregate particles by size within a given sample.
- **Specific gravity assessment:** Certain gravitational force is defined as the

ratio of the mass of a mass of equal water. The specific size of the compound is made to measure the strength or quality of an object.

- **Water absorption examination:** A test to determine the moisture content of a compound as a percentage of its dry weight. The sample is weighed, dried in an oven, and then weighed under normal conditions.
- **Flakiness index examination:** a percentage by the weight of the particles in it, its smallest size (eg: size) less than three-fifths of its size.
- **Elongation Index examination:** is a percentage by the weight of the particles in it, its size (eg: length) is

more than one and four-fives the size of it.

- **Impact value assessment:** The anti-impact material is known as durability. As a result of traffic congestion the measurements have an impact that has led to their fragmentation. Combined therefore they should have sufficient hardness to withstand their divisions due to the impact. This factor is measured by an impact value test. The amount of combined impact is a measure of resistance to sudden impact or shock, which may vary from its resistance to the applied pressure applied gradually.

Table 1: Test on Aggregates

Sl. No.	Test	Average Result	Permissible Value
1.	Sieve analysis	Fineness modulus = 2.9 Bulk specific gravity = 2.5	2.3 to 3.1
2.	Specific gravity	Apparent specific gravity= 2.3	-
3.	Water absorption	0.49	<2.0%
4.	Flakiness index	15%	Max 30%
5.	Elongation index	19%	Max 30%
6.	Impact value	22%	<24%

Test conducted for bitumen.

- **Specific gravity test:** Bitumen bond has specific gravity ranges of 0.97 to 1.02. In the event that bitumen contains mineral impurities the specific gravity will be higher. Thus it is possible for a quantitative extraction of mineral impurity in bitumen.
- **Flash and fire point test:** Flash point is defined as the temperature at which bitumen smoke temporarily ignites a flash in the form of a flash under specified test conditions. The fire point is defined as the lowest temperature under specified test conditions where low temperatures burn and burn.
- **Penetration test:** The bitumen penetration

test determines the hardness or softness of the bitumen by measuring the depth in millimeters there a standard loaded needle will go straight for 5 seconds while the temperature of the bitumen sample is maintained at 25 ℃.

- **Softening point test:** Softening point test is performed to determine the consistency of bitumen. This test gives an idea of the temperature at which bitumen gets a certain viscosity. The lubricating point is defined as the temperature at which the bitumen softens beyond a certain amount of abnormal softness, i.e. the bitumen softens and recedes about 25mm below the weight of the steel ball.

Table 2: Test on Bitumen

Sl. No.	Test	Average Result	Permissible values
1.	Specific gravity	1.1	Min. 0.99
2.	Flash point	197℃	-
3.	Fire point	217℃	-
4.	Penetration test	59	50 – 70
5.	Softening point	50℃	>47 Degrees

Mix design.

In this study, Marshal mix design has been used to determine the optimum binder content as per ASTM standards where the gradation mid-point is taken as the % passing values for the analysis. The mixes were prepared for 4 different combinations & checked for OBC from 2% to 8% by total weight of mixture at an increment of 2% both for dense graded & open graded asphalt mixtures.

The mix were compacted by applying 75 blows on each face for dense & 50 blows for an open graded asphalt mix using Marshall rammer. The Marshall Stability test is conducted on compacted cylindrical specimen of both dense & open graded friction course mix of diameter 101.6mm and thickness 63.5mm.

Marshal stability has been tested by keeping 1% fly ash as a constant filler material for all the mixes. Marshal stability test were based on ASTM standards conducted at 60 degrees & a loading rate of 50 mm/min for each mix type. Optimum binder content from the above studies after adding correction factor to the specimens is 5.5% for dense graded mix & 5.0% for open graded mixes.

- We start the mould with slab base course with hard and rocky soil.
- A layer of fly ash is scattered on the sub base course.
- We placed the recycled plastic sheet by dividing it into two half with slope towards the drains.
- A layer of fly ash layed above it.
- With the appropriate mix proportions course aggregates are layed.
- Fillers are used to replace fine aggregates.
- Later, the surface course is layed with bitumen.
- Then different types of coating is done for surface course.

Prime coat: The main coat is the use of low viscosity asphalt on a granular base to prepare the first layer (or course layer on the surface) of asphalt.

Binder Course: Binder course layer is the middle layer between the base course and the top layer. The first layer in the event of a double layer of bituminous layer rises. The Bituminous binder study is made of a bituminous-aggregate mixture, also called a measurement course.

Tack coat: Tack coat (also known as bond coat) is an easy application of asphalt emulsion between hot layers of asphalt layers designed to form a strong adhesive bond without slide. Heavy applications can be applied under layers with wings or at the edges where they serve as a coat of arms.

Dressing course: A course to wear a layer on the street, at the airport, and in the construction of a booth. The dressing course is usually placed in a binding strap placed at the base level, which is usually placed on a small base, located at the bottom.

- The mould is now finished and a stability check and stripping value test is performed

Marshal's strength test:

Marshal's strength test is a performance-based measurement performed on a bituminous alloy. The process consists of determining the properties of the mixture, the hardness of the Marshal and the flow analysis and finally the determination of the good bitumen content.

The power is measured in terms of the 'Marshall's Stability' of the mixture which is defined as the maximum load carried by the combined template at an average test temperature of 60 ℃. This is the temperature which is the weakest point of the small method used. The volatility is measured in terms of 'flow rate' measured by the change in sample width in which the load application is applied at the start time of loading and the load time. In this experiment we can try to experiment with the full content of the binder content of the combined type and the strength of the traffic.

Purpose of Marshall Mix Design:

- Density determination - voids analysis of a given bituminous compound.
- Determining the strength (Marshall stability value) and the flexibility (flow value) of a given bituminous compound.
- Determining the suitability of bituminous compounds to meet the prescribed process of divine course.

Preparing a test sample:

- Measure 1200 g of aggregates combined in the required proportions. We heat the

aggregates in the oven at a mixing rate.

- Apply bitumen to mixed temperatures to produce a viscosity of 170 ± centimeters by various percentages above and below the expected expected content.
- Mix items in a warm pan with warm mixing tools.
- Return the mixture to the oven and heat it to room temperature (to produce a viscosity of 280 ± 30 centistokes).
- Apply the mixture to Marshall's hot mold with a collar and base. Apply the mixture around the sides of the mold. Apply filter paper under the sample and over the sample.
- Place the mold on the base of the Marshall compaction.
- Press the information with 50 hammers (or as described), modify the sample, and combine the other faces with the same number of blows.
- After compaction, change the mold. With the collar at the bottom, remove the base and remove the sample by pressing it out

the extractor.

- Find the weight of the sample in the air and immersed, measuring the density of the template, to allow, calculate the voids structures.

Test process:

- Specimens heated up to 60◦ ± 1◦ either in a water bath for 30-40 minutes or in the oven for at least two hours.
- Remove the display from the water bath (or oven) and place it on the lower part of the broken head. Then place the upper part of the cracking head on the template and place the complete assembly in place of the test machine.
- Place the flow meter above the post and adjust it to read zero.
- Load at a rate of 50 mm per minute until the highest reading is achieved.
- Record high load readings on newtons (N). Immediately find the flow as recorded in the flow meter in mm units

Fig 2: Marshall stability Testing

Infiltration test:

The rate of entry at the speed or speed at which water enters the soil. It is usually measured by the depth (mm) of water that can penetrate the soil in one hour.

Entry rate is a measure of how fast water enters the soil. Slow water entering can lead to speculative landscaping or flooding.

A depth of 10 mm / hour means that a layer of water 10 mm above the ground surface, will take one hour to enter.

Waterproofing allows floodwaters to pass through the paved area, sludge and sludge, and in time, regular protective repairs will be required to keep soil infiltration levels low. Internal level assessments are often used to determine storage and quantity requirements.

