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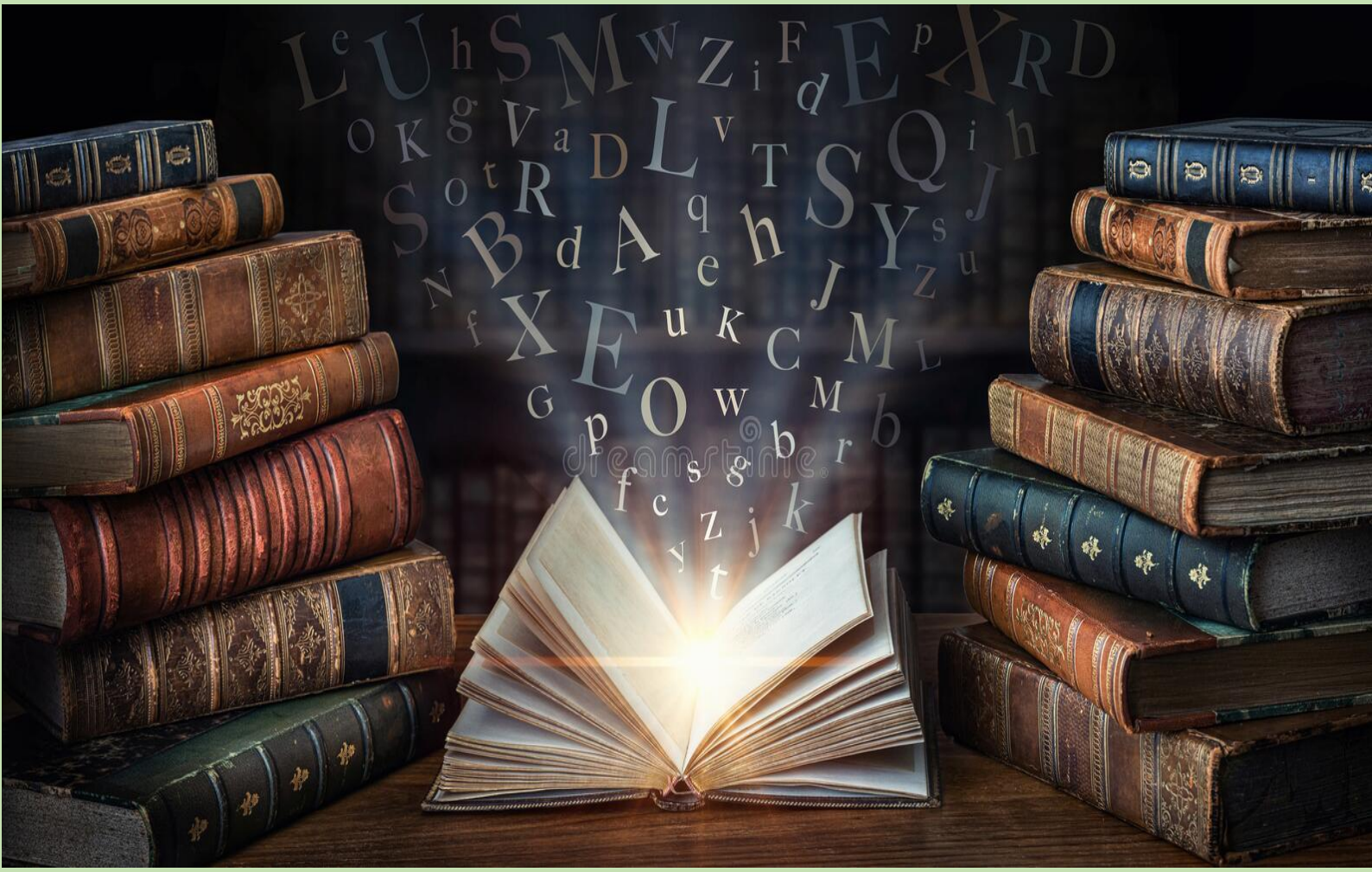

PROCEEDINGS OF NATIONAL CONFERENCE ON INNOVATIONS AND ADVANCES IN CIVIL ENGINEERING

Volume 1 June 24th 2022

ISBN: 978-81-956748-3-1

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Published by:

Dept. of Research & Publications, A2Z Edu LearningHub LLP

GOPALAN COLLEGE OF ENGINEERING AND MANAGEMENT BANGALORE

FIRST NATIONAL CONFERENCE ON INNOVATIONS AND ADVANCES IN CIVIL ENGINEERING (NCIACE- 2022)

JUNE 24th 2022

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ISBN: 978-81-956748-3-1

GOPALAN COLLEGE OF ENGINEERING AND MANAGEMENT BANGALORE

First National Conference on Innovations and Advances in Civil Engineering (NCIACE- 2022)

June 24th 2022

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DIRECTOR MESSAGE

It is indeed an honour to invite and welcome all the participants for the national conference organized by GCEM. Strategic transformation is the primary reason why digitalization, artificial intelligence and related changes are on the top of most corporate agendas. Many firms face major difficulties in growth due to lack of technology improvements.

Following the innovation-based view and a conceptual frame work of technological push and market pull effects is very important in today's global competitive world. The commercial success of these innovations is contingent upon existence of a good fit and response between the technological innovation and the accompanying business. The conference presents an important building block for successful digital transformation Best wishes to GCEM principal, Professor Dr. P M Shanmugavadivu HOD of Civil Engineering and creating a great platform for Academicians and innovators to come together. I wish all the participants all the very best in their presentations and future endeavours.

Dr.C Prabhakar
Gopalan foundation-General Secretary

PRINCIPAL MESSAGE

GCEM is embarking into a fresh page with a brand-new series of national conference with the theme “INNOVATIONS AND ADVANCES IN CIVIL ENGINEERING”-2022(NCIACE-2022). It is a timely theme for exploring how technology could be effectively utilized in the various structure of education to modify learning that makes it sensible for all living beings.

The theme has penetrated virtually into all areas of operations of education and entwined with educational practices. This conference offers a unique opportunity for our students by tapping out all their talent creative talents. To effectively benefit from technology applications, it is essential that education professionals set themselves ready for transforming their practices and keep identifying effective ways for transformations in their contexts. This conference refreshes like a window open to the sea breeze and the air currents, with the verbal spring of innovative thoughts which brings the limelight to the hidden talents of the students and the faculty.

At this juncture it is my bounded duty to record my profound gratitude to the philanthropic management, organizers professionally competent faculty and the committed supporting staff of inspiration for this conference to make this a great success.

Best wishes for the buddies, this is the modish platform for them to showcase their talents.

Dr.N. Sengottaiyan
Principal
GCEM

HOD MESSAGE

It is a matter of great pleasure to note that the Centre for Research in Civil Engineering Department is going to organise the 1st National conference on "INNOVATIONS AND ADVANCES IN CIVIL ENGINEERING"-2022(NCIACE-2022) held this year.

It is a matter of great pride that the organisers of the conference have been successful in creating such a huge impact on the target participants in such a short span of time.

The overwhelming response received from all over the country in the conference is simply amazing. It is heartening to acknowledge the fact that NCIACE-2022 has been sponsored by our institution. It is a great achievement on the part of the organisers to arrange the publication of the Proceedings of the conference in the form of a proceeding. The availability of the published book at online would add another dimension to the overall impact of the outcome of this conference on a larger section of research community all over the world. It is also encouraging to note that a delegate of international repute in the field are going to deliver invited lectures and key-note address in this National conference.

On behalf of the Department and also on my personal behalf I would like to thank the organisers of NCIACE-2022 for their untiring efforts and constant endeavour to make the workshop scale new heights.

Dr. P M Shanmugavadivu
Professor & Head – Civil
GCEM

ISBN: 978-81-956748-3-1

Spatial Distribution of Surface Water Quality and its Investigation on Mahanadi Basin, Odisha Using GIS Approach

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Abstract— Most of the third world countries having rivers passing through them suffer from the water contaminant problem. The problem is considered so difficult to get the water quality within the standard allowable limits for drinking, as well as for industrial and agricultural purposes. River water quality has gained significance as river water is being contaminated due to various human activities and it needs attention to ensure sustainable safe use. As a result, monitoring of water quality for both domestic and commercial use is absolutely essential for policy formulation that affects both public and environmental health. Geographical Information System (GIS) and Water Quality Index (WQI), which synthesize different available water quality data into an easily understood format, provide a way to summarize overall water quality conditions in a manner that can be clearly communicated to policy makers. This research aims to assess the water quality of the Mahanadi River using the water quality index method and GIS software. The river is considered a vital source of water for the residents and industrial activities. Twenty parameters (pH, DO, BOD, TC, TSS, TA, COD, NH_3-N, Free NH_3, TKN, EC, TDS, SAR, B, TH, Cl-, SO_4^{2-}, F^-, NO_3^-, and Fe^{++}) were taken from nineteen stations along the river. Various Physico-chemical analysis data of various water samples collected at different locations forms the quality database for the study. PH levels are slightly alkaline. Rest values obtained were compared with the guidelines for drinking purpose suggested by the WHO, BIS and CPCB Standards. The weighted arithmetic method was applied to 19 parameters to compute the water quality index (WQI) for the estimation of water potential. The interpolation method (IDW) was applied in ArcGIS 10.3 to produce the spatial distribution maps or generation of pollution potentiality map for 20 parameters at 19 stations along the Mahanadi River during the period of one year i.e. (2021-2022). WQI values calculated vary from 28.28 to 60.10. The river has a well to poor water quality rating, according to the WQI map. However, two stations, Cuttack D/s and Paradeep, have low water quality. All of the other sites are in the good category. The most significant contaminants are TC, BOD, and TKN. As per Nemerow's pollution index (NPI), some parameters had greater values above the WHO's acceptable and allowed thresholds. This is important to give comprehensive knowledge about the contamination reality of the river. Such that it becomes easier to understand the problem of contamination, analyze it, and find the suitable treatments and solutions.

Keywords: Water Quality Index, Mahanadi River, Weighted arithmetic method, IDW method, NPI

1. Introduction

Water is crucial for all living things to survive. If it is susceptible to bacteriological, chemical, or physical threats, it may be a source of a growing number of chronic human disorders (Lane et al. 2003). Although it is an important part of the environment, the quality of surface and ground water has long been degrading as a result of both natural and human-caused factors. Water quality is influenced by hydrodynamic, meteorological, environmental, geographical, and geological factors (Magesh et al 2013; Uddin et al 2018). Human activity that has a negative impact on water quality include mining, livestock farming, trash generation and disposal (industrial, municipal, and agricultural), increased sediment outflow or soil erosion owing to land degradation (Lobato et al 2015), and heavy metal contamination (Sanchez et al 2007). Furthermore, as people become more aware of the importance of drinking water quality to health policy and raw water quality to water bodies, the need to investigate surface water quality is becoming more pressing (Ouyang et al. 2005). Organic and inorganic causes degrade surface waters, rendering them unfit for drink, business, cultivation, recreational, and other uses (Kazi et al 2009). As a result, a water quality monitoring system is essential for the safeguarding of freshwater supplies (Pesce and Wunderlin, 2000). Experts believe that potentially hazardous materials pollution will eventually reach humans through the usage of polluted water (Rehman et al. 2018). According to Boyd et al. 2006, primary care specialists consider that pathogenic pathogens are the most major and important concern among the contaminants in drinking water. These germs will cause disease epidemics, causing serious health difficulties for a huge segment of the population. Geo-genic (natural disruption of the mineral belt) and human (mineral extraction, fertilizers, and liquid wastes) acts both contribute toxins into the environment (Muhammad et al. 2011; Devorak et al. 2020). To investigate the chemistry and safety of the river's flow, several processes have been implemented (Subramani et al. 2005; Moller et al 2007; Tsegaye et al 2006). (Yidana and Yidana, 2010) investigated the limitations on the water level and the severity of the regulating elements at various places in the flow system using traditional graphical approaches, multidimensional quantitative tools, and GIS. Horton 1965 was the first to propose the use of a WQI (Brown et al 1970). Based on the use of standard metrics for water characterization, the WQI has been considered as one criterion for surface water classification. WQI is a numerical tool that converts a large amount of water characterization data into a single number that indicates water quality

(Bordalo et al 2006; Sanchez et al., 2007). However, due to increased water consumption and diminishing water supply, achieving this feasible goal remains a challenge (Li and Qian, 2018). As a consequence of rising financial independence and industrialization, many developed and emerging countries' waterways have worsened to alarming levels in recent times due to rapid employment generation, mainly in developing nations, and fertilizer waste from fields containing crop residues (Omonona et al. 2019; Tripathi and Singal, 2019). The usage of fertilizers manures and water channels has a substantial impact on water quality (Ali et al. 2019; Rashid et al. 2019). Rising population, gigantic modernization, and livestock grazing, as well as insufficient governance of home, commercial, and urban wastes, decayed soil, and transportation infrastructures, have all contributed to the rapid deterioration of watersheds (Zhao et al. 2011; Ouyang et al. 2006; Masoud et al. 2014). We employed the Mahanadi River as a subject of study for the first time in this paper, building 19 major observation stations across the river bed and recognizing and reviewing 20 biochemical parameters in river water. There was a 1-year reporting phase taken. The primary objectives of this paper are (1) to examine the river water's physicochemical aspects, (2) establish the Mahanadi River's water quality using WQI testing and build a WQI diagram using GIS, (3) to describe how each water quality metric affects the WQI scores, (4) examine whether the water is suitable for consumption, gardening, or commerce and (5) Nemerow's Pollution Index (NPI) is used to quantify the principal contaminant existing in a sample water and, primarily on the NPI rating, to decide whether the sample is contaminated or non-contaminated.

2. Study Area

The Mahanadi basin spans 141589 km^2 and accounts for roughly 4.3 percent of India's total land area. It is situated between 8030 and 8650 east longitudes and 1921 and 2335 north latitudes. The Mahanadi River, which travels from west to east before draining into the Bay of Bengal, is one of India's major rivers. The main tributaries are the Hasdeo, the Seonath, the Mand, the Ib, the Bhadar, the Jonk, the Ong, and the Tel. It drains 50109 m^3 each year, with a high discharge of 44,740 m^3 s1 (Chakrapani and Subramanian 1990; Sundaray et al. 2006). Pharsiya village, 6 kilometers from Raipur's state capital, has a pool at a height of 442 meters (of Nagri town). Agriculture is the primary source of income for the local population. The river flows west during the first 56 kilometers of its voyage, passing through scattered hills and a small valley with little impact from industrial activity. Near Kanker, four tiny streams join the river, which then takes an abrupt northwest turn. Agriculture is the main source of income in the Kanker district. This area is rich in mineral deposits, including iron ore, quartzite. The Pairi River joins on its right at Rajim after approximately 113 kilometers of unbroken flow. Apart from agriculture, Rajim's people primarily rely on tourism, with a few industries such as a steel mill and a rice mill also present in the city. Seonath, the Mahanadi's first notable tributary, flows into the Mahanadi 13 kilometers upstream in Bilaspur District, at Sheorinarayan. When compared to Past River places, the district might be considered developed. The Mahanadi River turns east after going through a sangam of rivers of almost identical breadth that spans 138 kilometres. At Sheorinarayan town, the tributary Jonk joins from the right. The Hasdeo tributary joins it from the left after about 17 kilometers near Mahuadih. The Mand River joins it from the left later at Chandarpur. In the Mahuadih and Chandarpur areas, there is a lot of farming. The Mahanadi leaves Chhattisgarh and enters Orissa after a 28-kilometer journey. Near Bagra, the Ib River joins from the left. In the area, there is a big tract of woodland with little human activity. The river also feeds into the stony beds of the Hirakud dam, which is across the Mahanadi from Sambalpur City. The dam has a height of 61 meters and a length of 4.8 kilometers. The Hirakud Dam has far-reaching social implications, giving water and energy to those who are in need. The dam is responsible for flood control, irrigation, hydropower generation, and navigation. Sambalpur is home to a varied mix of businesses, including bauxite, coal, and dolomite. After passing through a series of rapids below the city, the river takes a southerly turn and splits into two sections around Charpali town, eventually reuniting around Dhama. The Mahanadi flows south for 11 kilometers below Dhama before turning southeast for 45 kilometers to Sonepur town. Around 11 kilometres upstream of Sonepur, the Ong River enters the Mahanadi from the right. After a slight shift to the southeast around Sonepur, where the Eastern Ghats Mountains begin, the Tel, the second-largest tributary, enters. The river separates into two arms again around Haudh, and the valley narrows drastically for the next 23 kilometers beyond Athmalik, going through the incredibly narrow Satkosis Gorge. The water quality station, Tikarpara village, is about 6 kilometers below the commencement of the narrowest pass. In the basin, Tikarpara is a well-known tourist resort. The river crosses the Eastern Ghats at Baramul, where the gorge terminates. Between the villages of Baramul and Baideshwar, the Mahanadi valley is flat with minor hillocks. Below Baramul, the river widens again, reaching a width of 1.6 km. It flows near Pathpur through the Kaimundi gorge. The river widens and bends left beneath this gorge, eventually arriving at the Naraj delta 11 kilometers west of Cuttack, the state capital. Below this delta, the Mahanadi River splits into two channels, and after breaking into numerous watery tributaries, it eventually debouches into the Bay of Bengal around False Point. The river in question is 851 kilometers long, with 357 kilometers in Chhattisgarh and the remainder in Orissa (Jain et al. 2007). The research region is illustrated with the basic topographic maps and stations that are required (Figure 1).

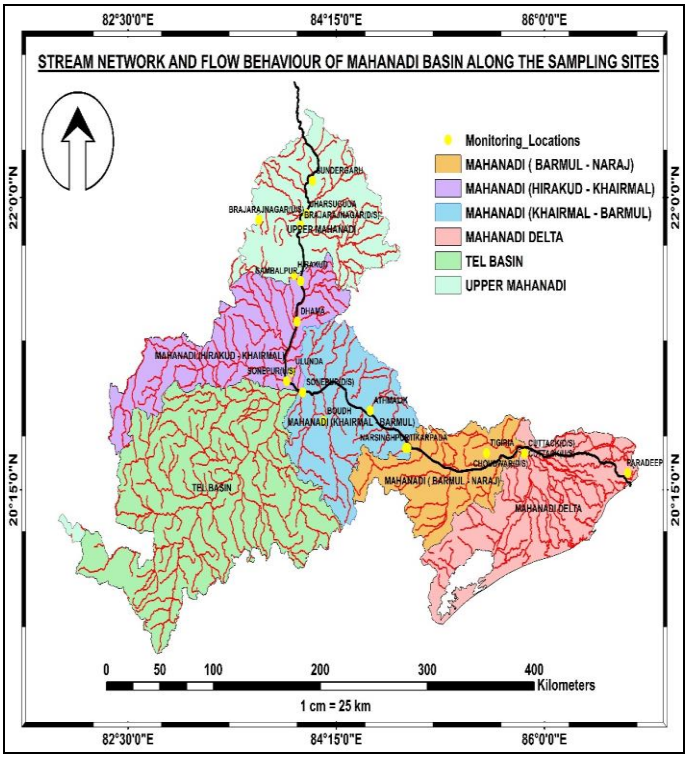

Figure 1. Location map of the study area

3. Sampling Procedure

The goal of this research was to figure out the physicochemical and bacteriological quality of waterways in Odisha's Mahanadi basin. Before being used, all sampling equipment's, were cleaned with cleanser, washed thoroughly with distilled water, immersed in 10% HNO3 for 24hrs, re-rinsed with deionized water, and air dried (Wondimagegne et al. 2016). Twenty water samples were collected from 19 sites using diverse water sources, with the reasons for each site being highlighted in the report (Table 1). Pre-rinsed 250 mL polyethylene bottles were used to collect water samples from nineteen different sites at each site. At the site, some physio-chemical parameters of water samples were collected, and samples from each location were combined in a one-liter polyethylene container with 2 mL nitric acid added to decrease metal adsorption on the plastic bottles' walls. The sampling date and location were then written on the sample containers (Gebremedhin et al. 2015). The samples were transported to the lab in an ice box and kept at 4°C until they were processed. All of the samples were frozen and stored until they were needed for chemical analysis.