Typical ASTM methods can be used to measure the penetration rate of a leaky area, however these tests can take hours to complete and require inframeter access

Results

Result of marshall stability test
Table 3: Marshall stability test

Speci men	% of Fly Ash (%)	Height (mm)	Wt. in Air (g)	Wt. in Water (g)	Saturation Wt. (g)	Stability (KN)	Flow (mm)
1	2	65.45	1240	724	1235	6.8	6.15
2		65.95	1299	756	1278	8.55	6.3
1	4	67.02	1280	740	1269	8.5	6.23
2		68.30	1310.5	754	1291	8.35	7.1
1	6	68.85	1335	769	1326	7.9	6.4
2		69	1337	765	1330	7.63	6.55
1	8	68.85	1322	760	1319	7.5	8.35
2		69	1270	710	1255	7.51	8.2

Graph obtained:
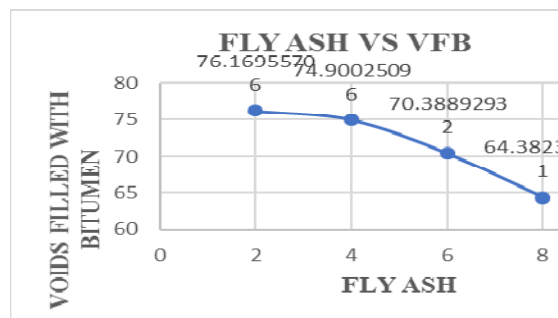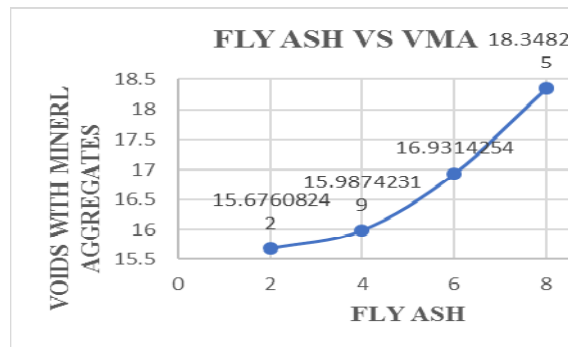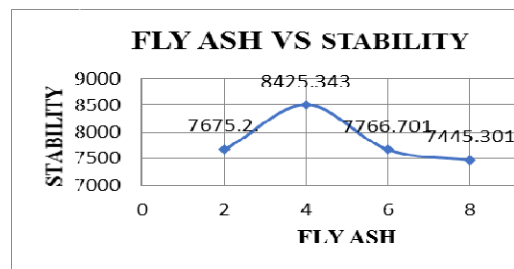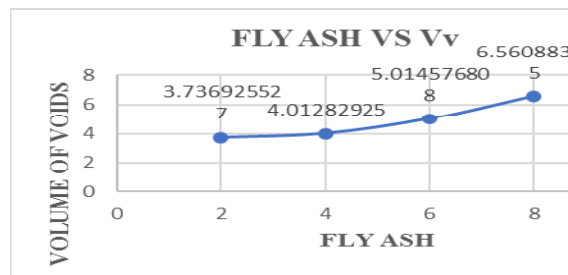
Result of infiltration test
Table 5: infilteration testing

Sr. No.	Time Period	Water Inserted in Lit.	Amount of Water absorbed in Lit.
1.	10 Min.	10 Lit.	8.2
2.	20 Min.	10 Lit.	10.4
4.	40 Min.	10 Lit.	14
5.	50 Min.	10 Lit.	14.2
6.	60 Min.	10 Lit.	14.8
7.	70 Min.	10 Lit.	14.9
8.	80 Min.	10 Lit.	14.9
9.	90 Min.	10 Lit.	14.9
10.	100 Min.	10 Lit.	14.9
Final Water Recovery = 75%			

- Area =l x b= 1.5x1.5 = 2.25 i.e. 2.25 square meter.
- Running water calculation - Rational Formula=c x i x A
- = Runoff factor x Rain power x location
- (c = constant, rainfall intensity in mm/hr., area in sq. m)
- = 0.3 x 32 x 2.25= 21.6
- Liter per hour in one day we can collect the amount of water =24 hours' x 21.6
- =518.4 liters per day

Conclusion

- The seepage level of standard bitumen is about 35% and the corridor with corridors is 75% and has holes the asphalt pavement surface costs almost the same as the normal asphalt we can carry with the porous pavement in the required areas.
- As porous pavement absorbs water so by this experiment we can provide good drainage system so that seepage water can be used or stored for various purposes.
- The maximum stability test obtained is 8.55 kN, so in case of conventional method it is 8.9kN. Therefore this satisfies the condition.
- As the value is more than 8 kN in case of fly ash , therefore it can be used as filler in BC mix for pavements of roads
- From the above experiment, it can be concluded that fly ash can be used as a substitute as fillers in road pavement and satisfies all criteria

Future scope

- Open corridors are usually low in power but by increasing their capacity and improving buildings they can be used in the construction of heavy traffic roads such as city roads, highway shoulders, etc.

- Due to permeable nature, it can be used in flood prone areas where water can be managed easily.

- Permeable pavements benefits proper drainage planning and maintenance for urban transport planning

Reference

1. Sumit Kumar Soni, Er. Sandeep Goyal, "Porous Asphalt Pavement Design: A Review", International journal of technical research(UTR), Vol. 7, Issue 2, july – august 2017

2. Dr. Zainab Ahmed A1-Kaissi, Omar Ghalib Mashkoor, "Durability of Porous Asphalt Pavement", Journal of engineering and sustainable Development, Vol. 20, No. 04, July 2016 ISSN 1999-8716

3. Vaibhav Patil, Pooja Patil, Jayashree Patil, Mrunal Patil, Kirtee Sawant, Mr. S. P. Patil, "A Research Paper on Porous Asphalt Pavement", International Journal of Trend in Scientific Research and Development (IJTSRD), ISSN No:2456 – 6470, Volume 2, Issue 4

4. Chavanpatil, M. G., & Chokakkar, M. S. (2018). The Study of Porous Asphalt Pavement with Emphasis in Road Construction Design. Int. Research Journal of Engineering and Technology, 5, 623-24.

5. Ranjeeth, S., & Latchoumi, T. P. (2020). Predicting Kids Malnutrition Using Multilayer Perceptron with Stochastic Gradient Descent. Rev. d'Intelligence Artif., 34(5), 631-636.

6. Prasath, D. S., & Selvakumar, A. (2015). A Novel Iris Image Retrieval with Boundary Based Feature Using Manhattan Distance Classifier. International Journal Of Innovative Technology And Creative Engineering (Issn: 2045-8711) Vol, 5.

7. Balamurugan, K. (2021). Fracture analysis of fuselage wing joint developed by aerodynamic structural materials. Materials Today: Proceedings, 38, 2555-2562.

8. Zhao, Y., & Zhao, C. (2012). Research on the purification ability of porous asphalt pavement to runoff pollution. In Advanced Materials Research (Vol. 446, pp. 2439-2448). Trans Tech Publications Ltd.

9. Satish kumar, Dr. Devinder Sharma, Er. Neeraj Kumar, "Approved Concrete Review Paper as a Road Route", International Research Journal of Engineering and Technology (IRJET) Volume: 04 Issue: 12, Dec-2017

10. Karthik H. Obla, "Eye made of concrete - The whole view", Article in Indian Concrete Journal - August 2010

11. Alalea Kia, Hong S. Wong, Christopher R. Cheeseman, "closes valid concrete: Review", in Article in the Journal of Environmental Management - May 2017

12. Talsania, S., Pitroda, J., & Vyas, C. M. (2015). A review of pervious concrete by using various industrial waste materials. J Int Acad Res Multidisciplinary, 2(12), 142-51.

13. • Kolluru Hemanth Kumar, "Review the paper on paved plans", Conference Paper • December 2014

TO DETERMINE THE BEHAVIOR OF STEEL STRUCTURE UNDER SEISMIC CONDITION USING ETABS SOFTWARE

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ABSTRACT

In this paper, the structural behaviour of a steel building under different seismic condition is found out using the software Etabs. Three main models area prepared, low rise (5 floors), moderate rise (10 floors) and high rise building (15 floors) and for each particular model, five different cases are made. The three models (including all the cases made for each model) are analysed and studied in different seismic zone factor (zone-5, 4, 3). The results (maximum story displacement, story drift and story shear) are taken out for each model, then a graph is plotted and the cases made for the main models are compared, and how each model and each cases behaves under different seismic conditions. For each result, we get to know how the building behaves in different seismic zone

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Introduction

Buildings are one of the most highly affected when it comes to seismic action. Providing a proper lateral load resisting system in earthquake-prone areas is a must, to ensure safety for the people and for other structures nearby. Steel is one of the materials which is good at resisting earthquakes because of the flexibility and low weight. When an earthquake hits, heavier and stiffer structures experience more of that earthquake load. The cost of foundation and superstructure significantly reduces upon the reduction of design forces. Comparing to others materials steel structures are generally light in comparison. As we know the earthquake force is associated with the inertia and mass of the structure, so upon reducing the mass of the structure, it leads to lower seismic design force.

Bracing system is one of the methods for resisting earthquake loads, the advantages of braces are high strength, high stiffness, less weight, and more economical. Upon providing bracing on a structure, the stability and stiffness significantly improve under earthquake loads.

Bracing system is a very common method used in construction, due to its ease to construct and being economical. The connection between beams and column is nominally pinned which then provides better stability and better resistance to lateral loads coming to the structure. In a braced multi-story building, two orthogonal bracing systems are provided in order to resist the lateral load.

- Horizontal bracing: The bracing is provided on each floor level, thus providing a load path transferring the load/forces to the plane of vertical bracing.
- Vertical bracing: The bracing is provided between two columns and it provides a load path transferring the load/forces to the ground thus making it more stable.

Methodology

The building that has to be design is for commercial automobile showroom. Now days, the design of steel building have been used for constructing automobile showroom instead of reinforced concrete buildings due to the following reasons:

1. They have high duticle strength and hence is applicable for sesmic design. because the strength and toughness of the steel is well suited for this kind of showroom.
2. It offers improved safety and resistance.
3. Steel building retains their value longer comparing to RCC.
4. It allows for the improved quality of construction and has less maintenance comparing to reinforced concrete building.
5. If any changes are required in the building, steel building can easily be disassemble in the future unlike the RCC.

Preparing a model for different heights in Etabs
Table 1: Different types of model

Models	Name of the model
A	Braces in all the floors except ground floor
B	Braces in alternate horizontal direction-1
C	Braces in alternate horizontal direction-2
D	Braces in alternate vertical direction
E	Standard model with no braces

Three different heights are prepared

1) Low rise building: Five different cases are made for this particular model.

Table 1: Test on Aggregates
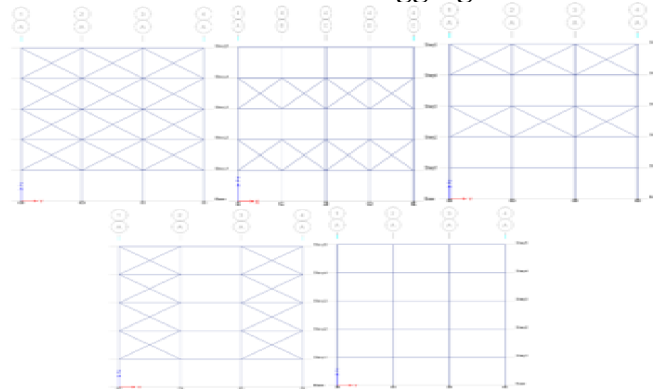
Fig 1: Low rise models

2. Moderate rise building: Five different cases are made for this particular model
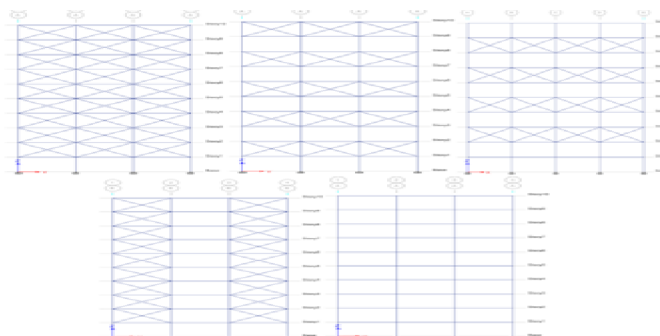
Fig 2: Moderate rise model

3. High rise building: Five different cases are made for this particular model.
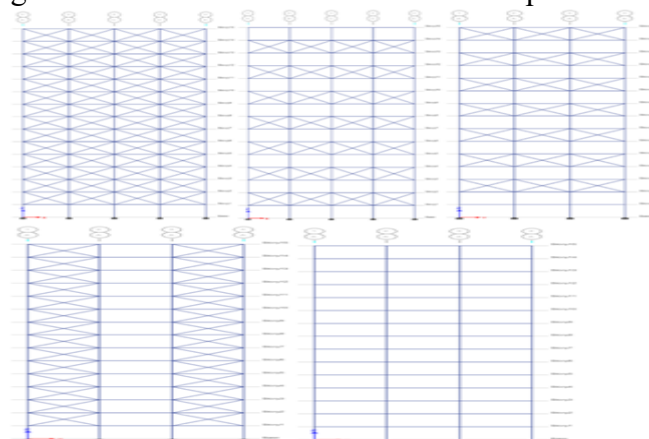
Fig 3: High rise building

Analysis of the model
Plan details
Given below are the plan details of the model
- Number of bays in X - direction: 4
- Distance between each bay in X-direction –5m
- Number of bays in Y-direction: 3
- Distance between each bay in Y - direction – 5m
- Number of floors in low rise building – 5 floors
- Number of floors in moderate rise building – 10 floors
- Number of floors in high rise building – 15 floors
- Height of each floor: 3m

Materials used

The materials and section that has been used in analyzing the models are given below:
- Column: ISHB 450-2
- Beam: ISMB 250
- Braces: ISLB 300

Modelling steps
- Making a new model
- Defining material properties
- Defining section properties
- Drawing beams and columns
- Drawing the bracings
- Assigning loads
- Defining load patterns
- Load combinations

- Running the analysis
- Designing

Analysing all the models in different seismic zones:
- Low rise building (5 Story): 5 different models (Model A, B, C, D, E) are analysed and designed in different seismic zone (3, 4, 5) and making sure the structure is safe.
- Moderate rise building (10 story): 5 different models (Model A, B, C, D, E) are analysed and designed in different seismic zone (3, 4, 5) and making sure the structure is safe.
- High rise building (15 story): 5 different models (Model A, B, C, D, E) are analysed and designed in different seismic zone (3, 4, 5) and making sure the structure is safe.

Results and discussions

- Click on display – story response plot – select max story displacement - copy the values to excel files then plot the graph.
- Click on display – story response plot – select max story drift – copy the values to excel files then plot the graph.
- Click on display – story response plot – select story shear– copy the values to excel files then plot the graph

Max Story Displacement
Low rise building
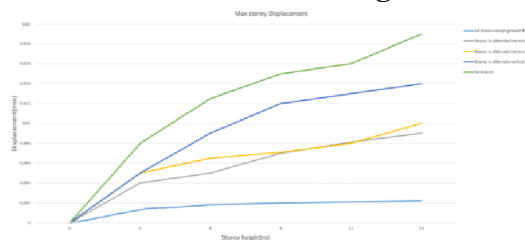
Fig 4: Zone-5
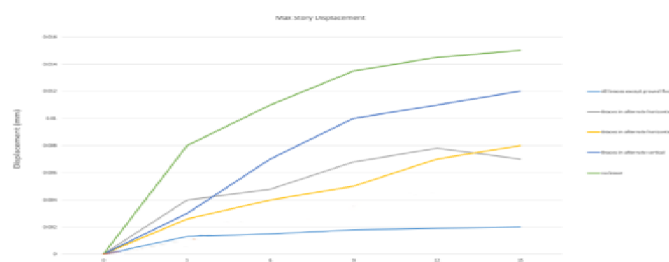
Fig 5: Zone-4
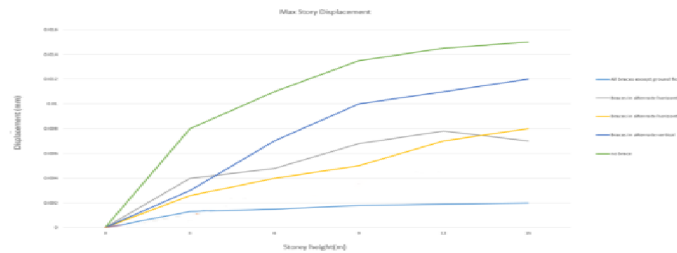
Fig 6: Zone-3

Model A has the lowest max story displacement and model E has the highest story displacement.