4. Results and Discussion

The key physicochemical characteristics of the studied water samples were collected and analyzed during a one-year interval (2021-2022) given in (Table 2). The pH of water is a critical indicator of water quality since it is regulated by carbon dioxide and the carbonate-bicarbonate balance. It is a significant variable in surveillance because it affects many biological and chemical activities within a water body, as well as all water system and rehabilitation operations. The drinking water recommendations and the (WHO 2011) have established a pH range of 6.5 to 8.5 as a suitable limit. The current water samples had pH levels ranging from 7.7 to 7.9, with a mean of 7.8 mg/l. According to the findings, all of the water samples have PH values greater than 7, indicating that the water is slightly alkaline. According to (CPCB 2015) criteria, PH values between 6.5 and 8.5 correspond to the Class A, B, C, D, and E categories (Table 3). According to the results, the stations R1 through R19 are good and suited for all drinking classes. DO is the most significant metric for assessing water quality since it has an impact on aquatic life and the dispersion of aquatic organisms (Rabee et al., 2011; Naubi et al., 2016). It varied from 7.26 to 7.83 mg/l in this study, with an annual mean of 7.68 mg/l, which was more than 6 mg/l more than the WHO's threshold. Higher levels were recorded in stations downstream of city wastewater discharges due to local household wastewater. This was driven by the fact that rising temperatures in river systems hinder the breakdown of ambient DO, as proved by (Kumarin et al., 2013). According to the CPCB, Class A should be less than 6 mg/l, Class B should be less than 5, and Class C and D should be less than 4. All of the sites have results that are higher than the CPCB's regulatory limits, indicating waste water contamination from both domestic and municipal sources. BOD is the amount of oxygen consumed by bacteria in the laboratory over the course of five days to break down organic molecules. BOD in drinking water should not exceed 5 mg/l, according to the BIS. It ranged from 1.05 to 2.40 mg/l in our study, with an annual mean of 1.36 mg/l. According to the WHO's quality criteria of fewer than 5 mg/l, it was generally low (WHO, 2011). According to the findings, limited or no mixing of organic compounds has aided in lowering the BOD level in this river water. TC is currently used as a bacterial contamination indicator, while fecal coliform is used as a contamination indication in water. During the study period, the TC count of the water samples ranged from 1212.4 to 42529.3, with a mean of 5151.3 per 100 ml. The value of TC should be less than 50 for Class A, 500 for Class B, and 5000 for Class C, according to (CPCB, 2015) recommendations. According to the findings, all of the stations are within the prescribed limits and fall into the Class C category, with the exception of Cuttack D/s, Paradeep D/s, and Chowdwar D/s, which have values larger than 5000 and hence do not fall into the Class C category. For effective monitoring and maintenance, these stations require adequate treatment. TSS usually refers to bigger settle able solids. TSS concentrations ranged from 28.63 to 74.90 mg/l on average, with a mean of 39.33 mg/l. The readings should be less than 100 mg/l, according to (CPCB 2015). The permitted limits are met at all sample locations. Alkalinity is the capacity of water to neutralize an additional acid is measured by alkalinity. Alkalinity of natural water should be greater than 20 mg/l (as calcium carbonate) for freshwater aquatic life. Concentrations ranged from 70.40 to 100.90, with an average of 85.71. According to WHO guidelines, all sampling locations are within the specified limits, i.e. (values should be less than 500 mg/l). In case of COD, under the Environment Protection Act (EPA) of 1986 in India, the maximum allowed limit for an industrial effluent discharged onto inland surface is 250 mg/l. Since discharge regulations are often predicated on the assumption of 10 times dilution, it is perhaps safe to assume that a COD

content of 25 mg/l or less is the desirable limit in a water body, even in India. According to the study, levels range from 6.8 to 21.9 mg/l, with a mean of 11.2 mg/l and minor seasonal changes. All of the stations had levels below 25 mg/l, indicating that they are safe to drink. In case of NH_3-N and Free NH_3**,** manufacturing and animal operations, as well as chloramine treatment, all contribute to ammonia in drinking water. Ammonium levels increases due to heavy agriculture in the catchment area of the water supply. As a result, ammonium is a symptom of contamination from germs, sewage, and animal waste. In the current studies, ammoniacal nitrogen concentrations ranged from 0.5 to 1.9 mg/l, with a mean of 0.7 mg/l, while free ammonia levels ranged from 0.51 to 1.93 mg/l, with a mean of 0.66 mg/l. According to (CPCB 2015), the value of ammoniacal nitrogen and free ammonia should be less than 2 mg/l. According to the report, all of the sampling sites for both incidents are within the CPCB's standard levels. All sites are safe according to WHO standards, with the exception of Choudwar D/s, which has a value of 1.93 mg/l, which is higher than 1.5 mg/l,

and its free ammonia values are within (WHO 2011) norms. All of the sites are classified as Class D. For stagnant water, TKN levels are particularly essential, since greater TKN values indicate a risk of eutrophication or a higher level of ammonia in the water, which can be harmful. TKN levels range from 3.28 to 11.80 mg/l, with a mean of 5.73 mg/l. The readings are higher than the (CPCB, 2015) acceptable limit of 3 mg/l. As a result, all sampling locations are affected by organic contamination, lowering the water quality. EC refers to the potential of a substance to convey an electrical current is measured by its electrical properties in water. The existence of ions, their overall abundance, mobility, and measurement temperature all affect this capacity (Prosser et al., 2001). Since conductivity yields a reasonable estimate of the number of dissolved components in water (Muhammad et al., 2011), it is an important aspect in water quality measurement. The EC value ranged from 138.10 to 7779.35 s/cm in this investigation, with a mean of 580.86 s/cm. The conductivity limit set by the WHO is 400–1200 s/cm. As a result, with the exception of Paradeep, all of the investigated samples' EC values were within the permitted limit for drinking. Except for paradeep, which was rated as bad, all samples taken were rated as excellent (EC (S/cm): 100–250) based on Richard's classification (Richards, 1954). According to (Talling 2009), urban and agricultural outflow, as well as leaching of soil contamination, are the main sources of TDS. The concentrations of TDS in this sample ranged from 82.30 to 13230.60 mg/l on average, with an average of 803.69 mg/l. According to rules (WHO 2011), the most acceptable and highest allowable amounts are 500 mg/l and 1000 mg/l, respectively. As a consequence, with the exception of Paradeep, all total dissolved solids readings in the examined area were within the expected limits for drinking. As a result, the low TDS levels in the water from the chosen sites indicated that it was being used for drinking and other domestic purposes. Although boron is necessary for plant growth, when it exceeds 2 mg/l in irrigation water, it becomes hazardous to most field crops, disrupting the plant's metabolic functions. Its concentrations range from 0.03 to 0.55 mg/l, with an average of 0.08 mg/l. The results should be less than 2 mg/l, according to CPCB 2012. All of the samples are within the acceptable ranges and fall into the Class E category. The dissolved calcium and magnesium carbonates in surface water are measured by total hardness (TH). Although the WHO recommends a maximum hardness of 600 mg/l, the overall perception is that 300 mg/l is sufficient. According to (WHO 2011) categorization, 0 – 75 suggests moderate, 75 – 150 indicates fairly hard, 150 – 300 denotes strong hard, and > 300 implies very strong hard. The most ideal limit is 100 mg/l. In the research area, TH spans from 51.20 to 2195.20 mg/l, with an average of 186.45 mg/l. All values are just under 300 mg/l, with the exception of Paradeep, making it suitable for all activities in all sampling locations. As a result of the data, it may be deduced that the classification of hardness is "strong hard." The maximum amount of chloride allowed in drinking water is 250 mg/L (1000 mg/L if no other source is available) (BIS 2012). Surface water samples in the research area had chloride concentrations ranging from 9.65 to 4904.91 mg/l, with an average of 269.23 mg/l. Except for Paradeep, all sampling locations are within the limits. Sulfate is a common ion in the earth's crust, with concentrations ranging from a few milligrams per liter to a few milligrams per liter in water (Bartram et al, 1996). Anions are a sort of ion that can be found in practically all types of water. (WHO, 2008) drinking water quality criteria indicate a SO_4^{2-} threshold level of 250 mg/l. Sulphate levels in drinking water must not exceed 200 mg/L (400 mg/L if no other source is available) (BIS 2012). The sulphate concentrations in this study's data ranged from 4.97 to 376.07 mg/l. Only one of the samples in this investigation, Paradeep, showed levels that above the permitted limit. Fluoride levels in drinking water of 0.7–1.2 mg/l help to avoid gum disease. If the dose is exceedingly high (more than 1.5 mg/l), tooth discoloration or blotchiness may develop. Fluoride concentrations in water samples ranged from 0.26 mg/l to 1 mg/l in this study, with an average of 0.37 mg/l. Fluoride levels in all tested water samples were below allowed limits, according to WHO drinking water quality requirements. Nitrate is the most common source of nitrogen for most plants, it is commonly employed as a fertilizer. Its concentrations in surface water are typically modest, although they can rise due to agricultural land leach or runoff, as well as interference from human and animal wastes (WHO 2011). The quantities of nitrate in the samples analyzed ranged from 1.29 to 2.7 mg/l, with a mean of 2 mg/l, well below the 50 mg/l maximum allowed level set by the World Health Organization. This demonstrated that the NO_3 concentration in the water in the study area is safe for drinking and other household purposes. All of the sampling locations are safe to drink and use for cultivation. Fe^{++} is a vital component of the human body that is necessary physiologically in a variety of ways (Moore 1973). The maximum acceptable value of iron in drinkable water is 0.3 mg/l, while the maximum allowable value is 1.0 mg/l (Sharma and Chawla 1977). According to the (WHO, 2011), levels up to 2 mg/l (ten times the normal value) do not pose a health risk. Levels in the samples tested ranged from 0.60

to 2.61 mg/l, with just an average of 1.31 mg/l. The iron levels in the river water were outside the WHO permitted threshold of 0.3 mg/l, according to this report. A somewhat higher iron concentration could be due to the type of the aquifer delivering water (Shigut, 2017). The taste of water with an iron content of greater than 0.3 mg/l might be unpleasant. Iron elimination plants should be established before to drinking at stations like Paradeep. Spatial distribution maps of individual physical parameters are prepared and represented in (Figure 2).

WQI Calculation: It's a handy tool for expressing water quality in a clear and simple manner by merging multiple water quality parameters into a single-valued unit with a lower number of values (Sener et al. 2017; Wang et al. 2017). (Horton 1965) proposed the WQI, which was initially used to examine the quality of drinking water (Brown et al. 1970; Misaghi et al. 2017; Kumar et al. 2018). It has been estimated using (Pesce and Wunderlin's 2000) approach and is represented by eq. WQI_{Sub} = K $(\sum_{i=1}^{n} Ci * Pi)/ (\sum_{i=1}^{n} Pi)$**,** where the standardized value allocated to each component is Ci, while the weightage of the parameter is Pi. K is a discretionary constant that could be anywhere between 1.0 and 0.25 relying on the researcher's visual examination of river toxicity. A score of 1.0 is assigned to water with no obvious contamination, while a value of 0.25 is assigned to substantially contaminated water. These findings are then examined to the (BIS 10500) and (WHO 2011) standard guideline values. WQI was calculated to determine the acceptability of water for drinking purpose (Boateng et al 2016). (Table 4). Total 19 parameters were examined for WQI calculation, including pH, DO, BOD, TC, TSS, Alkalinity, COD, NH_3-N, Free NH_3, TKN, EC, TDS, B, TH, Cl-, SO_4^{2-}, F^-, NO_3^-, and Fe^{++}, and the desirable threshold of each characteristic was employed.

Table 1 Water Quality Ratings **(**Boateng et al 2016**)**

WQI LEVEL	WATER QUALITY RATING
0-25	EXCELLENT
26-50	GOOD
51-75	POOR
76-100	VERY POOR
>100	UNFIT FOR DRINKING

Table 2. Water Sampling Intake Points and its site justification

St. Symbol	STATIONS	JUSTIFICATION ON SITE SELECTED
R1	Hirakud	Reservoir that serves multiple purposes (irrigation and Hydroelectricity)
R2	Sambalpur	Influence of home sewage water upstream of Sambalpur municipality
R3	Sonepur(U/S)	Downstream of a prominent tributary's convergence (River Ong)
R4	Sonepur(D/S)	Downstream of a large tributary's intersection with drainage and sewerage outflow (River Tel).
R5	Tikarpada	Captive breeding site for crocodiles, as well as a sanctuary
R6	Narsinghpur	Modern agricultural operation in a populous area
R7	Cuttack(U/S)	Cuttack municipality is built upstream.
R8	Cuttack(D/S)	Significance of Cuttack's waste water emission and Jagatpur Commercial Estate's toxic waste release
R9	Paradeep	Implications of the Paradeep Manufacturing Area's Waste Water Export
R10	Sundergarh	Water intake point and major human settlement
R11	Jharsuguda	Impact of industrial and mine discharges, water intake point
R12	Brajarajnagar(U/S)	Water quality before industrial impact. Water intake point and major human settlement
R13	Brajarajnagar(D/S)	Impact of industrial and mine discharges, water intake point
R14	Dhama	To assess water quality improvement along Dhama stretch
R15	Ulunda	To assess water quality improvement along Ulunda stretch
R16	Boudh	Sub-divisional town
R17	Athmalik	Sub-divisional town
R18	Tigiria	Municipal sewage
R19	Choudwar(D/S)	Downstream of Choudwar town

Table 3. Computational examination of water quality parameters

Sl. No	Parameters	Min	Max	Mean	Stdev.	Skewness	Kurtosis
1	PH	7.74	7.92	7.82	0.05	0.02	-0.84
2	DO	7.26	7.83	7.68	0.14	-1.87	3.66
3	BOD	1.05	2.40	1.36	0.34	1.84	4.19
4	TC	1212.40	42529.20	5151.25	9193.97	4.15	17.64
5	TSS	28.63	74.90	39.33	11.56	1.89	4.06

6	TOTAL ALKALINITY	70.40	100.90	85.71	8.24	0.07	-0.61
7	COD	6.76	21.88	11.25	3.96	1.63	2.52
8	NH3-N	0.51	1.93	0.66	0.31	4.03	16.97
9	FREE AMMONIA	0.02	0.06	0.03	0.01	2.04	5.71
10	TKN	3.28	11.80	5.73	2.07	1.49	2.94
11	EC	138.10	7779.35	580.86	1743.33	4.36	18.99
12	TDS	82.30	132360.60	812.80	3007.19	4.36	19.00
13	B	0.03	0.55	0.08	0.12	4.02	16.85
14	SAR	0.41	16.59	1.34	3.69	4.36	18.99
15	TH	51.20	2195.20	186.45	486.60	4.35	18.97
16	CL_2	9.65	4904.91	269.23	1122.58	4.36	19.00
17	$S0_4^{2-}$	4.97	376.07	26.43	84.68	4.36	18.99
18	F	0.26	1.00	0.37	0.17	3.26	11.13
19	NO_3	1.29	2.70	2.00	0.41	-0.22	-0.66
20	FE	0.60	2.61	1.31	0.46	1.04	2.41

Table 4. Categorization based on usage

CLASS	USE
A	Drinking water supply that has not been treated conventionally but has been disinfected
B	Outdoor showering that is well-organized
C	Supply of drinking water that has been treated conventionally and disinfected
D	Fish farming and wildlife rehabilitation
E	Horticulture, industrial cooling, or sewage treatment

For performance analysis, the findings of all 19 sampling points analyses were used. The distributed maps of the water quality measure, as well as the resulting WQI maps are created using Geospatial System (GIS) approaches. To obtain WQI score, the weights for each water quality indicator were determined based on their respective weights in the sheer functionality of water and drinking. (Table 5) shows that the computed WQI scores ranging from 28.28 to 60.10, with an average of 34.84. Spatial map distribution is shown in (Figure 3). WQI readings are divided into five categories as per the grading of water quality (Jonnalagada and Mhere 2001), with 0-25 indicating excellent, 26-50 indicating well (good water), 51-75 indicating poor, 76-100 indicating very poor, and > 100 indicating unsafe for drinking. Furthermore, the Mahanadi River's water quality is in the Good to Poor category for drinking, owing to the intake of municipal wastewater pollutants, as well as fertilizers discharged along the river's bed. The water quality in R1 to R7 and R10 to R19 sites is good, however the water quality at Paradeep and Cuttack D/s is bad. It leads to waste water discharge, the leather products, and marble manufacturers. Because it is located downstream, it is assumed to receive urban effluents, causing the water quality to worsen and endangering human health. The water appears to be drain water from a city. The water is practically still here, and pollutants haven't dispersed. In terms of WQI, all of the stations perform well quantitatively, and this is due to massive pollutants being diffused and washed away by intense rainwater.

Table 5. Water Quality Index (WQI) along Mahanadi River

Sampling Symbol	WQI values	Rating of Water
R1	28.28	Good
R2	34.59	Good
R3	28.58	Good
R4	34.42	Good
R5	32.86	Good
R6	32.39	Good
R7	33.61	Good
R8	52	Poor
R9	60.1	Poor
R10	34.63	Good
R11	28.32	Good
R12	31.4	Good
R13	34.44	Good
R14	33.97	Good
R15	28.68	Good
R16	32.68	Good
R17	33.69	Good
R18	34.75	Good
R19	32.6	Good

NEMEROW'S POLLUTION INDEX (NPI) ANALYSIS

It is the most basic approach to determine the water quality index. The NPI for river water was computed by multiplying the total amount of each element in surface water by its average background concentration value (Mohan et al. 2007; Swati et al. 2015).

$$C.F. = C_n / S_n \quad \text{---------- (1)}$$

Where Cn denotes the percentage of the parameter whose identification is indicated by n, and Sn denotes the nth parameter's predefined allowable limit. Mahanadi sampling stations were identified as a result of appraisal. In light of Eq. (1), NPI > 1 can be classified as contamination, implying that it is present in excess quantity or quantity and has the ability to trap water bodies, whereas NPI < 1 can be classified as non-contaminated and considered safe for consumption. The values obtained of the various types of NPIs for all of the Mahanadi basin's 20 elements are shown in (Table 6a, 6b). As per NPI results, DO is the most contributing characteristic in all sampling locations, promoting a higher pollution index and, as a result, leading to a major pollutant. Attributed to the prevalence of industry, oil refineries, and paper pulp manufacture, TC is a significant contamination source for Paradeep, Cuttack D/s, and Choudwar, deteriorating the purity and potentially transmitting to man through drinking and bathing. It also

occurs as a result of the densely populated and productive farming activity. In all samples collected except Hirakud, Sonepur, Cuttack U/s, Jharsuguda, Tigiria, and Choudwar D/s, TKN contributes more pollutants, whereas for variable TDS, NPI > 1 is present in all locations except Chowdwar owing to the combination of aluminum and power plants at Hirakud dam, charge chrome industry, and power plant at Choudwar D/s. Furthermore, the effluent from a paper mill in Jagatpur and two existing fertilizer factories in Paradeep is dumped directly into the river. The concentrations of TH, chloride, and sulphate are larger in paradeep and fluoride in Choudwar D/s, implying that municipal sewage wastes provide the majority of the elements found in the riverbed. It can also be generated by man-made and home sewage issues. There is also various steel, aluminum, electricity, sponge iron, and other businesses in the area upstream of Hirakud Dam and surrounding the dam, according to this study. Liquid waste and runoff from quarrying, livestock, enterprises, and agriculture have altered the physiochemical attributes of river water.