Moderate rise building
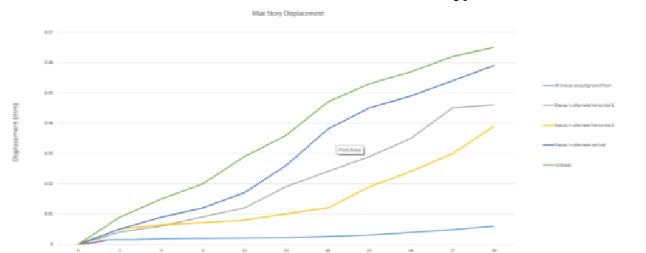
Fig 7: Zone-5

Fig 8: Zone-4
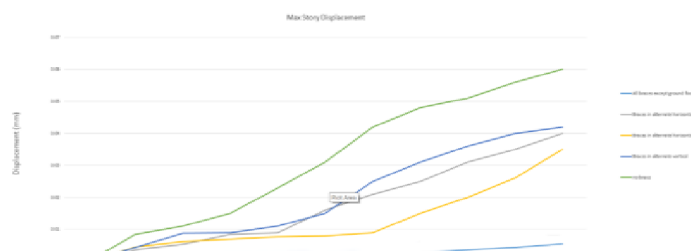
Fig 9: Zone-3

Model A has the lowest max story displacement and model E has the highest story displacement.
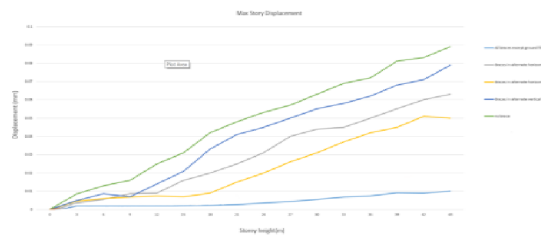
High rise building
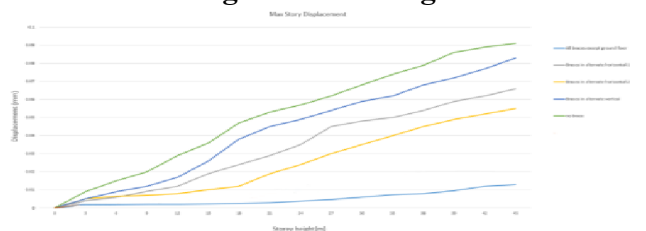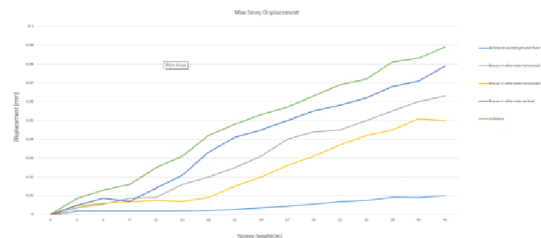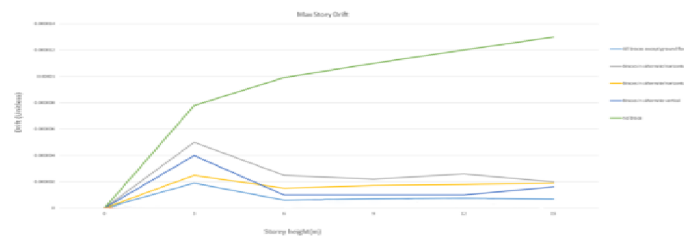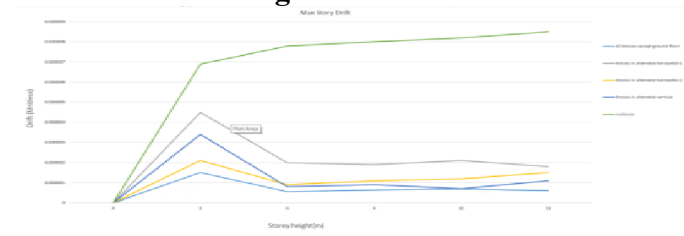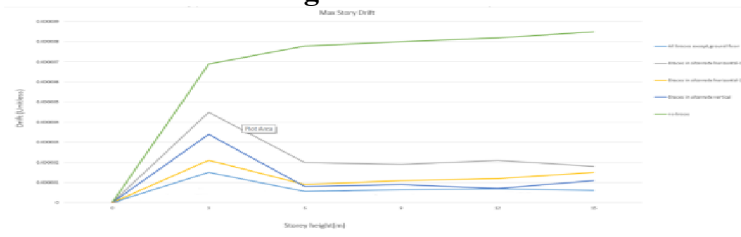

Fig 10: Zone-5

Fig 11: Zone-4

Fig 12: Zone-3

Model A has the lowest max story displacement and model E has the highest story displacement
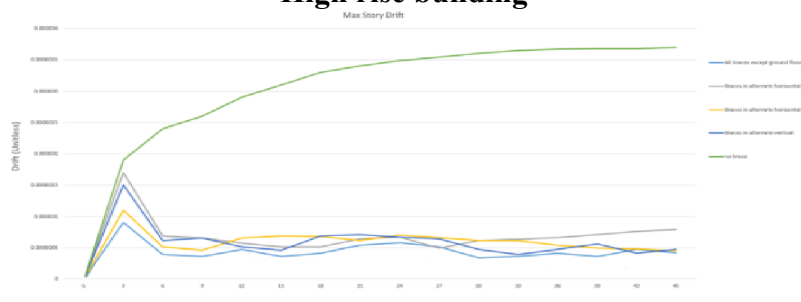
Max Story drift
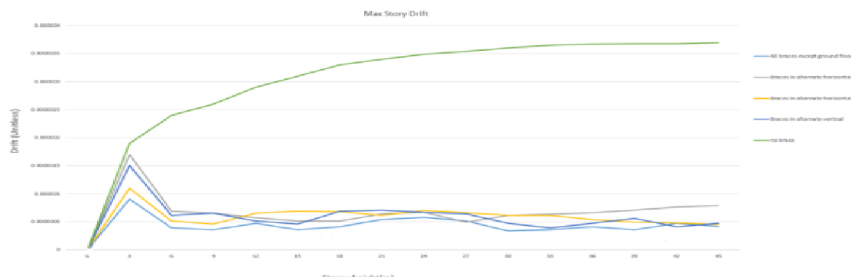**Low rise building**

Fig 13: Zone-5

Fig 14: Zone-4

Fig 15: Zone-3

Model A has the lowest max story drift and model E has the highest story drift

Moderate rise building
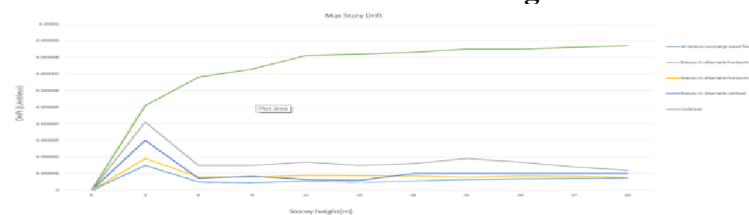
Fig 16: Zone-5
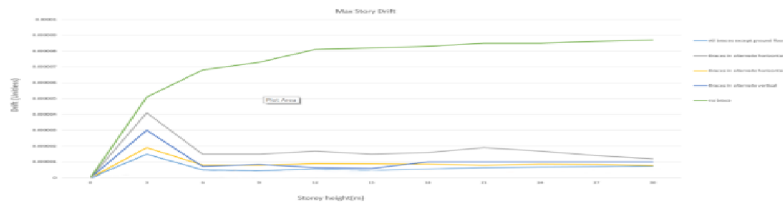
Fig 17: Zone-4
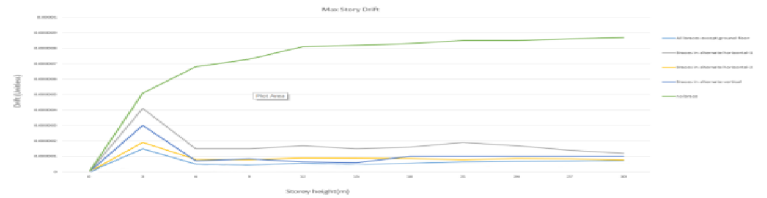
Fig 18: Zone-3

Model A has the lowest max story drift and model E has the highest story drift

High rise building

Fig 19: Zone-5
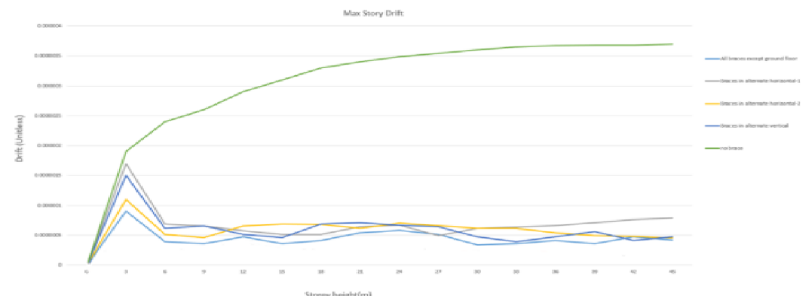

Fig 20: Zone-4

Fig 21: Zone-3

Model A has the lowest max story drift and model E has the highest story drift
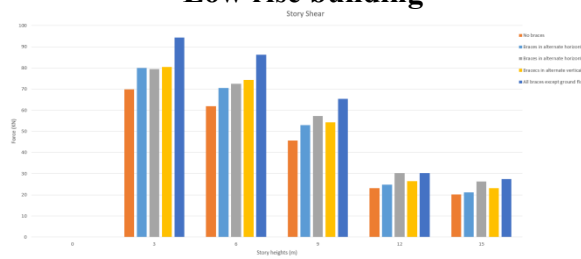
Story Shear

Low rise building
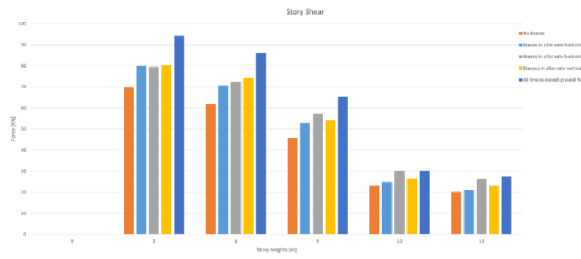

Fig 22: Zone-5
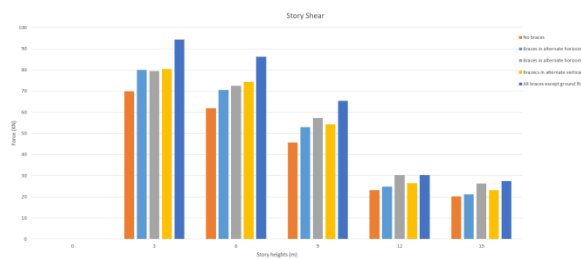

Fig 23: Zone-4

Fig 24: Zone-3

Model E has the lowest story shear and model A has the highest story shear
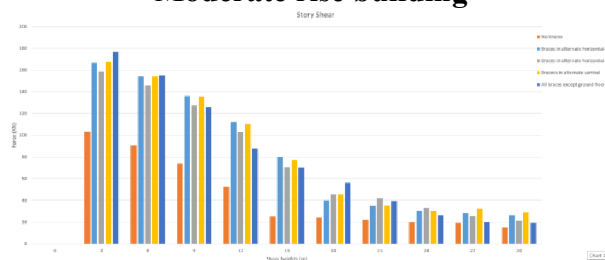
Moderate rise building

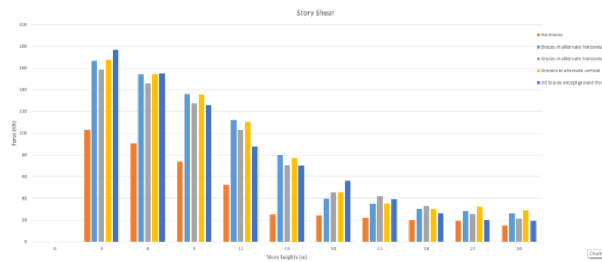**Fig 25: Zone-5**

Fig 26: Zone-4

Fig 27: Zone-3

Model E has the lowest story shear and model A has the highest story shear.

High rise building

Fig 28: Zone-5

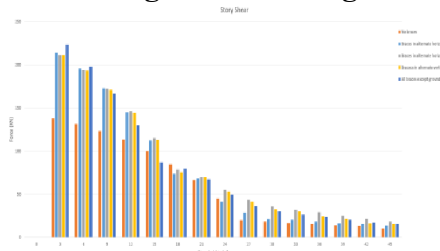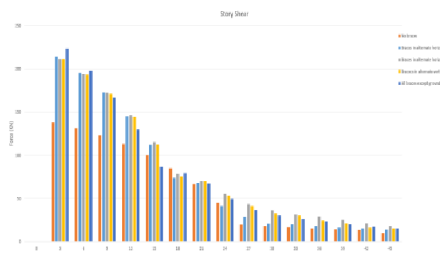**Fig 29: Zone-4**
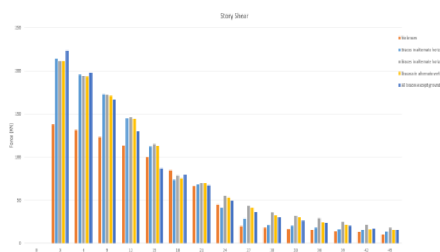
Fig 30: Zone-3

Conclusion

The following conclusions are made after the completion of the work. Different models have been analysed using Etabs Software under different seismic conditions and under the lateral load resisting sysem braces;

1) In zone 5, 4 and 3, model A has the lowest displacement and story drift in all the three models (low rise, moderate rise and high rise)

2) As the seismic zone increases from zone-3 to zone-5. Max Displacement also increases

3) As the seismic zone increases from zone-3 to zone-5. Max story drift t also increases

4) Zone-3 has the lowest value of story shear as comparing to other seismic zones.

References

1. Adithya, M., Swathi Rani, K. S., Shruthi, H. K., & Ramesh, B. R. (2015). Study on Effective bracing systems for high rise steel structures. SSRG International Journal of Civil Engineering (SSRG-IJCE), 2.

2. Javanmardi, A., Ibrahim, Z., Ghaedi, K., Ghadim, H. B., & Hanif, M. U. (2020). State-of-the-art review of metallic dampers: testing, development and implementation. Archives of Computational Methods in Engineering, 27(2), 455-478.

3. Berman, J., & Bruneau, M. (2003). Plastic analysis and design of steel plate shear walls. Journal of Structural Engineering, 129(11), 1448-1456.

4. Bruneau, M., & Bhagwagar, T. (2002). Seismic retrofit of flexible steel frames using thin infill panels. Engineering Structures, 24(4), 443-453.

5. Federal Emergency Management Agency. (2003). NEHRP recommended provisions for seismic regulations for new buildings and other structures. Fema.

6. Collins, K. R., Wen, Y. K., & Foutch, D. A. (1996). Dual-level seismic design: a reliability-based methodology. Earthquake engineering & structural dynamics, 25(12), 1433-1467.

7. Dr. B P Annapoorna, Mohammed Ali Boodihal (2019) 'A Study on Steel Plate Shear Wall'. , Steel Compos. Structure, Int. J., 18(1), 165-185.

8. Nandi, G. V., & Hiremath, G. S. (2015). Seismic Behavior of Reinforced Concrete Frame with Eccentric Steel Bracings. International Journal of Civil Engineering (SSRG-IJCE), 2(6).

9. Jadhav Manjo Babaso, Patil G. R (2018) 'Steel Plate Shear Wall for Tall Buildings'. Comput. Method. Appl. Mech. Eng., 71(2), 197-224.

10. Goel, R. K., & Chopra, A. K. (2005). Extension of modal pushover analysis to compute member forces. Earthquake Spectra, 21(1), 125-139.