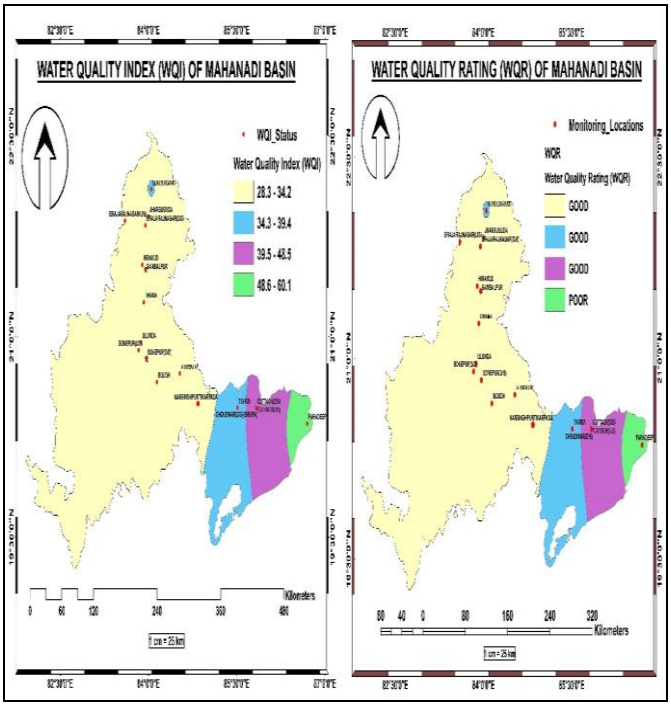

Figure 3. Spatial distribution map of WQI values

Variables	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10
PH	0.92	0.92	0.92	0.93	0.92	0.92	0.93	0.93	0.92	0.91
DO	1.28	1.27	1.30	1.30	1.29	1.29	1.31	1.21	1.24	1.30
BOD	0.21	0.26	0.22	0.32	0.21	0.22	0.25	0.48	0.28	0.22
TC	0.40	0.80	0.28	0.64	0.50	0.77	0.47	8.51	1.60	0.44
TSS	0.36	0.31	0.31	0.33	0.38	0.33	0.34	0.47	0.75	0.56
Alkalinity	0.41	0.42	0.45	0.49	0.43	0.46	0.39	0.44	0.51	0.35
COD	0.29	0.40	0.32	0.45	0.33	0.35	0.34	0.66	0.48	0.23
NH3-N	0.27	0.31	0.26	0.31	0.27	0.28	0.36	0.36	0.29	0.27
FREE AMMONIA	0.01	0.01	0.01	0.02	0.01	0.01	0.02	0.02	0.01	0.02
TKN	0.75	1.68	0.82	1.16	1.17	1.06	0.79	1.21	2.36	1.50
EC	0.08	0.08	0.08	0.10	0.09	0.08	0.08	0.09	3.46	0.06
TDS	4.22	3.17	4.66	5.24	5.56	5.08	4.89	5.05	508.87	3.51
B	0.02	0.02	0.02	0.02	0.03	0.02	0.02	0.03	0.28	0.01
SAR	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.00
TH	0.25	0.26	0.27	0.29	0.25	0.26	0.25	0.27	7.32	0.17
CL_2	0.04	0.04	0.06	0.05	0.04	0.04	0.05	0.05	19.62	0.04
$S0_4^{2-}$	0.04	0.04	0.03	0.04	0.04	0.04	0.05	0.04	1.88	0.03
F	0.28	0.30	0.32	0.36	0.30	0.31	0.32	0.32	0.63	0.26
NO_3	0.05	0.05	0.04	0.04	0.04	0.04	0.03	0.04	0.06	0.03
FE	0.33	0.31	0.22	0.34	0.49	0.48	0.56	0.46	0.87	0.64

Table 6a. NPI values at individual sampling station Table

Variables	R11	R12	R13	R14	R15	R16	R17	R18	R19
PH	0.91	0.91	0.91	0.93	0.92	0.92	0.92	0.93	0.92
DO	1.28	1.29	1.25	1.29	1.29	1.28	1.29	1.30	1.30
BOD	0.22	0.21	0.30	0.38	0.27	0.28	0.27	0.30	0.28
TC	0.54	0.36	0.61	0.68	0.24	0.38	0.72	0.47	1.17
TSS	0.42	0.41	0.52	0.30	0.29	0.36	0.30	0.32	0.43
Alkalinity	0.39	0.39	0.38	0.49	0.44	0.44	0.46	0.39	0.44

6b. NPI values at individual sampling station

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COD	0.25	0.24	0.32	0.44	0.31	0.32	0.34	0.33	0.73
NH3-N	0.28	0.27	0.31	0.31	0.26	0.27	0.28	0.36	0.96
FREE AMMONIA	0.01	0.01	0.01	0.02	0.01	0.01	0.01	0.02	0.03
TKN	0.66	1.25	1.60	1.09	0.78	1.13	1.09	0.77	0.90
EC	0.07	0.07	0.07	0.10	0.08	0.09	0.09	0.08	0.09
TDS	3.74	3.74	4.13	5.28	4.71	5.53	5.07	4.87	0.02
B	0.02	0.02	0.02	0.02	0.03	0.05	0.03	0.04	0.07
SAR	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17
TH	0.19	0.19	0.20	0.29	0.27	0.26	0.25	0.25	0.34
CL_2	0.04	0.04	0.04	0.04	0.06	0.04	0.04	0.04	0.08
$S0_4^{2-}$	0.03	0.03	0.03	0.04	0.03	0.03	0.03	0.04	0.05
F	0.28	0.27	0.30	0.36	0.32	0.30	0.35	0.36	1.01
NO_3	0.03	0.06	0.04	0.05	0.05	0.06	0.05	0.04	0.05
FE	0.41	0.42	0.36	0.31	0.20	0.44	0.45	0.53	0.51

The results revealed probable pollutants as well as the water quality class (Table 7). This degradation is the result of a combination of natural and manmade causes. The discharge of untreated urban waste water into surface water systems is the most significant cause of anthropogenic contamination. Agriculture, mining, land drainage, and the release of effluents from businesses and oil refineries are among non-point sources that contribute significantly. This scenario is causing the natural architecture of river systems to be disrupted, causing water quality to degrade day by day, and has become one of the world's most serious environmental issues. In a geospatial map, the graphic depiction of distinct classes and characteristics of each concerned sampling site are depicted (Figure. 4).

Table 7. Class and parameters responsible for downgrading water quality

St. Symbol	Class (Table 3)	Parameters Responsible for Downgrading
R1	C/D/E	TC, TKN
R2	C/D/E	BOD, TC, TKN
R3	C/D/E	TKN
R4	C/D/E	TC
R5	C/D/E	TC, TKN
R6	C/D/E	TC, TKN
R7	C/D/E	TC, TKN
R8	C/D/E	BOD, TC, TKN
R9	Not conform to any class	EC, TKN, TDS, TH, CL, SULPHATE
R10	C/D/E	TC, TKN
R11	C/D/E	TC, TKN
R12	C/D/E	TC, TKN
R13	C/D/E	TC, TKN
R14	C/D/E	TC
R15	C/D/E	TC
R16	C/D/E	TC
R17	C/D/E	TC
R18	C/D/E	TC
R19	C/D/E	TC, TKN

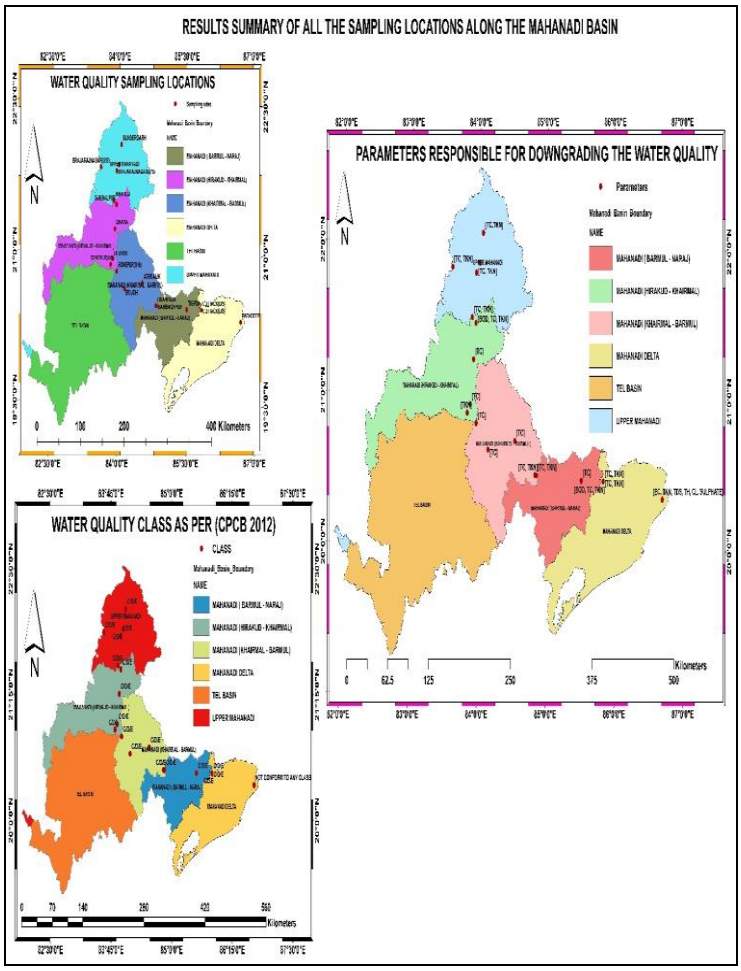

Figure 4. Summary results of all sampling locations which contributes contamination/pollution

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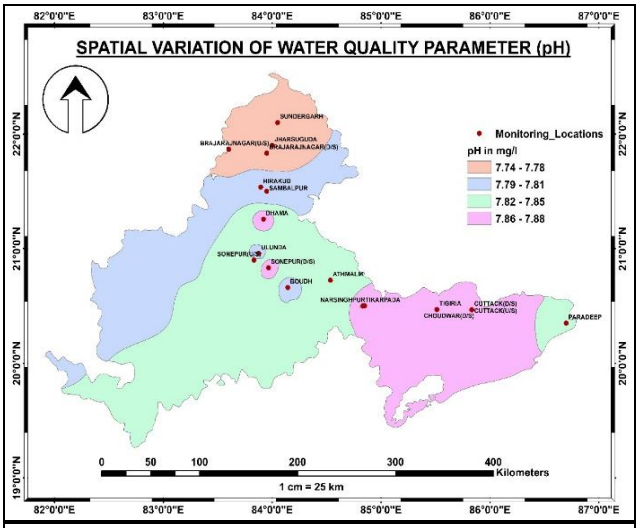

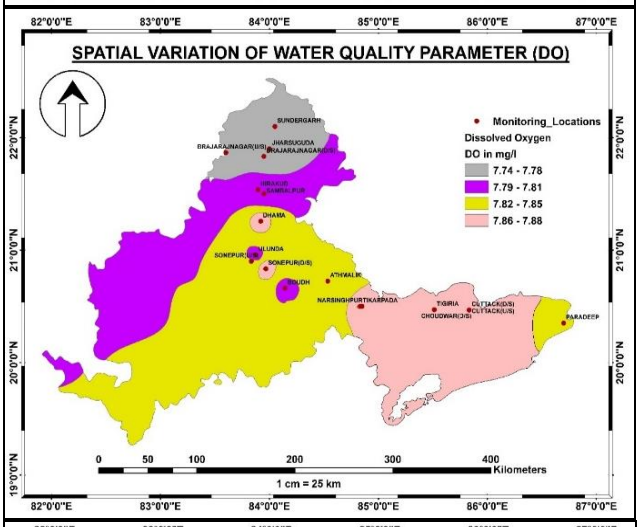

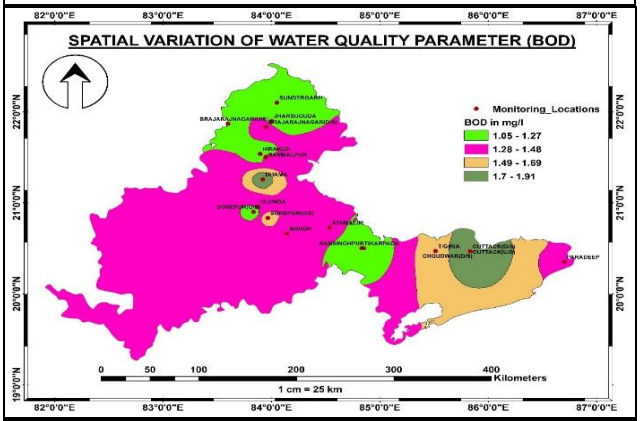

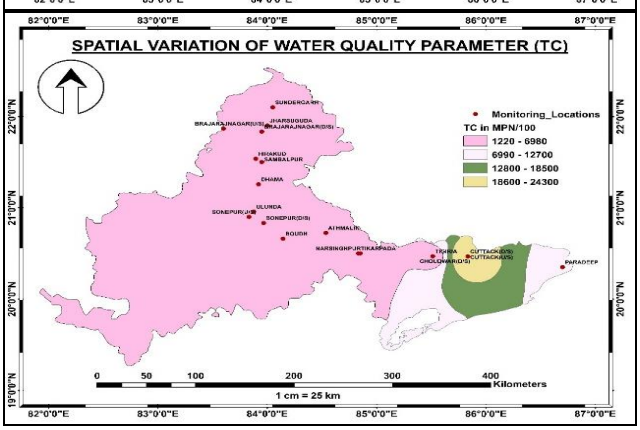

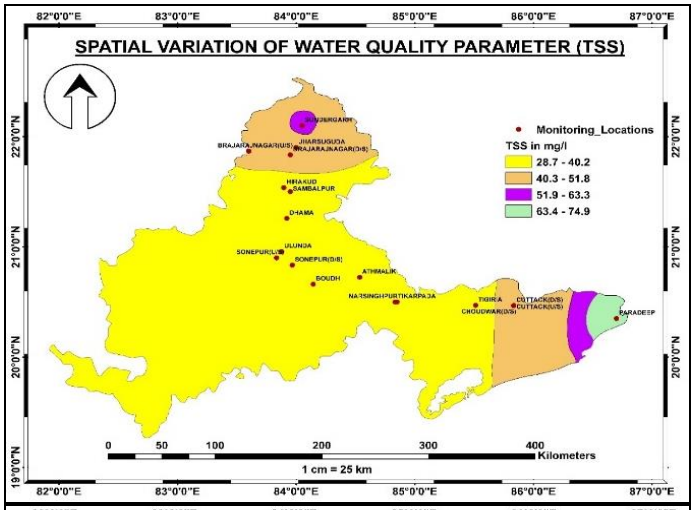

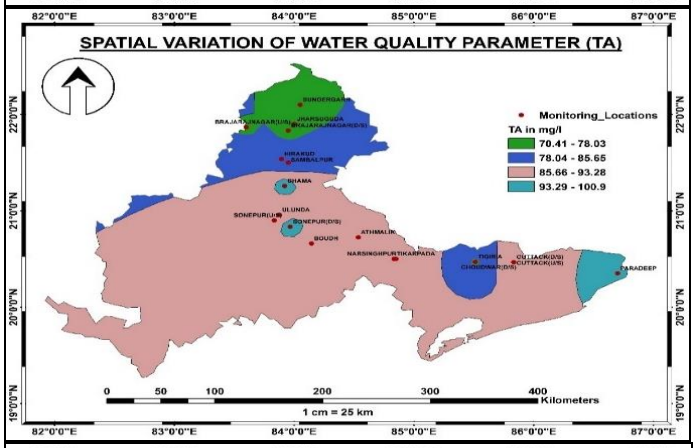

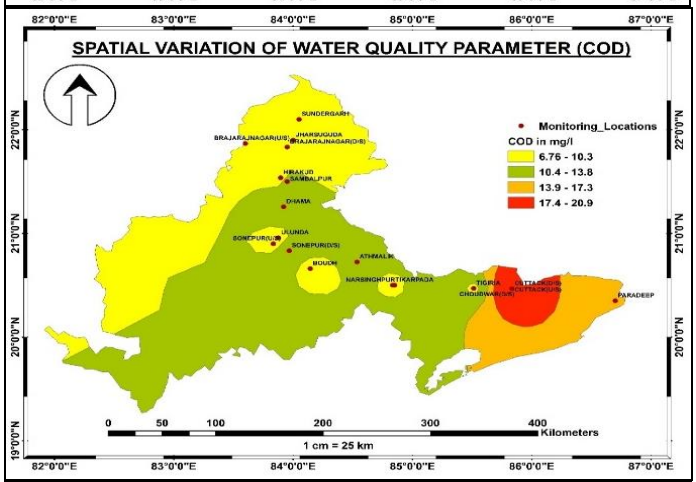

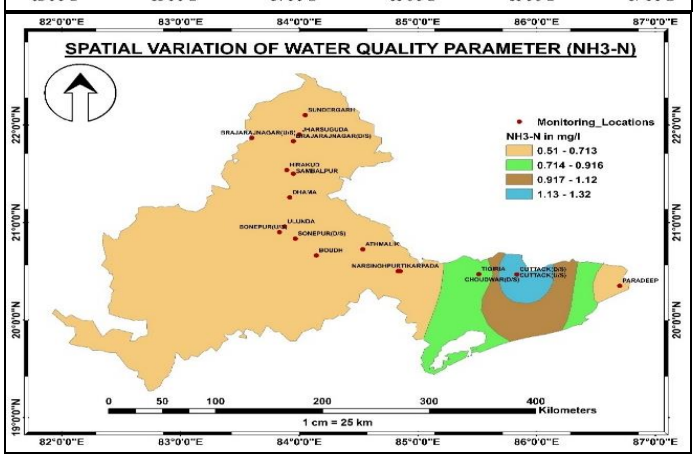

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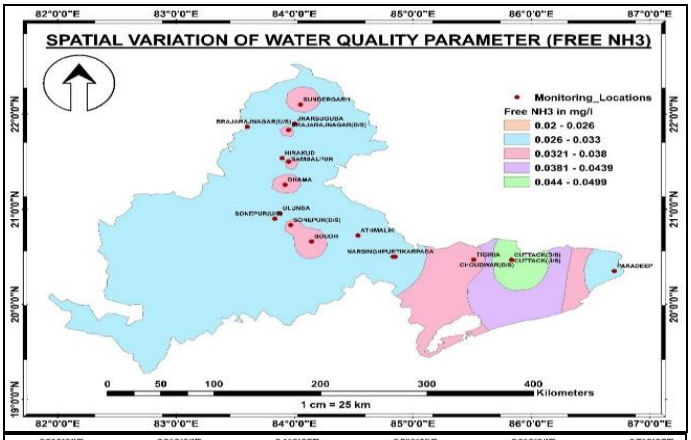