11. Calvi, G. M., Priestley, M. J. N., & Kowalsky, M. J. (2007). Displacement-based seismic design of structures. In New Zealand conference on earthquake engineering (Vol. 2007). Iuss Press.

12. Leon, R., & Desroches, R. (2006). Behaviour of braced frames with innovative bracing schemes. National Science foundation NSF award CMS-0324277.

13. Krishnan, S. (2008). Modeling steel moment frame and braced frame buildings in three dimensions using FRAME3D. Proc., 14WCEE. Kunnath, SK, Reinhorn, AM, Abel, JF, and Park, YJ (1990a)." A Macromodel Approach ToPractical Analysis of R/C Buildings Under Seismic Excitation." Computer Aided Analysis andDesign of Concrete Structures, 2, 1155-1167.

14. Mahin, S. A., Malley, J. O., Hamburger, R. O., & Mahoney, M. (2003). Overview of the US program for reduction of earthquake hazards in steel moment-frame structures. Earthquake spectra, 19(2), 237-254.

15. Safvana P and Anila S 'Seismic analysis of brace steel and composite structure using etabs software'. International Journal of Recent Scientific Research Vol. 9, Issue, 4(C), pp. 25689-25691, April, 2018.

16. Sagar Dhok, Prof. P. V. Muley, Dr. T. N. Boob, Prof. P. R. Barbude 'applicability of combinations of Damper for Steel Frame Structure'. J. Structure Eng., 141(7), (C4015003)1-14.

17. Qiao, S., Han, X., Zhou, K., & Ji, J. (2016). Seismic analysis of steel structure with brace configuration using topology optimization. Steel and Composite Structures, 21(3), 501-515.

18. Sonali Pandey, Dr.Krishna Murari, Ashish Pathak, Chandan Kumar (2018) 'A Review on Shear wall in High Rise Buildings'. International Journal of Engineering Research & Technology (IJERT), Vol. 3 Issue 5, May – 2018.

19. kumar Dubey, S., Doni, A., & Kute, S. Y. Ultimate Strength of Epoxy Repaired Reinforced Concrete Frames.

20. Ranjeeth, S., & Latchoumi, T. P. (2020). Predicting Kids Malnutrition Using Multilayer Perceptron with Stochastic Gradient Descent. Rev. d'Intelligence

Artif., 34(5), 631-636.

21. Prasath, D. S., & Selvakumar, A. (2015). A Novel Iris Image Retrieval with Boundary Based Feature Using Manhattan Distance Classifier. International Journal Of Innovative Technology And Creative Engineering (Issn: 2045-8711) Vol, 5.

22. Balamurugan, K. (2021). Fracture analysis of fuselage wing joint developed by aerodynamic structural materials. Materials Today: Proceedings, 38, 2555-2562.

23. Zhang, Y., & Zhan, X. (2019). Study on Seismic Behavior of Steel Frame-Steel Shear Wall with Assembled Two-Side Connections. Mathematical Problems in Engineering, 2019.

24. Khan, Z., Narayana, B. R., & Raza, S. A. (2015). Effect of concentric and eccentric type of bracings on performance based seismic analysis of RC building. International Journal of research in Engineering and technology, 4(6), 278-283.

To explore the quality of drinking water in Devanahalli Taluk Karnataka

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ABSTRACT

One of the important source of water is Ground water, 50% of the world's population depends on groundwater of which 43% is used for irrigation use. Hence the quality of groundwater is important . In this project the selected area for studies is devanahali taluk which is located in Bengaluru Rural district. Due to the drastic development of Bengaluru urban city and the location of KIA (Kempegowda International Airport) we need to concentrate on this area in all the aspects for the future sustainability of Bengaluru city. There are about 212 villages and 2 towns in this taluk with a population of 2,09,622 lakh. The total area of devanahali taluk is 446sqkm. Identification of bore wells with the respective latitude and longitude and checking physical-chemical parameters of the water sample and mapping in the software the given task can be executed by integrating various shape file and validated collected bore well data using GIS..
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Keywords: Bore wells, Ground water, GIS, Physical and chemical parameters, Water quality.

Introduction

One of the most precious renewable resources on earth is ground water. Lack of water is could be dangerous of living beings on the earth.

There are two sources of water they are -

* Surface water
* Ground water

More than 1500 million people depends on this earth depend on groundwater for drinking and domestic purposes.In many areas around the world groundwater may be the only source of water for rural and urban population.Water Quality Index (WQI) is a important parameter for assessing the quality of water. WQI is a very useful tool for communicating the information on overall quality of water.Ground water is the fresh water that is stored in the pores of the soil particle and between rocks . The source of ground water is Precipitation or melting ice.

Ground water can stay in ground for many years it may be hundreds or thousands of years. Through ground water table it can seep and fill rivers lakes, ponds, wetland, and can be helpful to mankind for domestic, industrial and irrigation purpose. Water is collected in pores in the rock and pores are not connected and water will not move further. The process by which by which precipitation recharges the ground water is called as recharge**.** Due to drastic development of urbanization, industrialization and population demand of water is increasing day by day but the available quantity is the same with all this large quantity of fresh water is polluted by sewage water, industrial waste, and various types of harmful chemicals produced to environment by human activities. Thus the quality and the quantity of water supplied should be of good significant. In order to achieve this we should the certain parameters of water supplied these parameters are basically classified into two types they are

* Physical Parameters
* Chemical Parameters

Physical parameters include 5 parameter they are taste, color, odor, temperature and Turbidity these are physical parameters of water

Chemical parameters include Ph, Total harness, Total Alkalinity, Chloride, Calcium, Total Dissolved Solids, Nitrate, Magnesium, Ammonia, Sulphate, etc these are some the chemical parameters of water. We should ensure these parameters values should be in limits of **BIS** bureau of Indian Standards of drinking water. If the parameters value exceeds the limited value then the water should be treated accordingly and then supplied.. We have collected water sample from 10 villages of Devanahalli taluk in month of March and tested and compared with BIS standards of drinking water and mapped in ARC-GIS software. Devanahalli taluk is blanketed by four classes of soils they are clayey, clayey mixed, loamy skeletal and rocky land. The soil

of the surface in this area are medium to coarse-grained texture, sub-surface soils are deep and heavily textured (S. Srinivasa Vittala et al. (2008)) In Devanahalli taluk there is no perennial rivers there are few streams that rise in hills and fill number of tanks in taluk. Hence ground water is main source of water in this study area.

Literature Review

Assessment of water quality index for the groundwater in Tumkur taluk, Karnataka state, India Ramakrishnaiah C.R et.al, (2009) objective of the paper is Analysis of the result have to been used to suggest model for predicting water quality and the outcome of this paper is the quality of groundwater is not satisfactory according to BIS standards so treatment is needed to maintain the standards of ground water quality and make sure that it is protected from pollutants before supplying it to consumers

Anitha Pius et.al, (2012) objective of paper was to study and analyze the selected study area with help of results of water quality parameters and comparing with water quality index results are drawn for the particular sample if there is any problem we can smartly solve it with help of GIS tool and techniques. Later the outcome of water quality parameters are mapped and studied effectively and steps to taken as per problem with spatial variation water quality

map created with GIS tool.

Ashwani Kumar Tiwari et.al, (2014)The objective of the study is to indicate ground water existing in west bokaro coal field. As it is coal mineing area analyst dug 33 around the area and collected sample were tested to match standards of drinking according to BIS for drinking water and WQI were generated for sample test results and it was found that water is not suitable drinking directly According to the results 79% of water sample fall under excellent quality and rest 21% fall under poor water quality index. Author has concluded the result that we need treat water before it is supplied to the public for drinking purpose.

Groundwater quality assessment of Dhanbad district, Jharkhand, India The objective of the study is to evaluate the ground water quality and verify it weather it is safe for public use in Dhanbad area Areas were selected where there was coal mining and heavy industries was present Around 79 wells were identified which was initially supply water for drinking and collected sample were tested was summarized by author in the following way that it exceeds the permissible total hardness limit of 500 mg/l.The water is also suitable for industrial purposes and is acceptable for industrial requirements irrigation, with a low alkalinity and moderate to high salinity risk.