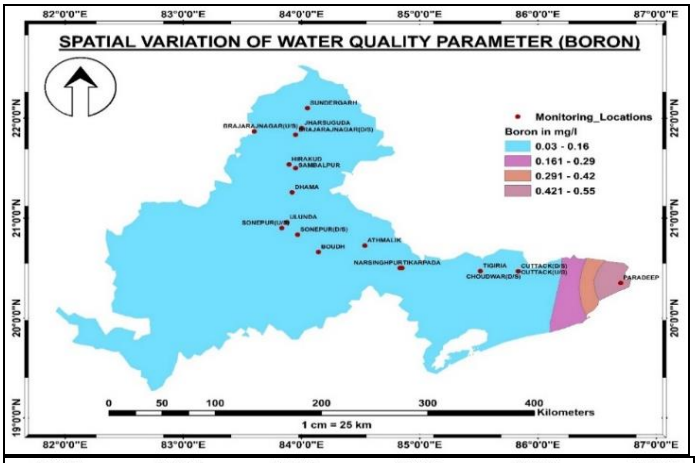

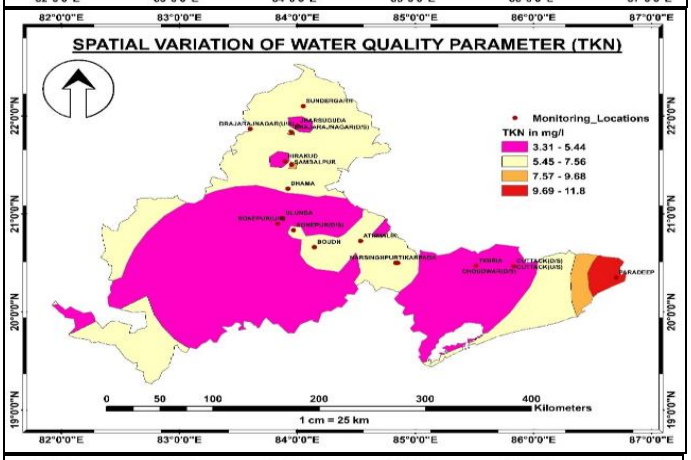

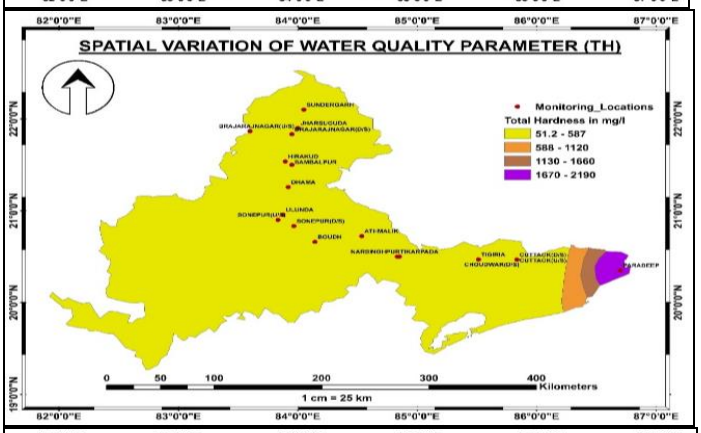

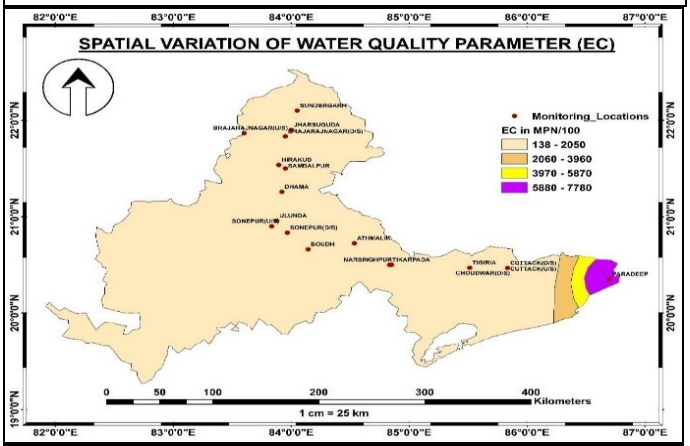

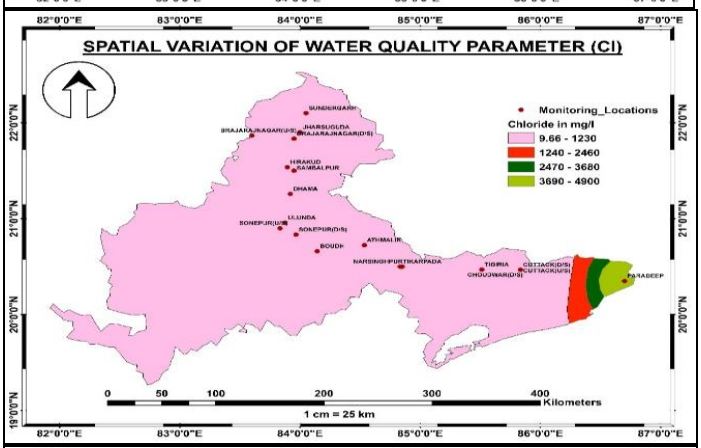

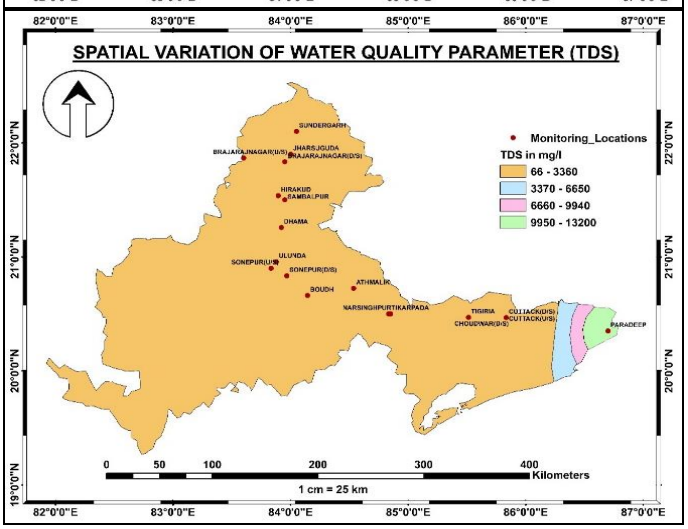

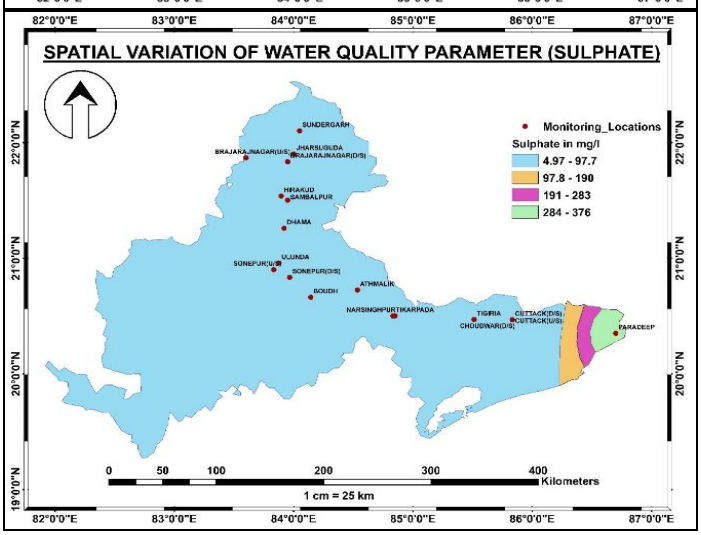

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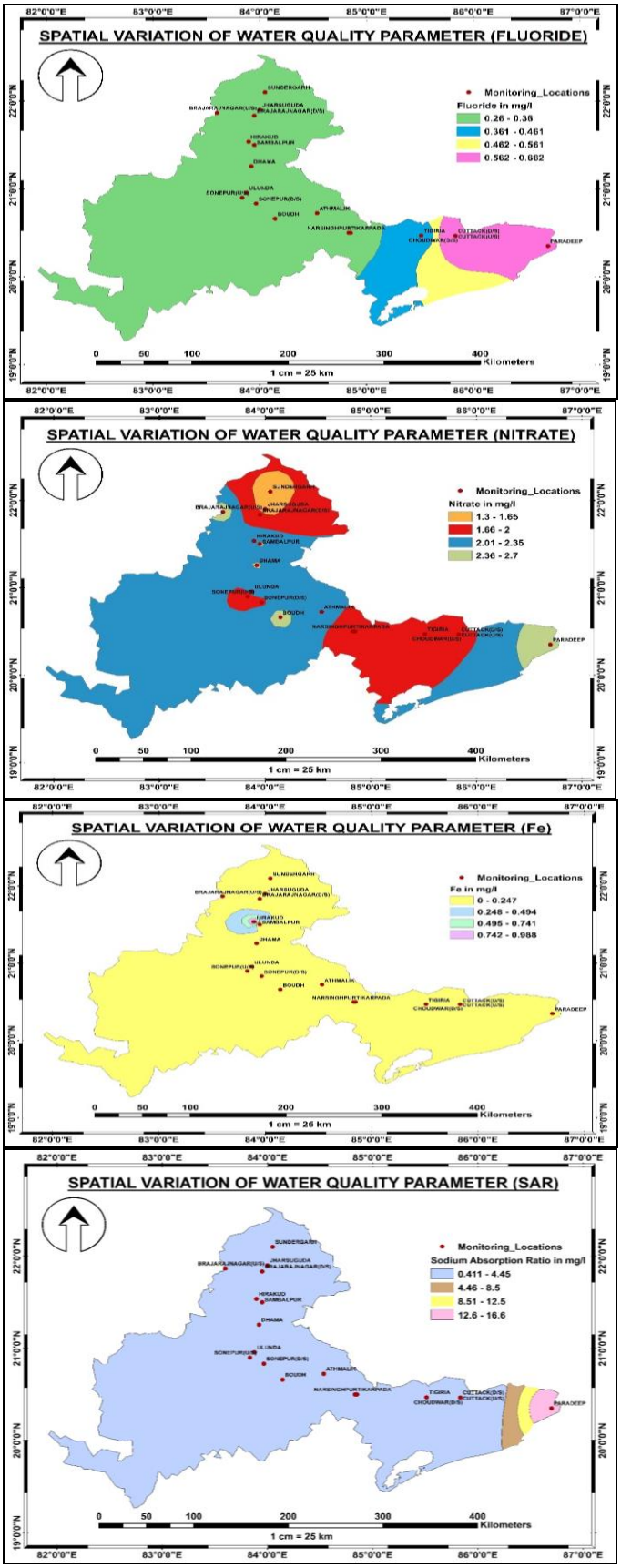

Figure 2. Spatial distribution maps of individual physicochemical parameters such as (pH, DO, BOD, TC, TSS, TA, COD, NH_3-N, Free NH_3, TKN, EC, TDS, B, TH, Cl-, SO_4^{2-}, F^-, NO_3^-, Fe^{++} and SAR)

5. Conclusion

The Mahanadi River's water quality and viability as drinking water were tested in this investigation. 19 collection sites have been identified, and 20 quality parameters were picked for annually analysis and verification, in order to ascertain the water quality. The outcome of the various physicochemical investigation show that the river water specimens have alkaline features. Due to local domestic sewage, larger DO values were reported downstream of city sewage water flows, demonstrating waste water contamination from both residential and governmental origins. As per the WHO's quality attributes of fewer than 5 mg/l, BOD was generally low. In case of TC, all of the stations are within the prescribed limits and fall into the Class C category, with the exception of Cuttack D/s, Paradeep D/s, and Chowdwar D/s, which have values more than 5000 and hence do not fall into the Class C. According to WHO guidelines, TSS, boron, COD, and TA are all within permissible ranges. The quantity of ammoniacal nitrogen and free ammonia will be less than 2 mg/l, thus according CPCB 2015. According to the report, all of the samples collected for both incidents are within the CPCB's required level. The TKN readings are higher than the acceptable limit of 3 mg/l ((CPCB 2015), all sampling locations are affected by organic contamination, lowering the water quality. Except for Paradeep, all of the samples studied had EC values that were within the acceptable range for drinking. Apart from Paradeep, all TDS readings in the observation group were well below the permissible limit for human consumption. All sites R1 to R19 are graded "excellent (sodium danger class S-I)" for agriculture (Sundaray et al 2009) and fall into the Class E group for SAR, according to Richard's classification. TH measurements are less than 300 mg/l, other than Paradeep, indicating that the hardness classification is “strong hard.” Increased sulfate intake through drinking water can cause diarrhea in humans, while excess magnesium in surface water has a laxative impact on the human system. Only one of the samples, Paradeep, exhibited levels higher than the acceptable limit. Fluoride levels in all tested water samples are still within allowed limits. Sites such as Paradeep, where iron removal plants should be installed prior to consumption. Because of the influx of residential and industrial wastes, as well as farming practices deposited across the river's banks, the Mahanadi River's water quality is in the Good to Poor category for consumption. The locations R1 to R7 and R10 to R19 have acceptable water quality, whereas Paradeep and Cuttack D/s have low water quality. In case of NPI, the most essential indicators/parameters that are accountable for contamination or polluting agents are DO, TC, TKN, TDS, TH, Cl, SO_4^{2-}, and F^-. The Mahanadi River's water is generally good, with few exceptions in urban areas and areas with limited mobility. Conservation, continuous monitoring and preventative administration strategies are required for the river. Future work will evaluate the water quality index

along the river by measuring more samples including the turbidity besides the measured samples in the current study.

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ISBN: 978-81-956748-3-1

DEVELOPMENT OF ECO-FRIENDLY LIGHTWEIGHT BRICK MANUFACTURING USING PAPER WASTE

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ABSTRACT

The construction industry is known to be one of the largest consumers of non-renewable resources. Concrete is one of the most widely used building materials in the world and it must continue to evolve to meet the growing needs of all its users. A new nature study estimates that the world has 3.04 trillion trees. Nearly 4 billion trees in the world are cut down each year to make paper. Widespread use of this waste paper as a brick production material will prevent the environmental impacts of this waste disposal. The main purpose of this study is to use waste paper as an alternative raw material. The purpose of this study is to determine the weight, compressive strength, water absorption capacity, hardness, etc. of paper concrete bricks using scrap paper grades to determine their usability as a building material. A mixed ratio of brick material is cement, sand, and shredded paper (1: 1:3, 1: 1:4, 1: 1:5). When using pulp with cement and sand, the weight of bricks is about 50% less than that of ordinary fired clay bricks. So, the paper concrete brick will greatly reduce the dead weight of the structure. Paper concrete bricks are lighter and relatively more economical and can be used for partitions and non-load-bearing walls.

Keywords: Light Weight Brick, Paper Waste, Papercrete, Paper Pulp

1. INTRODUCTION

Paper concrete is a fibrous cementitious compound made from scrap paper and Portland cement. These two ingredients are mixed with water to create a paper cement paste, which can then be poured into moulds, allowed to dry, and used as a durable building material. It should be noted that Paper Crete is a relatively new concept with limited scope. Paper concrete has three derivatives, namely fiber concrete, padobe, and fidobe. Fiber concrete is a mixture of paper, Portland cement, and water. In recent years, interest has returned to traditional building materials, especially those made from renewable or recycled materials, 'papercrete' is one of the materials that is attracting attention. the mind of the public. Paper concrete is a composite material consisting of Portland cement, shredded paper, water, and/or sand. The combination of these materials could provide a means of providing affordable housing on a large scale. It has been reported that Papercrete: is an expensive alternativebuilding material; has good sound absorption and heat insulation; is a lightweight and fireproof material. There are no toxic by-products or excess energy consumption in the production of paper concrete. Padobe does not have Portland cement. Here, instead of Portland cement, clay is the binder. It is a mixture of paper, water, and earth with clay. Fidobe is like Padobe, but it can contain other fibrous materials. This soil must have more than 30% clay content.

With ordinary bricks, if the clay content is too high, the bricks may crack during the drying process, but adding paper fibers to the soil mixture will strengthen the dry brick block. It provides flexibility that helps prevent cracking. The environmental impact of paper is huge, which has led to changes in the industry. With the use of modern technology, the logging of disposable paper has become a cheap commodity, resulting in a high level of consumption and waste. The production and use of paper have some adverse effects on the environment, known as paper pollution. Discarded paper is a major component. Considering this, a building material called mache was invented. Paper concrete is an innovative composite material developed for the construction of an ecological house using paper, cement, and water. It has been reported to be a cheap alternative building material, with good heat absorption and insulation, lightweight and fire resistance. The types of paper used for production are the ones that must be recycled. An exclusive recycling opportunity is to use scrap paper as a building material. Since the construction industry uses a largeamount of non-renewable resources, the potential function of scrap paper for the production of lightweight, low-cost composite bricks for construction not only offers the potential use of recycled waste paper. but also reduce demand. pressure on the world's natural resources.

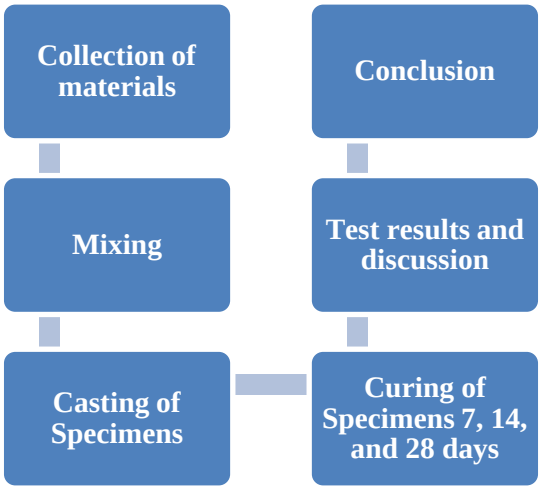

Fig 1: Methodology of the Process

2. LITERATURE STUDY

M. Manoj Kumar et. al., 2017 focus on using scrap such as waste paper and fly ash into cost-effective building bricks and recycling scrappaper without affecting the environment and society. The investigation was conducted to evaluate the strength, durability, and structural properties of fly ash paper concrete building bricks. The ingredients used to prepare the paper concrete mix are ordinary Portland cement (grade 53), fly ash, fine aggregate, coarse aggregate, paper, and water. The specific gravity of the cement fly ash is 2.3 and the weight percentage of water for the cement to produce a paste is 29%. Then, the cubes are molded and the drying method (air-dried) is applied. On the 18th day from the date of brick casting, the compression test was conducted. The thesis concludes that paper concrete bricks are relatively cheap, lighter, more flexible, and also more suitable for earthquake-prone areas. The bricks do not expand or contract, so glass panels or glass bricks can be wrapped and lined with paper concrete and can be used in interior partitions.

Isaac I. Akinwumi, et. al., 2014 determine the density, water absorption, compressive strength, and fire resistance of paper concrete produced from waste newspaper and office paper to determine its suitability for use as a building material. build. For each mixture of old newspaper and old office paper, the ratio of cement, sand, and old paper used were 1: 1:0.2, 1: 1: 0.4, 1: 1: 0.6, and 1: 1: 0.8. The cubes were created using a mixture of paper concrete and concrete that was cured for 7, 14, and 28 days, by immersion in water. The healing period is limited to 28 days. For each mixture ratio considered, the bulk density, water absorption, compressive strength, and fire resistance of paper concrete made with newsprint were found to be higher than those of paper concrete made with newsprint. by desk paper. The water absorption and fire resistance of concrete paper are high and increase as the waste paper content increases, while the bulk density and compressive strength of concrete paper are low and increase as the waste paper content increases. Paper concrete has been recommended as an effective and durable material for the production of lightweight, refractory solid or hollow blocks, used in the construction of bulkheads for buildings, especially tall buildings. Mixing ratios have been recommended for the production of hollow and solid blocks using paper concrete.

J S Sudarsan et. al., 2017 In the study, that waste paper was used as a partial replacement for concrete. The study is based on the potential of using lightweight composite bricks as building materials and the potential of using scrap paper for low-cost production. An experimental investigation was carried out to analyze the mix optimization for paper concrete bricks based on water absorption, compressive strength, and unit weight. Paper concrete bricks are produced from scrap paper and quarry dust with partial replacement of cement by another industrial by-product Fly ash in different proportions of 25%, 40%, and 55%. Properties such as mechanical strength, and standard quality comparable to conventional bricks through standardized tests such as hardness, strength, and fire resistance, and a cost-benefit analysis was performed. and research. The 230mm x 110mm x 80mm specimens were subjected to 7–28 days of air conditioning and sun exposure before testing them. The bricks are tested according to the procedure provided, note that the expansion is zero.

Bhupesh Pandey et. al., 2019 studied the use of scrap paper to produce lightweight and inexpensive concrete. The work is carried out in different stages using different mixtures. Different ratios of cement, fine aggregate, paper, and waterproofing admixtures have been reviewed and tested. Waste paper after collection is chopped to size 10 mm x 1 mm and soaked in water to make pulp. The pulp was added with the dry ingredients and manually mixed. Deflection test, compaction coefficient test, water absorption test, compression test, and structural test were carried out, and the deflection value (78mm and 83mm), compaction coefficient (0, 87 and 0.84), water absorption (12.13% and 14.37%) and check that the concrete block must be compacted and free of defects. In this study, they intend to make concrete by partially replacing cement with shredded paper to obtain economical and environmental concrete.

3. MATERIAL PROPERTIES

Materials which used to produce cement paper bricks are cement, fine aggregates, shredded paper, and

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water. Fine aggregate with a specific gravity of 2.65 and fineness of 4.66%. Several tests were performed on fine aggregates with a sieve analysis of 4.75 at less than 150 microns come under zone II grade ,53 cementgrade (ordinary portland cement) was the primary binder. In construction. material tests are carried out for cement having a specific gravity of 3.16 and a cement consistency of 6.5 mm from bottom and are performed with initial and final setting times of the cement. The cement was evaluated at an initial setting time of 27 min and a final setting time of (320) min and a cement fineness of 2946 cm2/g.

In this experiment, the main thingis that the collection of waste paper from several offices and factories will be dumped into the fields. Absorbent paper for 3-4 days then mix with fine aggregate and cement.

Table 1: Physical properties of fine aggregate

S.no	Test analysis	Experimental value
1	Fineness modulus	4.66 %
2	Specific gravity	2.65
3	Zone	II
4	Water absorption	1 %

Table 2: Test value of the cement

S.n	Test Analysis	Experimental Value
1	Specific gravity	3.16
2	Consistency	6 mm (from bottom)
3	Initial setting	27 (min)
4	Final setting	320 (min)
5	Fineness	2946 cm^2/gm.

Fig 2: Papercrete

Fig 3: Mix for the specimen

4. EXPERIMENTAL WORK

4.1COMPRESSIVE STRENGTH TEST

Pour 90x90x 190 mm test pieces for different mixing ratios. The cast bricks are kept for 7 and 14 days. The bricks were then tested in a 2000 kN compressor for 7 and 14 days. The compressive strength of concrete is determined according to the following formula

Compressive strength = P/A

4.2 WEIGHT TEST

The weights of ordinary fired clay bricks and the weights of paper concrete bricks are compared below the table. All bricks are weighed in an electronic balance in good condition.

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4.3 WATER ABSORPTION TEST

A water absorption test is required to check if the tile is suitable for waterlogged areas. According to article 7.2 of IS 1077:1992, brick, after soaking in cold water for 24 hours, water absorption should not exceed 20% of dry weight for grade 12.5, and for the grade above 12.5, water absorption must be between 12.5 and 15%.

4.4 HARDNESS TEST

A good brick needs to be scratch resistant against sharp objects. So, for this test, a sharp instrument or fingernail is used to make a scratch on the tile. If there are no scratches on the tile, it is said to be a hard brick. In this test, a scratch is made on the surface of the tile. While scratches are made using nails on the brick, a very small impression will be left on the surface of the fiber concrete brick. Therefore, this test indicates that the fibrous concrete brick is sufficiently stiff.

4.5 SOUNDNESS TEST

The soundness test of bricks shows the nature of bricks against sudden impact. In this test, 2 bricks are chosen randomly and stuck with one another. The sound produced should be a clear bell ringing sound and brick should not break. Then it is said to be good brick. In this test, two bricks were taken and they were stuck with each other. The bricks do not break and produce a clear reverberation sound. So bricks can be used safely.

4.6 SHEAR BOND STRENGTH

A three-brick assembly is used to obtain the shear bond strength of the brick mortar joints. The bottom two bricks of the triplet are rested on the bottom platform of the testing machine while the middle brick is not restrained against any movement. The vertical load is applied to the middle brick so as to impart shear force to brick-mortar interface at the joint.

5. RESULT AND DISCUSSION

5.1 COMPRESSIVE STRENGTH TEST

Table 3: Comparison with the Conventional brick and Mix ratio of strength test

S. No	Mix Ratio	Curing Days Of	Load (kN)	Compressive Strength
1	Conventio	-	167.92	9.82
2	1:1:3	7	69.68	4.07
		14	143.64	8.4
		28	195.28	11.42
3	1:1:4	7	91.26	5.34
		14	167.07	9.77
		28	266.25	15.57
4	1:1:5	7	49.25	2.88
		14	94.39	5.52
		28	175.79	10.28

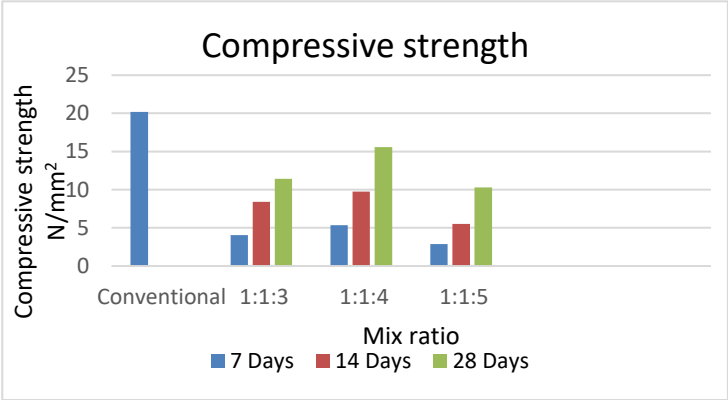

Fig 4: Compressive strength of a brick

5.2 WEIGHT TEST

Table 4: Different Mix Ratio with conventional brick weight test

S.no	Mix Ratio	No of days of curing	Weight (kg)
1	Conventional	-	3.15
2	1:1:3	7	2.25
		14	1.78
		28	1.56
3	1:1:4	7	2.01
		14	1.68
		28	1.41
4	1:1:5	7	1.83
		14	1.36
		28	1.23

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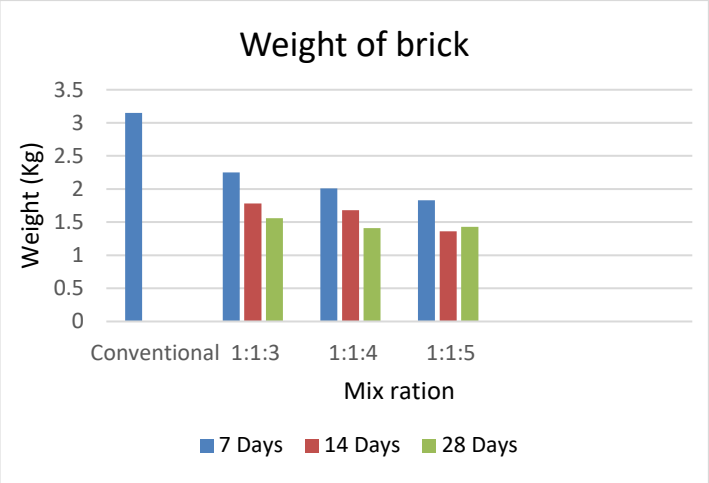

Fig 5: weight result with conventional brick and mix ratio

5.3 WATER ABSORPTION TEST

Table 5: Water Absorption test with different ratio with conventional brick

S.no	Mix Ratio	Curing Days Of	Dry Weight	Wet Weight	Water Absorption
1	Conventional	-	3.15	3.69	17.14
2	1:1:3	7	2.25	2.77	23.50
		14	1.78	2.22	24.93
		28	1.56	1.97	26.37
3	1:1:4	7	2.01	2.52	25.81
		14	1.68	2.15	28.03
		28	1.41	1.84	30.67
4	1:1:5	7	1.83	2.34	27.95
		14	1.36	1.78	31.07
		28	1.23	1.64	33.86

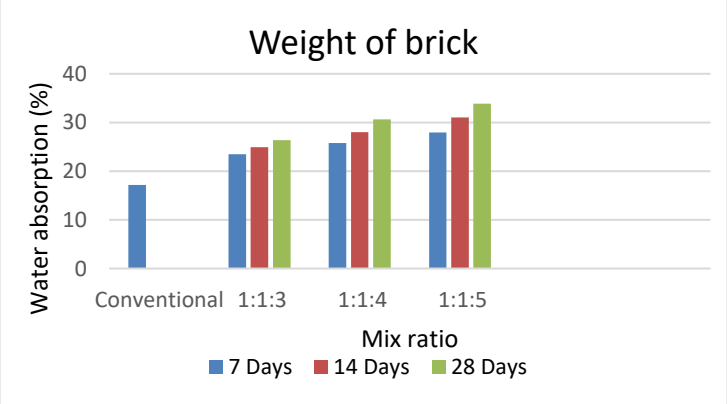

Fig 6: Water absorption of a mixed specimen with the weight result

5.4 Shear bond strength

Table 6: Shear bond strength with mixed specimen ratio

S.no	Mix Ratio	Curing Days Of	Load (kN)	Compressive Strength (N/mm^2)
1	Conventional	-	5.85	0.25
2	1:1:3	28	10.062	0.43
3	1:1:4	28	12.402	0.53
4	1:1:5	28	7.254	0.31

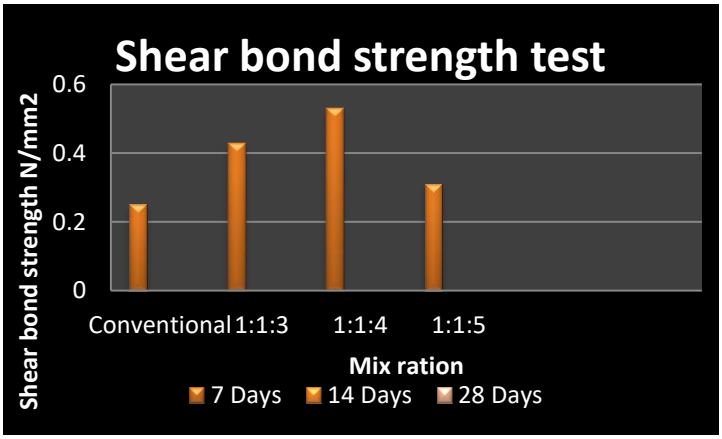

Fig 7: Shear bond strength result

6. CONCLUSION

- Regarding the compressive strength above, the results obtained in the compression test show that the paper concrete bricks are only acceptable for non-load bearing walls.
- Judging by the weight test above, paper concrete bricks are 1/3 to 2/5 smaller than ordinary fired clay bricks. Due to the lower weight of paper concrete bricks, the total dead load of the building will be reduced.
- Due to their less weight and greater flexibility, these bricks are potentially ideal materials for earthquake-proneareas.
- Considering the above water absorption test, the water resistance of paper concrete bricks is more than 20%, so it is not suitable for waterproofing and exterior wall. However,

by providing a waterproof coating (silicone-based waterproofing), it can also be used as an exterior wall.

- These bricks do not expand or contract, so glass panels or glass blocks can be mounted and lined with paper concrete.

- The above tests clearly show that paper concrete is capable of providing a lightweight, environmentally friendly concrete block with less use of natural resources.

- In addition, the production cost of paper bricks is much lower than that of ordinary bricks.

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ISBN: 978-81-956748-3-1

ENVIRONMENTAL AND SOCIAL IMPACTS: A CASE STUDY OF CHENNAI METRO

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Abstract—The Environmental Impact Assessment (EIA) is a tool with the aim to identify, predict, evaluate, and prevent the impacts of a project on the environment. CMRL Phase II project totaling 118.9 km involves 3 corridors - C3, C4 and C5. For this study, C4 of Chennai Metro Rail Phase-II stretches from Lighthouse to Poonamallee Bypass that accounts to 26.1 km consisting of 30 stations with a maintenance depot. Corridor 4 overall is expected to generate environmental and socioeconomic benefits in terms of decreasing air pollution from traffic congestion and serving the growing travel demand. Universal accessibility has been reflected in the design following international best practices. Green building features like rainwater harvesting, solar energy panels at elevated stations' roofs, energy efficient air conditioning and lighting will be considered in station design. Identification of negative and positive impacts arising from pre-construction, construction and operation are done through both direct and online survey across the proposed route of C4.

Based on detailed assessment of the potential impact due project location and design, construction and operation, for each of these adverse impacts, mitigation measures have been proposed. The impacts include both temporary as well as permanent effects. Thus the proposed mitigation measures and impact management helps to reduce the adverse effects on the environment as well as on people and further making the project more sustainable and economical.

Keywords—EIA; Metro; Environmental; Chennai; Sustainable

I. INTRODUCTION

This Chennai Metropolitan Area (CMA) comprises the City of Chennai, 16 Municipalities, 20 Town Panchayat and 214 Village Panchayat in 10 Panchayat Unions. As per Census 2011, the population of CMA and City area is 89.2 Lakh and 46.8 Lakh respectively. Large-scale urbanization in IT/ITES and industrialization with rapid growth of vehicular population has laid severe stress on urban transport system in City.

The Phase-I of Chennai Metro covers 54 km in 2 corridors - Washermenpet to Airport, Chennai Central to St. Thomas Mount including an extension of Phase-I, from Washermenpet to WIMCO Nagar. With a view of developing effective and efficient mass transit system in addition to the existing public transportation and Phase-I Metro rail system, CMRL proposed to build Metro Rail Phase-II Corridors for 118.9 km covering 3 corridors - C3, C4 and C5.

TABLE I. CORRIDORS DETAIL IN CHENNAI METRO RAIL (PHASE II)

Corridors	Length	No of stations
C3- Madhavaram to SIPCOT	45.8	50
C4- Lighthouse to Poonamallee Bypass	26.1	30
C5- Madhavaram to Sholinganallur	47.0	48
Total	**118.9**	**128**

a. Source: Detailed Project Report, Chennai Metro Rail

II. ENVIRONMENTAL IMPACT ASSESSMENT

The infrastructure projects are important for development of a nation. However, most of the infrastructure projects on account of their sheer size and nature are invariably accompanied by significant environmental and social impacts during different phases of the project. The nature of these impacts could be either positive/negative, depending upon the surrounding environment and also the resident community.

EIA is a process, which ensures if all environmental matters are taken into account quite early in the project at planning process itself. It takes into consideration not only technical and economic considerations but also, traditional aspects like impact on local people, biodiversity etc. C4 of Chennai Metro Rail Phase-II stretches from Lighthouse to Poonamallee Bypass, that accounts to 26.1 km across the city to do Environmental Impact Assessment is considered for this study.

III. OBJECTIVES OF THE STUDY

The main objectives of the study are:

i. To study the major environmental and social impacts associated with Metro Phase II construction and operational activities in Chennai.

ii. To prepare a stated questionnaire to assess possible impacts due to the Metro Rail Phase-II Construction process.

iii. To identify feasible methods to minimize the impacts through impact assessment and impact management.

ISBN: 978-81-956748-3-1

IV. METHODOLOGY

A. Literature Review

Provided a handy guide to understand the Environmental Impact Assessment. This guided as an overview for the previously published works done on a this specific genre.

B. Screening and Scoping

Screening is the process of determining if environmental impact assessment is required. Since the cost of the project is more than 100 crore, that is about 70,000 crore, the impact assessment is required one as per Indian regulation.

C. Identification of Attributes for Questionnaire

Involves surveying targeted people, about vast range of problems they faced due to Metro Rail Construction. The various attributes, inclusive with the questionnaire related for this study are to be identified.

D. Preparation of Survey Questionnaire

The questionnaire is to be prepared based on the attributes that are identified during earlier studies.

E. Conducting the Survey

The survey is to be conducted in and around the Corridor 4 stretch. The questionnaire is to be filled based on their feedback about the environmental and social impact that they have faced or predict to be faced.

F. Analyzing the Data

The data collected in the survey will be analyzed and some ideas and suggestions are made in view of these results.

G. Recommendations

Recommendation of the possible mitigation and impact management plans through the survey.

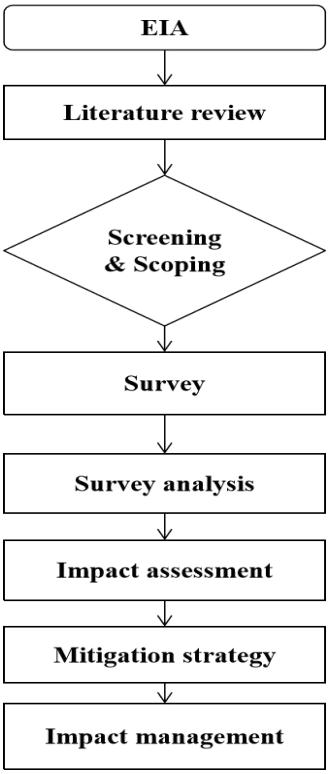


Fig 1. Overview of Methodology

V. REVIEW OF LITERATURE

Literature reviews proved a handy guide to comprehend the Environmental Impact Assessment. This acts as an overview of the previously published works on this specific topic. Provided several basic steps for conducting a survey, for determining aim/goal, conducting background work, determining level of complication of the questions, determining target for the survey and determining the time to undertake survey.

Moreover, it has given an idea about various environmental impact studies of different metropolitan cities.

A. Critical Issues Related to Metro Rail Projects in India

This journal discusses the development of Delhi metro corridors and the issues associated with it. This study helps us to know about the critical issues Delhi metro rail faced and also about the environmental impacts of it. It gives a brief idea about land acquisition and the Resettlement & Rehabilitation processes of the project .[1]

B. Dallas Area Rapid Transit Impact Study (DART)

This journal provides a strategy and a schedule for measuring changes in land use and development in the Dallas area due to the DART system. Helped to understand various methodologies for land use analysis. Also shows the development impacts before and after the transit system.[2]

C. A Study On Effect Of CMRL Routing System And Future Growth

This journal focuses on the future growth of CMRL along with parallel change in people's lifestyle and the ways to enhance the transit's reliability and safety. Also the factors which impact the growth of area before and after the project. This gives us an idea on positive impacts of metro and also several negative impacts like deforestation, water resources depletion etc,. [3]

D. MRTS, Guidelines for Noise and Vibrations, RDSO

This document lays guidelines for noise reference levels, vibration impact criteria, noise and vibration mitigation measures to reduce excessive noise and vibration caused by metro railway projects .This study makes us to understand about the importance of impacts caused by noise and vibrations since many such project may arise in future.[4]

E. Environmental Impact Assessment of Phase-2 Corridors of Delhi Metro

Provides brief analysis of Delhi Metro Environmental Impact, both positive and negative impacts including the environmental management plan. This gives an idea about the severity and areas of impacts to be studied for Chennai metro rail and the extent of it's impact on environment and society.[5]

F. Chennai Metro turns off AC in trains due to city's water crisis

The Chennai Metro Rail, which reportedly guzzles 9,000 liters of water a day has begun turning off air-conditioning in an effort to deal with the water crisis.

G. Metro only an added advantage:Residents

Increased the rent from Rs.15,000 to Rs. 17,000 since the residence is located just minutes away from the bus stop and

ISBN: 978-81-956748-3-1

Metro Rail station. Also easy access to public transport and are able to save money and time.

H. All is not well with Chennai Metro Rail

The `20,000-crore Chennai Metro Rail project has been ridden with technical glitches, internal problems, and incomplete works in underground and elevated stretches.

VI. IMPACT ASSESSMENT THROUGH SURVEYING

A. *Survey*

To know the impacts of both pre-construction and post-construction phase of metro construction, survey was taken from Lighthouse to Poonamallee stretch. Due to the pandemic situation, both in-person survey and online survey were considered efficient.

In-Person Survey: A questionnaire was prepared, including questions about personal details, opinion on metro construction, difficulties or problems faced and suggestions. Surveying was undertaken near Porur-Chennai Bypass crossing and SRMC Hospital construction sites and targeted at a wide age group of people.

Online Survey: A Google form was created for online surveying and with help of acquaintances residing along the corridor 4 stretch, circulated the Google form among their family and neighbors to collect data

VII. DATA ANALYSIS

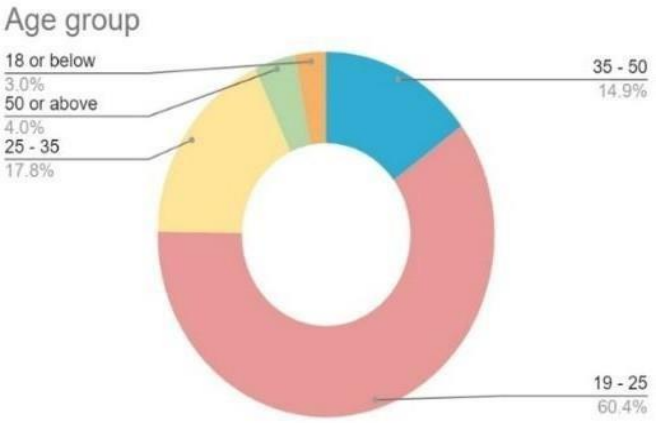


Fig. 2. Age Distribution chart

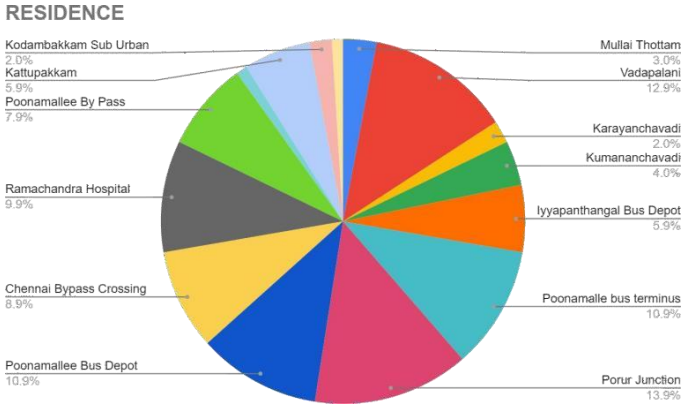


Fig. 3. Locality

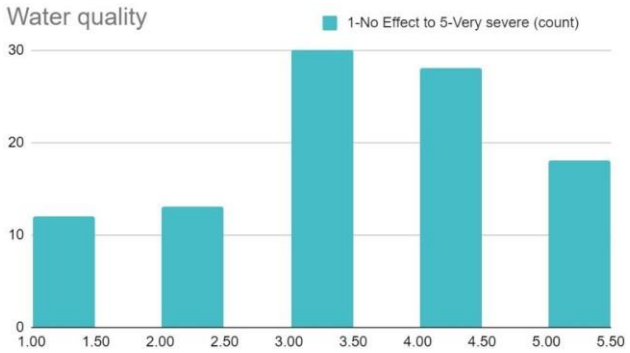
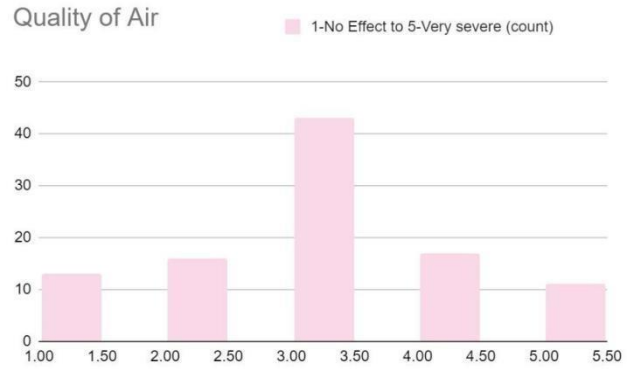


Fig. 6 Effects on water quality



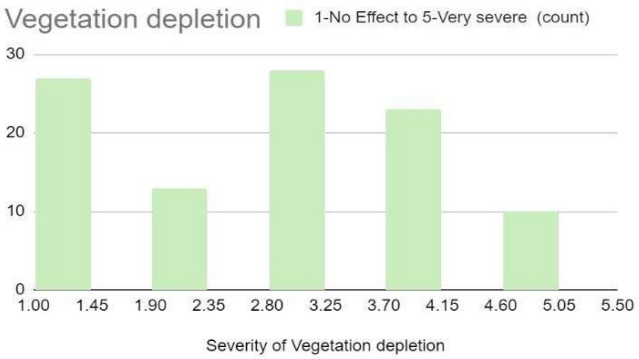


Fig. 6 Effects on Vegetation depletion

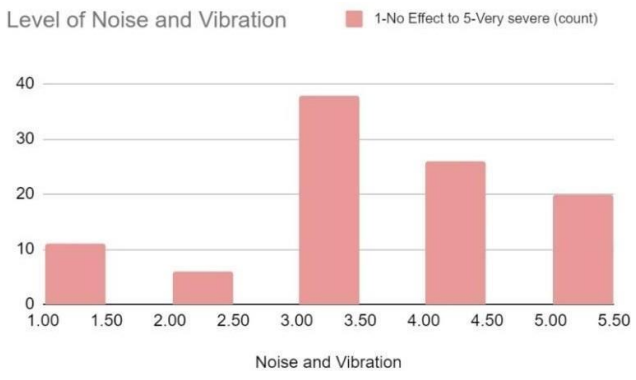


Fig. 7. Effects on Noise & Vibration

ISBN: 978-81-956748-3-1

Fig. 8. Effects on Traffic

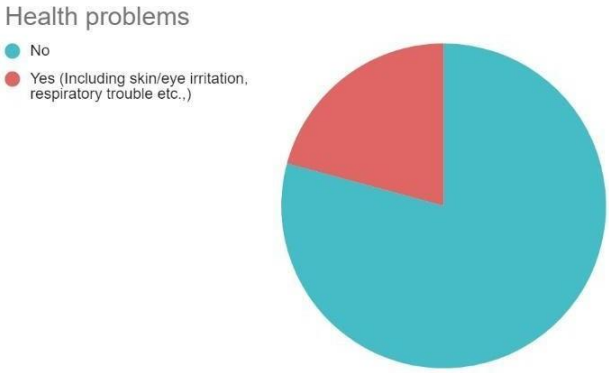


Fig.9. Effects on health conditions

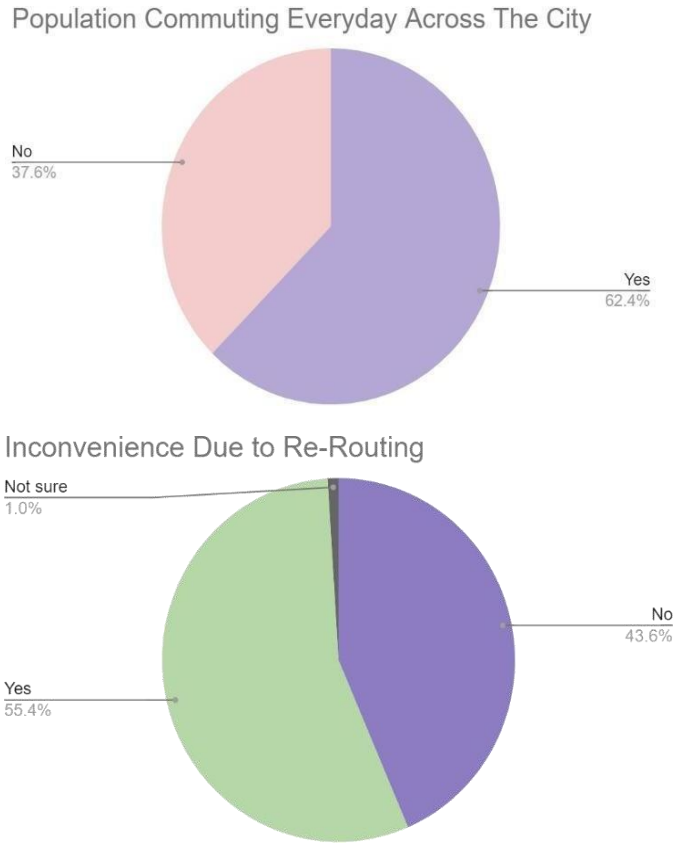


Fig. 10(a) & 10(b). Effects of Re-routing

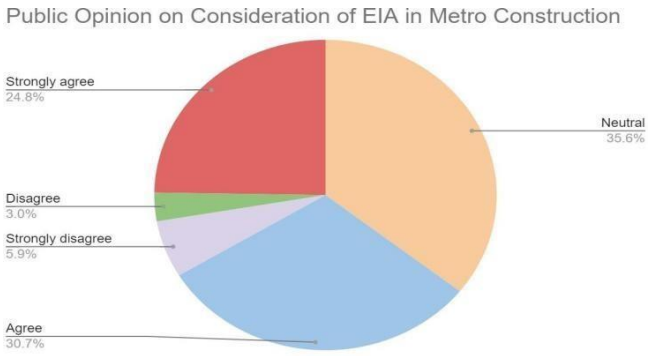


Fig. 11. Public opinion towards EIA consideration in Metro construction

VIII.IMPACT ASSESSMENT

The traffic condition near SRMC Hospital is shown in Fig. 12. Thus, some people are driving their bicycles in the footpath also due to heavy traffic, which may cause interference with the pedestrians and passengers at open bus stops. Other issues faced by the public has also been surveyed. Most of them are facing issues due to improper road condition, drainage facilities, reduced road width which cause heavy traffic congestion

Fig.12. Traffic condition near SRMC Hospital

Fig. 13. Road condition

└.