Methods and Methodology
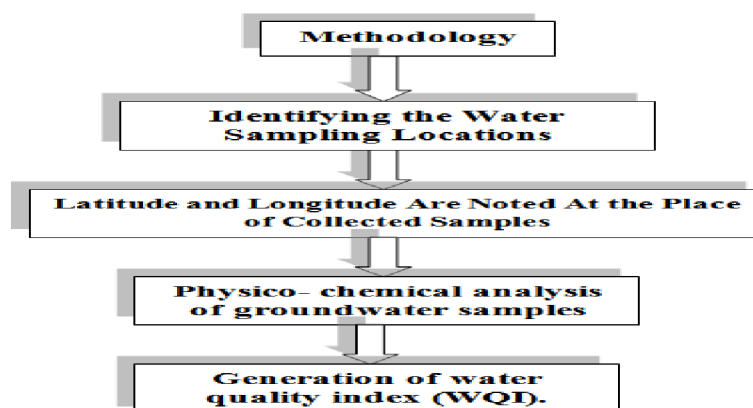
Primarily we did literature review on the topic later we downloaded the topographical map from Google earth pro. Later we selected the villages from where we need to collect the water sample for studies once it was finalizes in the month of March we collected 2 liters

sample of sample from each location in sampling bottle and stated and then transported to lab for further test and studies related to physic chemical parameters. Then we generated Water Quality Index WQI of all the samples finally we prepared spatial

representation of water quality parameters map using ARC –GIS software.

Identifying the Water Sampling Locations

We selected study area i.e., the area taken into consideration for the physico-chemical analysis of groundwater quality. Selected the study area is Devanahalli taluk which is located in Bengaluru Rural district. Due to the drastic development of Bengaluru urban city and the location of KIA (Kempegowda International Airport) we need to concentrate on this area in all the aspects for the future sustainability of Bengaluru city.

Then we decided the ten no of locations in study area via Attebele, Avathi, Bullahali, Byarapanahalli Gobbarakunte, Gonuru, Kodag Urki, Kurburakunte, Venkatagiri Kote, Yelur**.** Latitude and Longitude Are Noted At the Place of Collected Samples. Latitude and longitude position of bore well collected as we collated the water sample

TABLE- 1 Latitude and longitude details

SL NO	LOCATION	LATIUDE NORTH	LONGITUDE EAST
1	Attebele	13 16' 41"	77 42' 52"
2	Avathi	13 17' 45"	77 43' 32"
3	Bullahali	13 18' 50"	77 43' 32"
4	Byrapanahalli	13 17' 21"	77 43' 20"
5	Gobbarakunte	13 16' 47"	77 45' 42"
6	Gonuru	13 20' 25"	77 45' 34"
7	Kodag Urki	13 18' 27"	77 41' 52"
8	Kurburakunte	13 27' 18"	77 72' 22"
9	Venkatagiri Kote	13 19' 46"	77 44' 0"
10	Yelur	13 19' 45"	77 42' 30"

Table-1 shows the latitude and longitude of the details which were recorded in the study area.

Physico-chemical analysis of groundwater samples

In this phase, physic-chemical analysis was carried out i.e., the analysis of various physic-chemical parameters was carried out in environmental laboratory. In other words, the experimental procedures were adopted for obtaining the content of physic c-chemical parameters present in collected groundwater samples.

The acceptable limit and permissible limit of the physic-chemical parameters is taken from **IS 10500:2012 (SECOND REVISION)**

Physical Parameters tested were

1. Taste,
2. Color,
3. Odor,
4. Temperature
5. Turbidity.

Chemical Parameters tested were

6. Ph
7. Total harness
8. Total Alkalinity
9. Chloride
10. Calcium
11. Total Dissolved Solids
12. Nitrate
13. Magnesium
14. Ammonia,
15. Sulphate

These are the physio chemical parameters which were tested in lab and compared with BIS Standards.

Generation of Water Quality Index (WQI).

Water quality index (WQI) provides information about water quality in a single value.. There are many models present to generate water quality index but we selected CCME method for calculating water quality index. This Method was published in 2001 and contains the guidelines for assessing water quality index. Some of the paper published based on this method are Al-Janabi et al., (2012), Munna et al.,(2013), Gyamfi et al.,(2013), Saleem et al.,(2015), Lamare and singh(2016).

CCME have three main elements:

- F1 (Scope)
- F2 (Frequency)
- F3 (Amplitude)

Formula's used in Calculation of WQI

Step – 1 calculating the scope Value (F1 Value)

$$F1= \frac{\text{Number of failed Variable}}{\text{Total number of variable } *100}$$

Step – 2 calculating the Frequency Value (F2 Value)

$$F2= \frac{\text{Number of failed Test}}{\text{Total number of variable } *100}$$

Step 3

- There are three steps in step 3 they are Used when the test parameters is not exceed the objective (Standard BIS value)

$$\text{Excursion} = \frac{\text{Failed Test value} -1}{\text{Objective}}$$

- Used when the test value falls below the objective

$$\text{Excursion} = \frac{\text{Objective} -1}{\text{Failed no of test}}$$

(Normalize Sum of Excursion)

$$Nse = \frac{\text{Summation of Excursion}}{\text{Total no of Test}}$$

$$F3 = \frac{nse}{nse +0.01}$$

Overall calculation

$$\text{CCME WQI} = \left(\frac{\sqrt{F1 + F2 + F3}}{1.73} \right)$$

TABLE-2 CCME WQI TABLE

CCME WQI	Ranking	Water quality Characters
95-100	Excellent	Water quality is good without or very less presence of impurities
80-94	Good	Water quality is good but has certain impurities
65-79	Fair	Certain Parameters are not in the limits
45-64	Marginal	Water should be treated well before using
0-44	Poor	Water is unfit for domestic purpose

These are the ranges given by CCME for the value of WQI.

Results & Discussion

The result of also the pysio chemical parameters is obtained by various test method and these results are compared standard value. Various test method for different parameters are shown in table.3

TABLE-3 TEST DETAIL

SL NO	PARAMETERS	TEST ADOPTED
1	Ph	Electrometer (PH meter)
2	Alkalinity	(Titration)
3	Tds	(Titration)
4	Chloride	TDS Probe
5	Calcium	(Titration)
6	Magnesium	(Titration)
7	Nitrate	Spectrophotometer
8	Ammonia	(Titration)
9	Sulphate	(Titration)
10	Turbidity	(Titration)
11	Hardness	EDTA titration

These are the method in table-3 adopted to test the given water sample of the study area These test results were compared with standard BIS value table-4 of drinking water BIS STANDARDS are shown in table.4

TABLE-4 BIS STANDARDS

SL NO	PARAMETERS	BIS STANDANDS
1	Colour	<5
2	Turbidity	<1
3	Taste	Agreeable
4	Odour	Agreeable
5	Temperature	27
6	Ph	6.5-8.5
7	Hardness	200
8	Alkalinity	200
9	Chloride	250
10	Calcium	75
11	Tds	500
12	Nitrate	45
13	Magnesium	30
14	Ammonia	0.5
15	Sulphate	200

Table-5 shows the standard value of the parameters for drinking water as per BIS
The results obtained are as follows shown in table 5,6 physical parameters

.