IX. SUGGESTED MITIGATION MEASURES

As the Impact assessment done for the case study of Chennai metro Phase-II construction leads to few additional suggestions in mitigation measures through survey as well as from errors in the previous projects, a few measures are suggested as follows:

A. Lack of employees during operation

Smooth functioning of metro requires labour and man power, for operation and maintenance which has to be studied and analyzed beforehand to avoid unnecessary energy wastage. So needed to start recruitment process at the early stage of completion of the project (Reference 1)

B. Lack of skilled and trained employees

Special training facilities can be provided to employees with good pay scale for the successful processing of the project. This can effectively reduce technical faults in construction, operation and maintenance works.

C. Avoiding litigation

Ignorance of people plays a main role in such cases. Clear norms and regulations should be set in place to provide knowledge and to create awareness among people about the project and property rights to avoid chaos among property holders.

D. Pacifying aggrieved land owners

Organizing meetings and giving proper compensation at the right time to pacify land owners helps in avoiding unwanted intervention in the project.

E. Leaking roof

Phase-1 construction has shown some leakage of roofs at a few terminals. More preference can be given towards maintenance as well as adequate measures such as grouting.

F. Loss of trees

Deforestation in the construction area leads to loss of biodiversity and depletion of Oxygen. So, plantation of saplings in and around the locality can be implemented to maintain ecological balance in the particular zone.

G. Traffic Congestion

i. Based on conducted survey, temporary increase in public transport frequency can be done in the congested areas.
ii. Altering work hours in the congested zones to prevent peak hour traffic.
iii. Re-Routing plan can be implemented as follows for Porur CBC Station.

X. IMPACT MANAGEMENT

The environmental issues likely to develop during project construction and operation phases, could be minimized by making necessary provisions in the project design and adopting Impact Management Techniques. Among various impacts stated, Traffic congestion seems to be a great hindrance. Thus an alternate route as traffic management plan is suggested.

A. Traffic Diversion Plan

During construction traffic flow is disturbed, thus the need to keep the flow of traffic as efficient as possible through appropriate diversions, such as road widening, traffic segregation, one way movement, traffic diversion on influence are road, and utilization of service roads for traffic. The encroachment on the roadside are to be removed. In addition, an alternative traffic diversion plan is recommended.

B. Existing Route

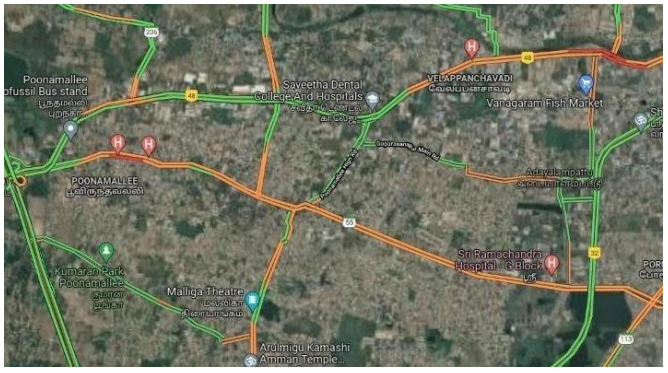


Fig.14. Typical Traffic on aWeek Day at 8.15 AM

From the survey conducted, it is clear that the existingroute, from Poonamallee Bypass to Chennai Bypass Crossing, along whichthe Phase II Metro rail is under construction suffers a serious traffic congestion, especially during peak hours. As a possible mitigation to

this condition, an alternative route of traffic diversion is suggested.

Fig 15. Typical Traffic ona Week Day at 4.15 PM

C. Proposed Traffic Plan

The suggested route stretches from Poonamallee Bypass along NH 45,through Porur Link Road reaching Chennai Bypass Crossing.

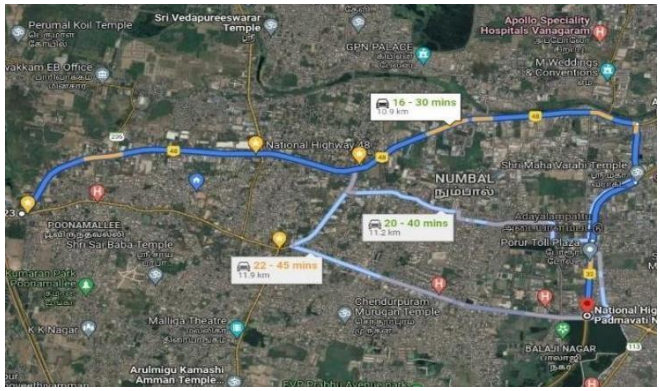


Fig. 16. Suggested route: Poonamallee-NH48 - Porur Link road - Porur

Fig. 17. Intersection of Diverted Route With Actual route

D. Expected Outcome of Diversion

The suggested route allows for multiple entry points along its course, thereby permitting a wide range of routes for mixed traffic flow. i.e., For instance,50% of public transport that is destined to reach the CBC (Porur) can be diverted through NH 45, for a faster and efficient trip, while the other traffic users who travel to and from intermediate points can make use of the SH-55, thereby reducing the traffic load in this congested lane. This diversion can be efficient as SH 55 has an exit point that leads to NH45 and allows a combination of routes to choose from.

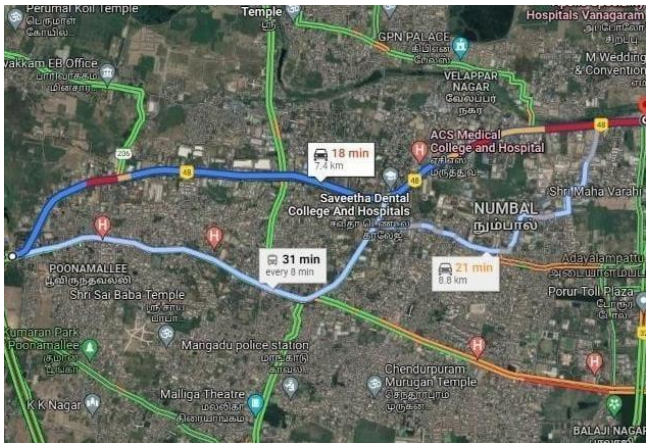


Fig. 18. Diverted Route

The routes NH45 and SH55 are connected by various link roads, of which the Porur Link road can prove efficient for an exit from NH45 to reach the CBC as shown in fig.19.

Fig. 19 Porur Link Road

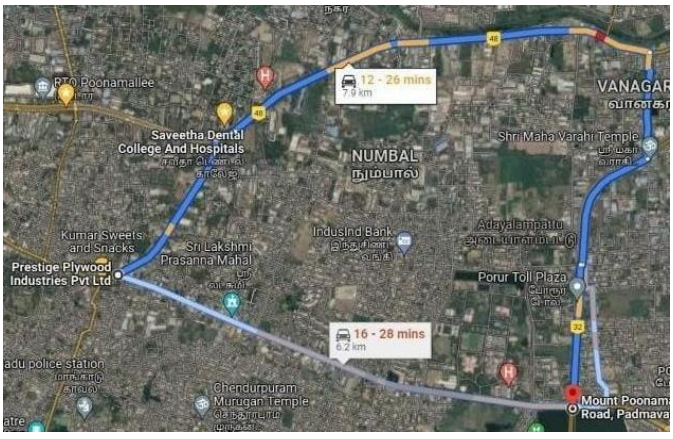


Fig. 20 Comparison of Both Routes

Although the suggested route is longer than that of the original route by 3 km, it is the faster of the two routes due to the heavy trafficcongestion caused by the narrowing of the roads by Metro Phase II Construction.

XI. CONCLUSION

From this study, the following conclusions were arrived.

i. From survey results, it is concluded that due to metro construction, the effect on water quality and air quality is moderate.
ii. The severity of Vegetation depletion, Noise and Vibration affects are also found to be moderate.
iii. Other issues faced by the public are also surveyed. Most prominent of the issues are improper road condition, drainage facilities, reduced road width which causes heavy traffic congestion, especially during peak hours.
iv. Impact of traffic congestion has more severe effect on people as well as on environment.
v. Also positive impacts such as increase in use of public transport, raise in property rate, urban development, employment opportunities, etc have also been forecast during the survey.
vi. Data obtained from survey was analyzed and the severity of the impacts were assessed and feasible mitigation strategies are recommended.
vii. The most severe of the impacts was found to be Traffic congestion in the vicinity of Phase II Corridor 4 Construction site and suitable Traffic diversion plan for the same is suggested.

ACKNOWLEDGMENT

Author expresses their profound gratitude to the travelers those who spare their valuable time in completing the survey successfully. Also, authors are indebted to Sri Venkateswara College of Engineering (SVCE), Sriperumbudur (India) for supporting their project work and providing all the necessary facilities.

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ISBN: 978-81-956748-3-1

ANNEXURE I

SRI VENKATESWARA COLLEGE OF ENGINEERING
Environmental and Social Impacts of Metro Construction : SURVEY
QUESTIONNAIRE FOR METRO CONSTRUCTION

1. IDENTIFICATION

Name:
Gender: M / F / Other Age:
Address:

Occupation: Employed Unemployed Self-employed Student Other(specify:_____)

2. IMPACTS:

S.No	Impacts	Adverse	Moderate	Minor effect	No effect	Favourable effects
1.	Noise					
2.	Vibration					
3.	Vegetation depletion					
4.	Air pollution					
5.	Water quality					
6.	Other issues, please specify:					

(Please tick in the relevant box)

3. Is there any **development** within 1 km of metro construction? If yes, suggest any :

4. Any **prevention** taken to resolve the environment impacts? Suggest few convenient measures:

5. Have you faced any **health problems** during/after the construction?
   - □ Skin disease
   - □ Eye irritation
   - □ Respiratory problems
   - □ Others
   - □ No problem

6. **ANY LOSS SUFFERED:**
   - □ Losing entire house
   - □ Losing a part of the house
   - □ Losing shop/commercial buildings
   - □ Losing land
   - □ Other:

7. Received any **compensation** from the government due to resettlement? Yes, No
   Comments:

8. How will metro influence your **choice of transport mode**?

9. Your thoughts towards **consideration of environmental impacts** in metro construction:

10. Any other **comments** on metro construction:

ISBN: 978-81-956748-3-1

SMART TRAFFIC CONTROL SYSTEM ROAD INTERSECTION (BASED ON ULTRASONIC SENSOR)

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ABSTRACT

There are many problems occurred with the conventional traffic light controller and countdown timers. One of them is heavy traffic jammed where there has not been any realization on how to measure the level of this jammed thus pounder on the solution especially using time delay. Another problem with conventional traffic light is when there is no traffic, but the waiting still continous. In this study we introduced actuated signal system which overcome problems of pre-timed signal system. Actuated signal system use detector to count traffic volume respond to traffic signal light. In this study we highlight fully actuated signal system their advantages, disadvantages & basic principle. Through this study we concluded that fully actuated signal system is suitable for equal traffic volume & variable density. According study, fully actuated signal system not suitable for Indian traffic system. generally, in India adaptive traffic system is adopted.

Key words: Pre-time signal system, actuated signal system, fully actuated signal system, threshold, adaptive traffic control system.

1. INTRODUCTION

In today's challenging life, transportation has evolved to an important aspect in human's activities day by day. The increasing number of vehicles on the road shows an economic growth of any country. However, intersection also has caused traffic congestion and road accidents thus becoming more difficult to control. Apart from traffic light, which might not be useful enough in controlling traffic efficiently, there is no current technology up to date that proved to control situations such as availability of vehicles at a certain lane compared toother lane making hat certain lane crowded eventually. There are many problems occurred with the conventional traffic light controller and countdown timers. One of them is heavy traffic jammed where there has not been any realization on how to measure the level of this jammed thus pounder on the solution especially using time delay. Another problem with conventional traffic lights is when there is no traffic, but the waiting still happened as the road users increased thus leading to slower speeds, longer trip times, and increased queuing time. Now-a-days, controlling traffic congestion relies on having an efficient and wellmanaged traffic signal control policy. Traffic signals operate in either pre-timed or actuated mode or some combination of the two. Pre-timed control consists of a series of intervals that are fixed in duration. They repeat a preset constant cycle. In contrast to pre-timed signals, actuated signals have the capability to respond to the presence of vehicles or pedestrians at the intersection. Actuated control consists of intervals that are called and extended in response to vehicle detectors. The controllers are capable of not only varying the cycle length & green times in response to detector actuation, but of altering the order and sequence of phases. Adaptive or area traffic control systems (ATCS) belong to the latest generation of signalized intersection control. ATCS continuously detect vehicular traffic volume, compute optimal signal timings based on this detected volume and simultaneously implement them. Reacting to these volume variations generally results in reduced delays, shorter queues and decreased travel times. Coordinating traffic signals along a single route so that vehicles get progressive green signal at each junction is another important aspect of ATCS. In the subsequent pages, the operating principles and features of Vehicle-Actuated Signals & Area Traffic Control Systems will be briefly discussed. Demerits of the current system: 1.)

The presence of a fixed time period of signal operation irrespective of the lack Of comparison of the vehicle densities in the different parts of the road at a junction. 2.) Even if the road is empty and lacks the presence of vehicles, still receives a fixed time period of green signal which is of no use. 3.) This can lead to a large levels of traffic congestion since there is no uniform flow of vehicles from all the roads at the junction. 4.) Human irritability increases and this can be one of the main reasons for some of the traffic violations such as jumping signals, over speeding, etc. Proposed traffic control system: The main aim of the proposed system is to constantly monitor the

vehicle density present in all parts of the road at the junction. The basic flow of operation is as follows: collection of vehicle density data from the roads; next is to send the same data to the device which compares the same and arrives at a particular characteristic output pattern; then the execution of the output pattern which is reflected in the signal pattern. In this model, the IR sensors are used to detect the presence of any vehicle in that part of the road. When detected it sends a triggered output to Arduino UNO which is the heart of the project. Then Arduino analyses the number of such triggered outputs from the set of sensors placed in the different roads at the junction and correspondingly triggers the different LED lights in the signals in order to felicitate the vehicle movement .

1. Pre-timed Control

Pre-timed control is ideally suited to closely spaced intersections where traffic volumes and patterns are consistent on a daily or day-of-week basis. Such conditions are often found in downtown areas. They are also better suited to intersections where three or fewer phases are needed (3). Pre-timed control has several advantages. For example, it can be used to provide efficient coordination with adjacent pre-timed signals, since both the start and end of green are predictable. Also, it does not require detectors, thus making its operation immune to problems associated with detector failure. Finally, it requires a minimum amount of training to set up and maintain. On the other hand, pre-timed control cannot compensate for unplanned fluctual in traffic flows, and it tends to be inefficient at isolated intersections where traffic arrivals are random. Modern traffic signal controllers do not explicitly support signal timing for pre-timed operation, because they are designed for actuated operation. Nevertheless, pre-timed operations can be achieved by specifying a maximum green setting that is equal to the desired pre-timed green interval and invoking the maximum vehicle recall parameter described below.

2. ACTUATED SIGNAL SYSTEM

In contrast to pre-timed signals, actuated signals have the capability to respond to the presence of vehicles or pedestrians at the intersection. Actuated control consists of intervals that are called and extended in response to vehicle detectors. Basic Principles As stated earlier, Vehicle- Actuated Signals require actuation by a vehicle on one or more approaches in order for certain phases or traffic movements to be serviced. They are equipped with detectors and the necessary control logic to respond to the demands placed on them. Vehicle-actuated control uses information on current demands and operations, obtained from detectors within the intersection, to alter one or more aspects of the signal timing on a cycle-by cycle basis. Timing of the signals is controlled by traffic demand. Actuated controllers may be programmed to accommodate: • Variable phase sequences (e.g., optional protected LT phases) • Variable green times for each phase • Variable cycle length, caused by variable green times Such variability allows the signal to allocate green time based on current demands and operations. A proper clearance interval between the green & the red phases is also ensured. Advantages of Actuated Signals The various advantages of actuated signals are stated below: • They can reduce delay (if properly timed). • They are adaptable to short-term fluctuations in traffic flow. • Usually increase capacity (by continually reapportioning green time). • Provide continuous operation under low volume conditions. • Especially effective at multiple phase intersections. Disadvantages of Actuated Signals The main disadvantages are as following: • If traffic demand pattern is very regular, the extra benefit of adding local actuation is minimal, perhaps non-existent. • Installation cost is two to three times the cost of a pre-timed signal installation. • Actuated controllers are much more complicated than pre- timed controllers, increasing maintenance costs. • They require careful inspection & maintenance to ensure proper operation. Types of Actuated Control There are three basic types of actuated control, each using signal controllers that are somewhat different in their design: Semi-Actuated Control Full-Actuated Control Volume-Density Control 1) Semi-Actuated Control This type of controller is used at intersections where a major street having relatively uniform flow is crossed by a minor street with low volumes. Detectors are placed only on the minor street. The green is on the major street at all times unless a call on the side street is noted. The number and duration of side-street green is limited by the signal timing and can be restricted to times that do not interfere with progressive signal-timing patterns along the major street. Principles • Detectors on minor approaches only. • Major phase receives a minimum green interval. • The green remains on the main street until a call for service on the side street is registered. • If the main street has had enough green, the side street is given the green for just enough time to guarantee that its vehicles are processed. • Usually Point Detectors are used. • Detectors can be placed at either stop line or upstream location. Advantages • It can be used effectively in a coordinated signal system. • Relative to pre-timed control, it reduces the delay incurred by the major-road through movements during periods of light traffic. • It does not require detectors for the major-road through movement phases and hence, its operation is not compromised by the failure of these detectors. • Generally, the main street indeed has the green whenever possible. Disadvantages • Continuous demand on the phases associated with one or more minor

movements can cause excessive delay to the major road through movements if the maximum green and passage time parameters are not appropriately set. • Detectors must be used on the minor approaches, thus requiring installation and ongoing maintenance. • It also requires more training than that needed for pre-timed control. 2) Full-Actuated Control This type of controller is used at the intersections of streets or roads with relatively equal volumes, but where the traffic distribution is varying. In full actuated operation, all lanes of all approaches are monitored by detectors. The phase sequence, green allocations, and cycle length are all subjected to variation. This form of control is effective for both two-phase and multi-phase operations and can accommodate optional phases. Principles • Detectors on all approaches. • Each phase has a preset initial interval. • Phases are sequenced according to" calls" for service on all approaches. • Green interval is extended by a preset unit extension for each actuation after the initial interval provided a gap greater than the unit extension does not occur. • Green extension is limited by preset maximum limit. Generally, Point Detectors are used. • Detectors can be placed at either stop line or upstream location.

Advantages

Reduces delay relative to pre-timed control by being highly responsive to traffic demand and to changes in traffic pattern. • Detection information allows the cycle time to be efficiently allocated on a cycle by-cycle basis. • Allows phases to be skipped if there is no call for service, thereby allowing the controller to reallocate the unused time to a subsequent phase. Disadvantages • Initial and maintenance cost is higher than that of other control types due to the amount of detection required. • It may also result in higher percentage of vehicles stopping because green time is not held for upstream platoons. ~24~ 3) Volume-Density Control Volume-density control is basically the same as full actuated control with additional demand-responsive features. It is designed for intersections of major traffic flows having considerable unpredictable fluctuations. Volume-Density Controllers are designed for intersections of major traffic flows having considerable unpredictable fluctuations. They are generally used at intersections with high approach speeds (≥ 45 mi/hr). Here, detectors are placed on all approaches. Generally, this type of controller is used with Area Detectors. To operate efficiently, this type of control needs to receive traffic information early enough to react to existing conditions. So, it is essential that detectors be placed far in advance of the intersection. Concept of Volume- Density Controller Volume-Density Controllers are designed for intersections of major traffic flows having considerable unpredictable fluctuations. They are generally used at intersections with high approach speeds (≥ 45 mi/hr). Here, detectors are placed on all approaches. Generally, this type of controller is used with Area Detectors. To operate efficiently, this type of control needs to receive traffic information early enough to react to existing conditions. So, it is essential that detectors be placed far in advance of the intersection. Detection for Actuated Signalization The various types of detectors used for detection of vehicles are as following: • Inductive loop detectors • Magnetometer detectors • Magnetic detectors • Pressure-sensitive detectors • Radar detectors • Sonic detectors • Micro loop detectors etc.

3. LIMITATIONS (INDIAN PROSPECTIVE)

- The traffic in India behaves differently than the traffic in the western countries.
- Firstly, the vehicular composition of the traffic is different, consisting of mostly two and three-wheeled vehicles.
- Secondly, the drivers behave differently. Lane markings are often not followed and the concept of a queue of vehicles is often ambiguous.

4 CONCLUSIONS

A Well-designed Actuated Control Plan That Responds Appropriately To Traffic Demand Can Significantly Reduce Fixed Delay Of Trip Maker.

- It Is a Boon to Environment to Reduce Air Pollution and Saving in Fuel Consumption Due To Ideating Of Vehicle In Queue At Signalized Intersection.
- Use Of Actuated Signal Control Can Reduce Delay, Emissions, And Increase Capacity. At The Small And T-shaped Intersections, Considering the Pedestrian Waiting Time and The Operation Results of Vehicles, The Actuated Signal Control Is Also More Recommended.

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ISBN: 978-81-956748-3-1

STUDY OF PEDESTRIAN PREFERENCES FOR WALKING AS AN ACCESS MODE TO METRO RAIL

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Abstract*— Accessibility to the metro stations is one of the key factors influences patronage of metro system in cities. The accessibility can be given by providing good road connectivity to the stations as well as providing reasonable level of walkways for pedestrians. To get an opinion on requirements for good walkways in Chennai, a pedestrian opinion survey was conducted in and around selected metro stations. The methodology adopted consist of identification of surveying method, review the earlier studies and identify the attributes, carryout photographic survey of walkway around 500 m radius of selected metro stations, analyze the lacking facilities, prepare the Stated Preference questionnaire comprising the attributes identified based on earlier studies and photographic survey. SP Survey was conducted and the people were asked to fill their preferred walkway facility to improve the usage of pedestrian walkway for metro access. The data was coded/ analyzed and key parameters were identified in the choice of walkway facilities. From the study it is understood that people preferred to have at-grade walkways maintained in good condition for their metro stations.

***Keywords*— Accessibility; Metro; Walkways; Chennai**

I. INTRODUCTION

Chennai is the capital city of Tamil Nadu, located in the Coromandel Coast of Bay of Bengal and is the fourth largest metropolitan city in India. Public Transport (PT) system in Chennai metropolitan area is served by Metropolitan Transport Corporation (MTC) buses, suburban rail network and Mass Rapid Transit System (MRTS) till the year 2015. The combined share of public transport has decreased from 54% in 1970 to 28.5% in 2014.

Under these circumstances, it was essential to revamp the public transport system which resulted in formation of Chennai Metro Rail Limited (CMRL), an electric passenger railway system with high capacity and frequency, which is grade separated from other modes of traffic. In 2007, a survey was carried out and traffic demand forecast was done.

TABLE I. AN OVERVIEW OF CHENNAI METRO RAIL (PHASE 1)

Year	Corridors	No of stations	Daily passengers
2011[a]	Corridor -1 (Washermenpet - Airport)	25	318,532
	Corridor -2 (Chennai Central - St. Thomas Mount)	15	254,144

[a.] Source: Detailed Project Report, Chennai Metro Rail

The traffic demand forecast is done by taking 5.2% growth rate (as indicated by Government of Tamil Nadu) for the metro rail.

TABLE II. TRAFFIC FORECAST FOR CORRIDOR 1 AND 2 COMBINED TOGETHER

Year	2011	2016	2026
Total Passengers (in Lakhs) [b]	5.73	7.74	12.85

[b.] Source: Detailed Project Report, Chennai Metro Rail

II. NEED FOR THE STUDY

The projected passengers using metro rail for the year 2016 is 7.74 lakh passengers/day for the entire network, but the current passengers even in the year 2020 is only 1.21 lakh passengers/day. Based on the above data it is evident that users of the metro rail are only 15% of the forecasted data.

Most of the passengers of Metro rail use for traveling long distance and in order to improve more number of passengers to make use of Metro rail, it is needed to focus on passenger traveling short distance using other modes of transport. Also if pedestrian facilities are improved around the station area, more people may get attracted to use the metro rail.

In general most of them are using the private vehicles to reach the metro station. By improving the pedestrian walkway more people may come to metro station by walking, and it is the most sustainable mode of transportation due to their environmental benefits. Improvement of pedestrian infrastructure can also improve the usage of the metro rail as an urban transport.

III. OBJECTIVES OF THE STUDY

The objective is to make the commuters using other modes (bus/ car/ two-wheeler) to make use of pedestrian walkway as an access to metro station.

- To prepare a stated preference questionnaire proposing possible service qualities of walkways.
- To conduct survey among the public around the selected metro stations.
- To code the data and analyze using SST software.
- To identify the preferred pedestrian facility and recommend it in optimized manner.

IV. REVIEW OF LITERATURE

A. *Introduction*

Each individual will have their own unique value for a situation, a way to determine their value is to conduct a survey. The broadly used surveying techniques is Stated preference method, refers to a family of techniques which use individual respondents statements about their preferences in a set of options to estimate utility functions.

Several basic steps for conducting a survey are determining aim/goal, conducting background work, determining how complicated the questions should be, determining who to survey, determining when to survey and determining the sample size.

B. *Stated Preference Method*

Stated preference methods have proved useful in a variety of transport research contexts, including: Evaluating passenger priorities for the development of various characteristics of public transport systems, with a special emphasis on qualitative factors.

The first step in the design of a stated preference exercise is the definition of the variables ("factors") of interest and the values ("levels") of the factors that need to be evaluated by the respondents.

"Traditional" stated preference methods provide respondents with a set of descriptions of alternatives and ask them to express their preferences by sorting the alternatives in decreasing order of preference, or by giving a rating value for each. In the more recently developed choice experiments, respondents are asked to express their choices either by indicating one chosen alternative.

An important issue in the use of stated preference method is the quality of the survey and the context in which the survey questions are asked.

For this reason preference is for face-to-face interviews, conducted by experienced interviewers and also structured to ensure that the background to the respondent's evaluation process (for example, situational constraints, demographic characteristics planning processes) [1]

C. *Examining Human Factors*

The exploration of human factors of pedestrian walking and crossing behaviour in urban areas is essential, including their mobility characteristics, travel motivations, their risk perceptions, their value of time, their attitude towards walking and related preferences. [2]

The human factors to be examined were formulated, as follows:

- Demographics - Age , Gender, Income.
- Travel motivations - Walking frequency, Walking purposes

D. *Factors affecting the use and accessibility of pedestrian walkways*

The quality of pedestrian walkways in the transportation network is an important criteria that can affect the likelihood of walking. However, the provision of pedestrian facilities are usually neglected, despite its importance when it comes to urban transportation planning.

Only minimum facilities are provided for the pedestrian in some areas. Inadequate pedestrian facilities cause constant conflict between the pedestrians and the vehicles. [3]

E. *The contribution of Distance, Attitudes and Environment*

The quantitative approach was used to examine the impacts of walking attitude, walking distance, and perceived built environment on walking behavior for reaching the metro stations.

People walked more when there was a shorter distance between their starting points and the metro stations.

The impact of socio-demographic factors, perceived built environment, walking attitudes, and walking with others on walking for transport to reach the metro stations and the average walking distance is to be measured as well. [4]

F. *Role of Statistical Software in Data Analysis*

Demand for Statistical Software (SS) becomes more crucial part of data analysis, because of transition from manual analysis with paper to more efficient digital/electronic analysis. The emergence of statistical software in the twenty-first century is useful in improving demography studies and social investigation studies and to improve the quality of research. The Statistical Software that are used depends upon the type of analysis and their application. [5]

G. *Importance of Statistical Software in Research Work*

The value of statistics lies with organizing and simplifying data, to permit some objective estimate showing that an analysis is under control.

- Survey analysis is one of the most commonly used research methods, scholars, market researchers and organization of all sizes use surveys to measure public opinion.
- For qualitative and dichotomous variables, results must be presented as frequencies and percentages.
- For quantitative variables, the presentation is as means and deviations. [6]

H. *Advantages of using Statistical Software*

- Statistical software packages have contributed immensely to research analysis by helping to minimizing human and experimental errors in data analysis.
- Most reason for using statistical software was it easy usage, suitability for many statistical analysis.
- The complex analysis in time series, regression and variance analysis cannot be calculated manually effectively without statistical software packages.
- Statistical packages make research work robust and faster

I. *Statistical Software Tool (SST)*

SST (statistical software tools) was developed by Jeffrey Dubin and Douglas Rivers, a fast command-driven program to handle large data sets of the kind common in micro econometric and survey analysis using relatively sophisticated estimation procedures for limited dependent variable models and one that would be operable under either MS-DOS or UNIX operating system.

It combines the desirable features of speed, versatility and power with the virtues of user-friendliness and robustness. [7]

V. METHODOLOGY

A. *Study of Surveying Techniques*

The various types of surveying methods that were used in the earlier researches related to Transportation are to be analysed and the surveying method that is suitable for this study to be identified and selected.

B. *Identification of Attributes for Questionnaire*

Based on the earlier researches carried out involving surveying methods related to improvement of pedestrian walkway, the various attributes need to be covered in the questionnaire that are related for this study is to be identified.

C. *Carry out Photographic Survey*

The walkways around 500m radius the metro stations is to be viewed and photographs to be taken to represent the existing status of the walkways. The photographic survey to exhibit the walkways physical status, nearby amenities, surroundings, etc.

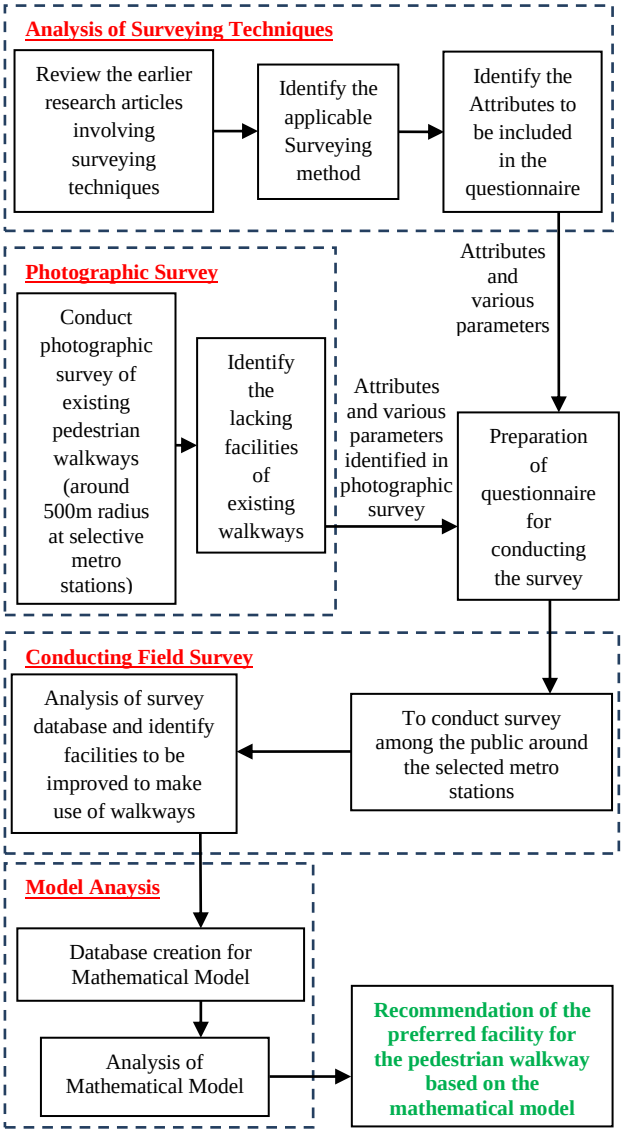

Fig. 1. Overview of Methodology

D. *Analysis of Photographic Survey*

The photos taken in and around the existing pedestrian walks ways are to be analyzed and the lacking facilities that could restrict the usage of the pedestrian walkways are to be indentified and those attributes also need to be covered in the questionnaire.

E. *Preparation of Survey Questionnaire*

The questionnaire to be prepared based on the attributes that are identified based on earlier studies and photographic survey.

F. *Conducting the Survey*

Survey will be conducted among the public around the selected metro stations. The questionnaire is to be filled based on their feedback about the facilities that could make them to use the walkways instead of vehicles to approach the metro stations.

G. *Analyzing the Data*

The data collected in the survey to be analyzed and the mathematical model to be developed using suitable Statistical Software Tools (SST).

H. *Recommendations*

Recommendation of the preferred facility for the pedestrian walkway based on the mathematical model.

VI. PHOTOGRAPHIC SURVEY

A. *Selection of Metro Stations*

The stations for Photographic survey is selected on two different Metro Rail routes.

Corridor - 1 (Washermenpet - Airport): (1) Nandanam; (2) Saidapet; (3) Little Mount; (4) Guindy

Corridor -2 (Chennai Central - St. Thomas Mount)

(5) Vadapalani; (6) Arumbakkam

B. *Selection of Streets*

The photographic survey is conducted around 500m radius from Metro stations and streets are choosen based on type of roads.

- Main roads along the Metro stations
- Arterial roads connecting to Main roads from residential areas
- Inner roads of residential areas are not taken in survey since they are of very narrow width and does not have walkway

C. *Walkwaysat Surveyed locations*

	The walkway is obstructed by the SWD opening which is annoying for the pedestrians to walk.
	The walkway being in the main road and very near to the metro station it is not provided with enough width
	Pavement blocks in the walkway are broken Dumping of construction waste in the walkway
	The walkway is in good condition provided with handrails.

Fig. 2. Photographs of existing walkways

D. *Inference of Photographic Survey*

- Initially from the literature review the attributes that are found relevant to the pedestrian walkway survey are identified .
- Also based on the analysis from photographic survey the drawbacks are identified in the existing walkway.
- The questionnaire for conducting the survey by stated preference method, is formulated based on the attributes that are identified from the literature review and photographic survey. The questionnaire is given in the Annexure I.

VII. COLLECTION OF DATA

A. *Field Survey on existing Foot path facilities*

The Face-to-Face interview is carried out with the public around the Metro stations and based on their feedback the questionnaire is filled.

B. *Preference of various Foot path Scenario*

The different Scenarios are provided in the Questionnaire and opt to choose from the preferred scenario, that could make them to use the walkways to approach the metro stations. The four different Scenarios are:

- Footpath is at same level with road
- Raised footpath
- Footpath with handrail
- Footpath with handrail & shelter

VIII. MODEL DEVELOPMENT

A. *Socio-Economic Characteristics*

The data collected (300 samples) from the public using the questionnaire is entered in the excel in binary format.

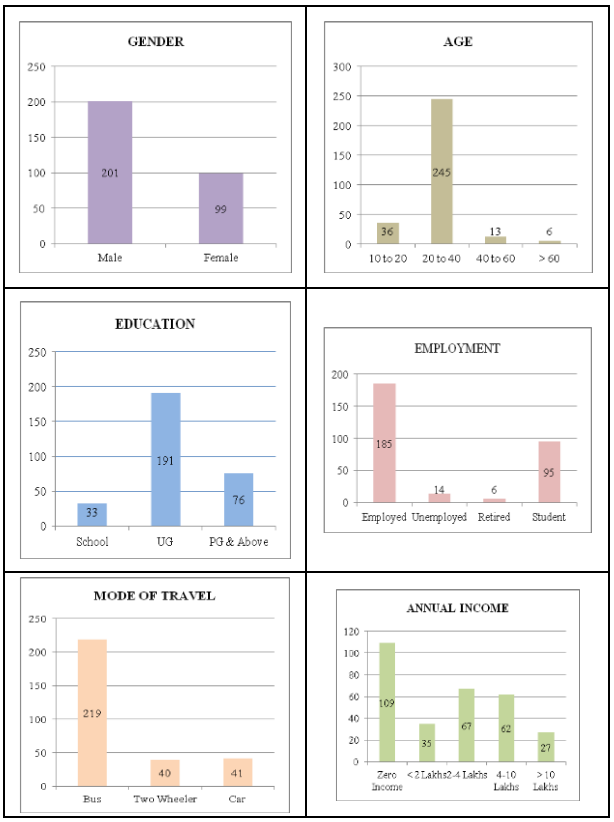

Fig. 3. Graphical representation of Socio-Demographic data

B. *Structure of the Model*

Following structure of the model is used for the analysis of the SP data.

$$P_{Shift} = \frac{e^{v_i}}{1+e^{v_i}} \quad \ldots. (1)$$

where,

P_{shift} = probability of shift from one mode to another mode ;

v_i = utility function with an error term 'ε' ;

$v_i = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots\ldots\ldots \beta_n x_n + \varepsilon$;

$\beta_1, \beta_2, \ldots$ = model parameters to be calibrated;

x_1 , x_2 = influencing factors in modal shift;

ε = a random error term.

C. *Data Analysis*

The 300 sample data for the 4 scenarios is entered in excel (data range from 1 to 1200) and is changed into *Input1.txt* using tab delimited format and *Input1.txt* is converted into *Input1.dat* format for performing the analysis.

D. *Calculation of t-statistic value*

The coding is done to find the t-stat value for first independent variable (*school*).

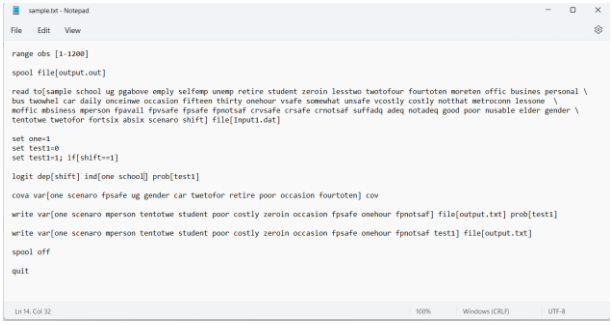

Fig. 4. Coding Syntax – single independent variable (*school*)

The 58 independent variables (parameters in questionnaire) are uniquely named in the coding. The input file (*Input1.dat*) and the output file (*output.txt*) are linked in the coding and saved as *sample.txt*.

The t-statistic value for the independent variable (*school*) is obtained from *sample.txt* using executable program SST.exe.

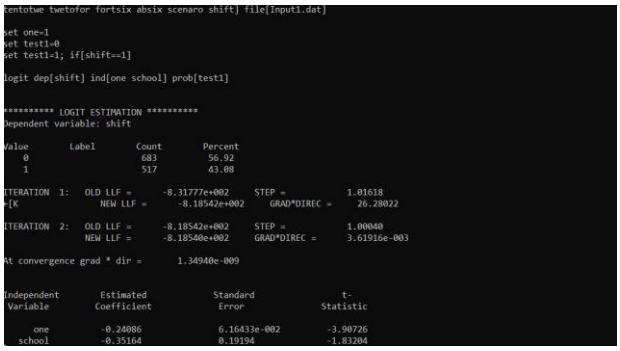

Fig. 5. Output from SST (t-stat) for the first independent variable (*school*)

The t-stat value -1.83204 for the independent variable (school) is noted.

Similarly the same procedure is carried out and the t-stat value is obtained for all the 58 independent variables.

The t-stat value obtained for the independent variables are sorted in descending order and the top 10 variables are taken for further analysis.

TABLE III. T-STAT VALUE OF INDEPENDENT VARIABLES IN DESCENDING ORDER

S. No.	Independent Variable	't' value
1	Scenario	9.351
2	People feeling footpath is somewhat safe	5.115
3	People having ug education	4.496
4	Gender	4.447
5	People travelling in car	4.388
6	People of age 20 TO 40	4.150
7	People who are retired	4.095
8	People feeling footpath is maintained Poorly	4.080

S. No.	Independent Variable	't' value
9	People travelling occasionally	3.996
10	People earning 4-10 lakhs	3.953
11	People who are employed	3.870
12	People feeling crossing at junction somewhat safe	3.825
13	People earning more than 10 LAKHS	3.777
14	people of age above 60	3.722
15	People who travel in metro for official work	3.720

E. Calculation of log likelihood value

Fig. 6. Coding Syntax – Top ten independent variable

The coding is done to find the log likelihood value for the combination of top ten independent variables (*scenaro, fpsafe, ug, gender, car, twetofor, retire, poor, occasion, fourtoten*).