TABLE-5 RESULT

SL NO	LOCATION	Color	Turbidity	Temp ©
1	Attebele	3	0.7	27
2	Avathi	2	0.9	30
3	Bullahali	1	0.5	27
4	Byrapanahalli	4	0.5	28
5	Gobbarakunte	3	0.75	30
6	Gonuru	2	0.6	27
7	Kodag Urki	1	0.45	28
8	Kurburakunte	4	0.85	28
9	Venkatagiri Kote	3	0.6	30
10	Yelur	2	0.8	27

TABLE-6 RESULT

SL. NO	LOCATION	Taste	Odor
1-10	All 10 Location Mentioned Above	Agreeable	Agreeable

Table – 7,8,9, shows the results of chemical parameters

TABLE-7 RESULT

SL NO	LOCATION	PH	Alkalinity	Hardness
1	Attebele	6.52	**202**	**370**
2	Avathi	6.68	**311**	**849**
3	Bullahali	6.5	93.0	270
4	Byrapanahalli	7.7	**246**	266
5	Gobbarakunte	7.1	113	208
6	Gonuru	6.5	76.7	93.6
7	Kodag Urki	7.03	165	324
8	Kurburakunte	6.52	109	106.1
9	Venkatagiri Kote	7.52	**254**	262
10	Yelur	6.52	101	54.0

TABLE-8 RESULT

SL NO	LOCATION	Cl (Mg/l)	Ca (Mg/l)	TDS (Mg/l)
1	Attebele	161	**108**	**650**
2	Avathi	**489**	**236**	**1640**
3	Bullahali	158	73.3	**520**
4	Byrapanahalli	74.3	70.0	**520**
5	Gobbarakunte	142	55.0	500
6	Gonuru	70.4	25.0	280
7	Kodag Urki	123	**83.0**	**620**
8	Kurburakunte	50.8	25.0	210
9	Venkatagiri Kote	112	**80.0**	**582**
10	Yelur	39.0	15.0	210

TABLE-9 RESULT

SL NO	LOCATION	NO$_3$ (Mg/l)	Mg (Mg/l)	NH$_4$ (Mg/l)	SO$_4$ (Mg/l)
1	Attebele	6.0	24.2	0.02	47.7
2	Avathi	8.0	**62.6**	0.01	108
3	Bullahali	4.7	21.2	0.04	42.4
4	Byrapanahalli	4.7	22.2	0.035	42.4
5	Gobbarakunte	4.5	17.0	0.045	7.9
6	Gonuru	2.2	7.5	0.025	3.7
7	Kodag Urki	5.2	28.3	0.015	48.9
8	Kurburakunte	2.0	10.6	0.010	4.0
9	Venkatagiri Kote	5.6	15.0	0.05	41.8
10	Yelur	1.4	4.0	0.09	4.0

These are results obtained as follows the bold values are exceeding the limit.

Further calculating the water quality index of sample based on the results obtain and formula mentioned above

TABLE-10 WQI RESULTS

SL NO	LOCATION	WATER QUALITY INDEX.	RANKING
1	Attebele	94.829.	Good.
2	Avathi	93.677.	Good.
3	Bullahali	94.407.	Good.
4	Byrapanahalli	94.407.	Good.
5	Gobbarakunte	100.	Excellent.
6	Gonuru	100.	Excellent.
7	Kodag Urki	96.323.	Excellent.
8	Kurburakunte	100.	Excellent.
9	Venkatagiri Kote	95.542.	Excellent.
10	Yelur	100.	Excellent.

Table-10 shows the detail of water quality index found by CCME method.

The spatial data and attribute database was generated for the water sample and was integrated for generation of spatial variation of maps of certain parameters like PH, turbidity, sulphate, etc. based on shape file obtained maps were created for the study area. This water quality map helps us to the condition water.

In physical parameters that is taste color odor and turbidity all the 10 sample satisfy the criteria and are safe for drinking according to BIS standards

In chemical parameters test was conducted on PH, Alkalinity, Hardness, Chloride, Calcium,

Total dissolved solids, Nitrate Magnesium Ammonia Sulphate and the results were as follows

PH

The ph range should be in between 6.5-8.5 according to BIS for drinking. In the present study all the 10 samples satisfy the criteria

Alkalinity

The Alkalinity range should be below 200 mg/l according to BIS for drinking. In the present study 06 samples satisfy the criteria.

Total Hardness

Total Hardness range should be below 300 mg/l according to BIS for drinking. In the present study 08 samples satisfy the criteria

Chloride

Chloride range should be below 250 mg/l according to BIS for drinking. In the present study 09 samples satisfy the criteria

Calcium

Calcium range should be below 75 mg/l according to BIS for drinking. In the present study 08 samples satisfy the criteria

Total Dissolved Solids

Total Dissolved solids range should be below 500 mg/l according to BIS for drinking. In the present study 04 samples satisfy the criteria

Nitrate

Nitrate range should be below 45 mg/l according to BIS for drinking. In the present study all the 10 samples satisfy the criteria.

Magnesium

Magnesium range should be below 30 mg/l according to BIS for drinking. In the present study 09 samples satisfy the criteria

Ammonia

Ammonia range should be below >0.05 according to BIS for drinking. In the present study all the 10 samples satisfy the criteria

Sulphate

Sulphate range should be below 200 mg/l according to BIS for drinking. In the present study all the 10 samples satisfy the criteria

Conclusion

- As per calculation of WQI we conclude that 40% of water sample has achieved good ranking and 60% water sample has achieved excellent ranking as per CCME WQI.
- We have noticed sample collected from some villages are having dip in WQI index hence we have to concentrate on treatment methods or plants for treatment in these villages and advice the local famers to use fertizers and pesticides judicially.
- In other villages water quality is excellent and we need to maintain the water quality index by educating the people
- As on 2021 all the 10 tested sample are suitable for drinking.
- Villages with Good quality are Attibele, Avathi, Bullahali, and Byrapanahalli.

Villages with Excellent quality are Gobbarakunte, Gonuru, Kodag Urki, Kurburakunte, Venkatagiri Kote, and Yelur.
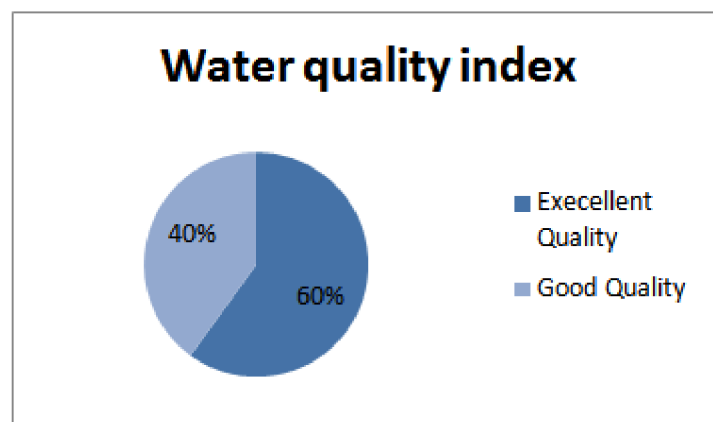
References

1. Balakrishnan, P., Saleem, A., & Mallikarjun, N. D. (2011). Groundwater quality mapping using geographic information system (GIS): A case study of Gulbarga City, Karnataka, India. *African Journal of Environmental Science and Technology*, *5*(12), 1069-1084.

2. Afreen Aba et.al Soil and Water environmental up gradation for Hirehalli Village Gram Panchayath in Karnataka by RS and GIS Technique

3. Pius, A., Jerome, C., & Sharma, N. (2012). Evaluation of groundwater quality in and around Peenya industrial area of Bangalore, South India using GIS techniques. *Environmental monitoring and assessment*, *184*(7), 4067-4077.

4. Ranjeeth, S., & Latchoumi, T. P. (2020). Predicting Kids Malnutrition Using Multilayer Perceptron with Stochastic Gradient Descent. Rev. d'Intelligence Artif., 34(5), 631-636.

5. Prasath, D. S., & Selvakumar, A. (2015). A Novel Iris Image Retrieval with Boundary Based Feature Using Manhattan Distance Classifier. International Journal Of Innovative Technology And Creative Engineering (Issn: 2045-8711) Vol, 5.

6. Balamurugan, K. (2021). Fracture analysis of fuselage wing joint developed by aerodynamic structural materials. Materials Today: Proceedings, 38, 2555-2562.

7. Ramakrishnaiah, C. R., Sadashivaiah, C., & Ranganna, G. (2009). Assessment of water quality index for the groundwater in Tumkur Taluk, Karnataka State, India. *E-Journal of chemistry*, *6*(2), 523-530.

8. Tiwari, A. K., Singh, P. K., & Mahato, M. K. (2014). GIS-based evaluation of water quality index of ground water resources in West Bokaro Coalfield, India. *Current world environment*, *9*(3), 843.

9. Vittala, S. S., Govindaiah, S., & Gowda, H. H. (2008). Prioritization of sub-watersheds for sustainable development and management of natural resources: An integrated approach using remote sensing, GIS and socio-economic data. *Current Science*, 345-354.