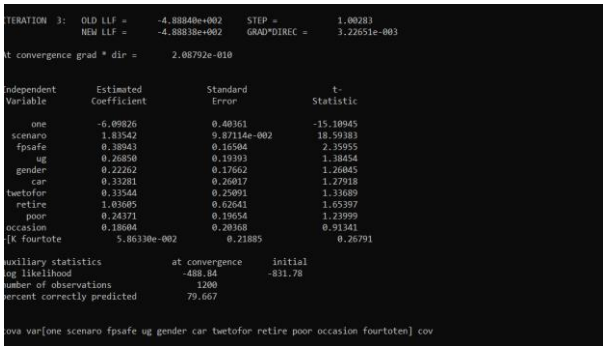

Fig. 7. Output from SST with top ten independent variables

The log likelihood value for top ten independent variables is obtained from *sample.txt* using executable file SST.exe.

log likelihood at initial(Initial LL) = - 831.78

log likelihood at convergence (Final LL)= - 488.84

ρ^2 = (Initial LL – Final LL) / (Initial LL)

ρ^2 = (– 831.78 – (– 488.84)) / (– 831.78) = 0.41

F. Selection of variables for Probability of shift

The inter correlation values between the top ten (based on t-stat value) independent variables are calculated using excel.

The high correlation between the two variables will nullify with each other and hence the variable (4-10 Lakhs) with high correlation value and the variable with low t-stat value (Occasionally) are removed and the remaining 8 variables are selected for further processing.

G. Probability of shift

The estimated coefficient and the t-stat for the selected seven variables are calculated using SST.exe. Thus the developed modal shift model is presented in Table V below. From the model it is observed that all the influencing variables have positive utility on the modal shift behaviour.

TABLE IV. ESTIMATED COEFFICIENT AND T-STAT FOR THE SELECTED VARIABLES

Variable Name	Estimated Coefficient	t-stat value
Constant	-6.07941	-15.10875
UG	0.2608	1.35524
Retired	1.13162	1.83390
Car users	0.33609	1.36100
Footpath somewhat safe	0.38597	2.34117
Footpath poorly maintained	0.26246	1.34419
Gender	0.2376	1.35920
Age (20-40)	0.36812	1.50644
Scenario	1.83345	18.59705
Initial Log-likelihood		-831.78
Final Log-likelihood		-489.3
ρ^2		0.412

Table shows the developed model for using the Stated Preference data. Thus developed model is used to estimate the probability of shift to metro for the proposed scenarios.

TABLE V. ESTIMATED PROBABILITY OF SHIFT TO METRO

Scenario	Scenario	Prob. of shift (%)
1	Foot Path at Road Level	3.89
2	Foot Path at Raised Level	19.64
3	Foot Path With Hand Rail	59.16
4	Foot Path With Hand Rail & Shelter	89.68

IX. CONCLUSION

The surveying method used is stated preference method. Based on the earlier researches and the Photographic survey on the prevailing condition of walkways, the lacking facilities are identified and the questionnaire is prepared. The Face-to-Face interview is carried out with the public around the Metro stations, the questionnaire is filled and opted to choose from the four preferred scenarios, that could make them to use the walkways to approach the metro stations.

The 300 sample data collected in the survey are analysed and independent variables are scrutinized based on their t-stat value and correlation value. The model is developed

using co-efficient value, log likelihood value and its rho square value using Statistical Software Tools (SST).

The estimated probability of shift for the four preferred scenarios are around “3.89% when the Foot Path is at Road Level”, “19.64% when the Foot Path is at Raised Level”, “59.16% when the Foot Path is With Hand Rail” and “89.68% when the Foot Path is With Hand Rail & Shelter”.

This shows that the most preferred facility for the pedestrians that could make them to use the walkways to approach the metro stations is “Foot Path is With Hand Rail & Shelter”.

ACKNOWLEDGEMENT

Author expresses their profound gratitude to the travelers those who spare their valuable time in completing the survey successfully. Also, authors are indebted to Sri Venkateswara College of Engineering (SVCE), Sriperumbudur (India) for supporting their project work and providing all the necessary facilities.

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ANNEXURE I

SURVEY QUESTIONNAIRE

STATED PREFERENCE QUESTIONNAIRE

Dear Sir/Madam,

Please give your response to the following questions by ticking (☐) the relevant box, which will help to give suggestions for improvement of footpath in the vicinity of the Metro Rail stations in Chennai.

Station:

1. Personal Details:

1.1 Education ☐ School ☐ UG ☐ PG and above

1.2 Employment ☐ Employed ☐ Self-employed ☐ Unemployed ☐ Retired ☐ Student

1.3 Annual Income ☐ <2.00 lakhs ☐ 2 – 4 lakhs ☐ 4 – 10 lakhs ☐ >10 lakhs

2. Details about Present Trip:

2.1 Destination……..

2.2 Purpose of Trip ☐ Official ☐ Business ☐ Personal

2.3 Mode of Travel ☐ Bus ☐ Two-wheeler ☐ Car ☐ Sub-urban rail ☐ others (please specify …….)

2.4 Frequency of travel: ☐ Daily ☐ Once in a week ☐ Occasionally

2.5 Travel Time for one trip: ☐ 15 min. ☐ 30 min ☐ > 1 hour

3. General Opinion about Metro Rail:

3.1 In general, Metro rail ☐ Very safe ☐ somewhat Safe ☐ Unsafe

3.2 I think that, metro travel is ☐ Very costly ☐ Costly ☐ Not that costly

3.3 Do you have Metro connection to your present trip ☐ Yes ☐ No ☐ Don't Know

4. Details about Metro Travel:

4.1 When did you last travel by Metro? ☐ within 1 month ☐ more than 1 months ☐ did not travel

4.2 If traveled, Origin …… …Destination…….

4.3 Purpose of Trip ☐ Official ☐ Business ☐ Personal

4.4 Fare paid ☐ Business ☐ Economy

5. Opinion on the present condition of the footpath:

Footpath is available for your metro station: ☐ Yes ☐ No ☐ Not sure

If 'yes', present footpath is: ☐ Very safe ☐ somewhat Safe ☐ Unsafe

Crossing at junction is: ☐ Very safe ☐ somewhat Safe ☐ Unsafe

Footpath width is: ☐ Sufficiently Adequate ☐ Adequate ☐ Not at all adequate

Condition of the footpath is: ☐ Good ☐ poorly maintained ☐ Not usable

Footpath is elder people friendly: ☐ Yes ☐ No

6. Footpath Scenario:

If continuous footpaths are provided without any undulation, which are the following scenarios prefer to use:-

Scenario 6.1: Footpath is at same level with road

If this type of footpath is provided, then I use to access metro rail: ☐ Yes ☐ No

Scenario 6.2: raised footpath

If this type of footpath is provided, then I use to access metro rail: ☐ Yes ☐ No

Scenario 6.3: Footpath with handrail

If this type of footpath is provided, then I use to access metro rail: ☐ Yes ☐ No

Scenario6. 4: Footpath with handrail & shelter

If this type of footpath is provided, then I use to access metro rail: ☐ Yes ☐ No

7. To be filled in by the surveyor:

7.1 Gender ☐ Male ☐ Female

7.2 Age ☐ 10-20 ☐ 20-40 ☐ 40-60 ☐ >60

ISBN: 978-81-956748-3-1

SOLUTION FOR BETTER TRAFFIC MOVEMENT ON BUSY ROADS OF INDIA

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Abstract— Although motorcycles are beneficial due to their accessibility, a constant increase in the number of motorcycles is compromising their own safety. By providing a separate motorcycle lane, this solution aims to reduce traffic congestion. This paper focuses on suggesting a solution without implementing any changes to the existing infrastructure.

Keywords— motorcycle, motorcycle lane, traffic congestion, safety, infrastructure

I. INTRODUCTION

On roads with a high level of traffic, conflicts between vehicles may be created when heavy commercial vehicles and fast-moving cars have to share the same roadway facility with the less protected and slower vehicles such as motorcycles, mopeds, and bicycles. On these road sections, separation of motorcycle flow from other traffic will not only improve link accidents with a motorcycle but can also improve the traffic flow especially when motorcycle traffic is heavy. As two-wheelers become more popular in the absence of public transport, the number of road accidents involving these is also growing. More than a third (37%) of those killed in road accidents in 2019 were two-wheeler riders, noted a Ministry of Road Transport and Highways of India report published in October this year. On August 21, 2021, 88% traffic congestion was reported in Mumbai. There are 20 intersections in Mumbai that have been designated as blackspots, which is about 38% of the total number of black spots in the city. From 2014 to 2017, there have been 416 crashes at these locations, 32% of which have been fatal. 30% of the fatalities at all black spots occurred at these intersections. Despite this fact, the number of motorcycles in Indian cities is on the increase. Such increase may change the current motorcycle use pattern and influence motorcycle safety in India in the near future.

LITERATURE REVIEW

1. *To Quyen Le, Zuni Asih Nurhidayati*

   A Study of Motorcycle Lane Design In Some Asian Countries Page Layout

   Traffic should be managed with effective motor lane design. Another effective way is road space allocation including barriers and improving road conditions to increase its efficiency and performance level of its service. 3 separate methods have been mentioned of 3 separate countries – Taiwan, Vietnam and Malaysia.

2. *Radin Umar R.S, Murray G Mackey, Brian L Hills*

   Preliminary analysis of exclusive motorcycle lanes along the federal highway F02, Shah Alam, Malaysia

   Thirty-seven different motorcycle accident prone zones were grouped together and analysed by implementing a methodology. Traffic segregation by means of exclusive motorcycle lane may prove to be one of the best ways to achieve the desired safety objective for routes with high population of motorcycles.

3. *Huy Huu Nguyen*

   A Comprehensive Review Of Motorcycle Safety Situation In Asian Countries

   There is a rapid growth in the increase of number of motorcycles and will continue to grow in future in Asian countries. Increase in number of motorcycles and the difference in use should be recognized and considered by concerned authorities.

4. *Teik Hua LAW, Radin Umar RADIN SOHADI*

   Determination Of Comfortable Safe Width In An Exclusive Motorcycle Lane.
   Three different types of motorcycle lane facilities are discussed – exclusive, inclusive, and paved shoulder road. Data collection is done by videotaping motorcyclists and assessing safe measurements. The analysis is done in two ways – Classification & Logical Regression Analysis.

5. *Hussain H., Radin Umar R.S, Ahmad Farhan M.S, Dadang M.M*
   Key Components Of A Motorcycle-traffic System

   The study indicates that a lane width must be greater than 1.6 m for two motorcyclists to pass each other within the motorcycle path. This study is done pertaining to the key components: width of the motorcycle, riding manner, operating space, static space, etc.

6. *Phathai Singkham Thailand*
   Separate Lane For Motorcycle To Reduce Severity Of Road Traffic Injury Among Motorcyclist In Thailand
   The study combines with 2 sections. Secondary data analysis of road traffic injury during New Year 2011-15 in Thailand has been done. Main focus is on association between crashing of motorcycle with larger vehicle and the severity of injury outcome. Another section is reviewing on motorcycle separate lane intervention from experienced countries.

7. *Hsu Tien-Pen, Dr. Ing*
Segregated Motorcycle Traffic Flow Countermeasures At Intersections

This study explains the segregated traffic concept vs mixed traffic concept. Methodologies like two-stage left-turn regulation, Head Start Holding Zone for motorcycles is done for analysis.

8. *Hsu Tien-Pen, Sun Jiang-Ling, Fu-Jen Yang*
Guideline Of Lane Width Of Mixed Lane For Motorcycle Traffic

Lane widths are assumed and analysis is done for the same. The lane width wider than 5 m is not necessary for mixed lane. If there is no congestion, 3.5 m width is enough for mixed lane. 1 m is recommended.

9. *Dr. Ing. Hsu, Tien-Pen, Dr.-Eng. Ahmad Farhan Mohd Sadullah, Dr.-Ing. Nguyen Xuan Dao*
A comparison study on motorcycle traffic development in some Asian countries – case of Taiwan, Malaysia, and Vietnam

This study is collaborative research involving researchers from Taiwan, Malaysia, and Vietnam. Analyze the existing motorcycle-related traffic problem, including traffic efficiency, parking issues, and traffic safety issues.

II. METHODOLOGY

This lane design is applicable to all the 5 classes of urban roads. These classes are as follows:

1. **Expressways:** These are generally constructed to have a direct connection between major points of traffic generation in industrial or commercial or business districts.
2. **Arterial Streets:** A general term denoting a street primarily for through traffic, usually on a continuous route.
3. **Sub-arterial Streets:** A general term denoting a street primarily for through traffic usually on a continuous route but offering a somewhat lower level of traffic mobility than the arterial.
4. **Collector Streets**: A street for collecting and distributing traffic from and to local streets and also for providing access to arterial streets.
5. **Local Streets**: A street primarily for access to the residence, business or other abutting property. They do not carry large volumes of traffic.

Let us consider a typical road intersection at which 4 collector streets intersect. This intersection consists of 1 signal for each road. Now, consider one single road out of these four as shown in the figure given below:

Fig. 1 shows a typical 2-lane road, at which various types of vehicles have stopped as the signal is red. The

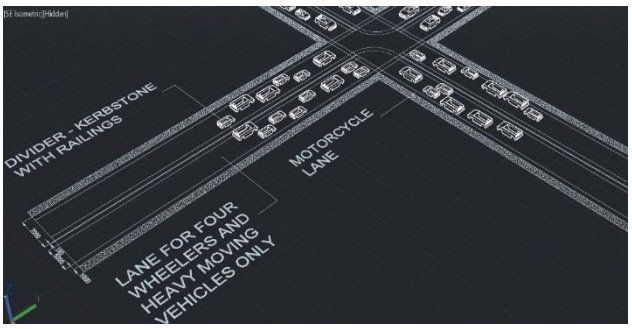

FIG 1. LANE SEGREGATION

following specifications have been taken into consideration while developing this lane design:

- According to IRC 86:1983, the standard width of a 2-lane road is 7 metres without kerbs and 7.5 metres with kerbs.
- According to IRC 3: 1983, Clause 5.1, no vehicle shall have a width exceeding 2.5 metres.
- The average width of lightweight bikes starts at 25 inches while middleweight and heavy street motorcycles are typically 30-35 inches wide.
- According to VEHQ, the average width of a car is 5.8 feet.
- The divider to be provided is a kerbstone with railings. According to Guidelines and Specifications for Roads of India, the height of the railing should be 1.21 metres, its length should be 1.385 metres, and its width should be 0.075 metres. These railings will be fixed in RCC pillars having the following dimensions: length=0.375 metres, width=0.15 metres and height=0.47 metres.
- Average speed of vehicles on urban roads is 30 to 40 km/hr in case of low traffic, and on residential streets, vehicles should maintain a 20 km/hr safe target speed.

The method we have suggested below includes segregation of lanes, i.e, providing separate lanes for motorcycles and other heavy moving vehicles. Consider one upside as is visible in the figure. On this side, one lane is provided on the right side of the footpath and the other lane is provided on the left side of the divider. Similar provisions are made on the downside.

At the intersection, the following arrangements should be made:

The motorcycles wanting to turn right and go straight must wait in the right lane of the upside. Similarly, the motorcycles wanting to turn left must wait in the left lane of the upside.

After all the motorcycles have moved in their desired directions, all the other heavy-moving vehicles should cross the intersection.

III. BARRIERS

Lack of space availability is a challenging factor in the provision of motorcycle lanes. Random road parking occupies a significant amount of space which instead can be allotted as an entire motorcycle driving lane. In the case of collector and local streets, pedestrians tend to walk on the main road, thus occupying space. The other barrier can be the

lack of patience of the drivers which disrupts the balance the traffic police try to maintain on roads. Cooperation of drivers and pedestrians is inevitable in making this design successful. Implementation of a new rule or new lane becomes difficult when there is no regard. Maintaining traffic discipline is a practice only some drivers follow. If one driver stops, the people behind try to overtake, blocking vehicles coming from the opposite direction.

VI CONCLUSION

The rapid growth of motorcycle ownership in most urban Indian cities should be managed by implementing methods that do not change the existing infrastructure. Providing some road space allocation for traffic segregation including barriers is one of the effective ways for motorcycle safety. By using Taiwan and Malaysian methods as inspiration to reduce traffic accidents, particularly for motorcyclists, existing roadways can be improved to increase the performance level of their service. Lane segregation can result in a vast reduction of travel time, fuel consumption, noise pollution, air pollution due to vehicle emissions, lapse time, stress on the driver and passengers, frequency of accidents and vehicle wear and tear. In order to get to the next stage of product development, a significant amount of research is needed in the traffic engineering department. Using simulation modelling, this lane segregation method can be analyzed and checked if it can be feasible and convenient in cities of India.

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4. Radin Umar R.S, Murray G Mackey, Brian L Hills, *Preliminary analysis of exclusive motorcycle lanes along the federal highway F02, Shah Alam, Malaysia*
5. Huy Huu Nguyen, *A Comprehensive Review Of Motorcycle Safety Situation In Asian Countries*
6. Teik Hua LAW, Radin Umar RADIN SOHADI, *Determination Of Comfortable Safe Width In An Exclusive Motorcycle Lane*
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ISBN: 978-81-956748-3-1

EFFECT OF RICE HUSK ASH FOR THE REPLACEMENT OF CEMENT IN PAVER BLOCKS

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ABSTRACT

India is one of the largest rice producing countries. The annual production of paddy rice in India is 132,013,000 tonnes in 2009-2010. There are three main biomass byproduct comes from rice viz. rice straw, rice husk and rice bran. Among these three byproducts, rice husk accounts to greater than 10% of the total rice production resulting in 13,201,300 tonnes in 2009-2010. The usual procedure adopted in disposing the rice husk is burning it in uncontrolled conditions or dumping, both creating environmental issues. With the objective of reducing these environmental issues regarding disposal and the emission of CO_2 from cement production, experimental research is undertaken to explore the possibility of utilization of the alternative material rice husk ash in paver blocks. Our paper is mainly concerned in minimizing the amount of cement used in the building elements. We have replaced cement with Rice Husk Ash (RHA) in Paver blocks in various proportions, from which the optimum replacement level of RHA is arrived. Also the rice husk ash is a carbon neutral green product and a light-weight material.

Keywords: Rice Husk Ash (RHA), Portland Pozzolana Cement, Paver blocks, Compressive Strength, Water Absorption, Efflorescence.

1.0 Introduction

India is one of the largest rice producing countries and per capita rice consumption is higher than that in any other countries. The main three biomass by product which comes from rice viz. rice straw, rice husk and rice bran. Rice straw and rice bran are used as feed for cattle, poultry, fish etc. and the rice husk is used for energy production. In India there are so many small rice mills, where rice husk is burned in uncontrolled manner. During growth, rice plants absorb silica from the soil and accumulate it into their structures. The silica which is concentrated by burning at high temperatures removing other elements, which makes the ash, a carbon neutral green product so valuable. Globally, the annual production of paddy rice is 508,697,332 tonnes and the total ash production could be as high as 44,297,363.67 tonnes in 2009-2010. In India the annual Rice production is 132,013,000 tonnes. Due to rapid industrialization throughout the world, the production of huge quantity of produced waste materials creates not only the environmental problem but also the depositional hazards. The process discussed here not only provides a solution for waste disposal but also recovers a valuable silica product, together with certain useful associate recoveries.

2.0 Review of literature

The tests conducted by Oyetola and Abdullahi[1] in OPC/RHA hollow sand Crete blocks has concluded that the optimum replacement level of OPC with RHA is 20% and the water requirement increases as the rice husk ash content increases; also the setting times of OPC/RHA paste increases as the ash content increases. Harunur, *et al*[2] has concluded that the use of RHA significantly improves the mortar strength at the 20% replacement level and at the later age. At 30% replacement level of OPC by RHA the porosity of mortar is increased at 28 and 90 days as compared to OPC mortar. Also the ultrafine RHA increased the mechanical behavior of the concrete which was proved by Guilherme, *et al*[3]. The experimental study presented the superior performance in the mixture containing 20% of RHA for all ages. The results of young's modulus and splitting tensile strength, at 28 days, indicated that the incorporation of the ultrafine RHA did not change these properties significantly. Khani, *et al*[4] has carried out various experiments to determine properties of concretes incorporating optimum RHA. Results show that concrete incorporating RHA had higher compressive strength, splitting tensile strength and modulus of elasticity at various ages compared with that of the control concrete. In addition, the result shows that RHA as an artificial pozzolanic material has enhanced the durability of RHA concrete and reduced the chloride diffusion. The study on the composition and micro structure of fly ash geopolymer which is replaced part of 20% rice husk ash (RHA) at different firing temperature of 450^{o}, 600^{o} and 700^{o}C was made by Chareerat, *et al*[5]. The optimum burning temperature of rice husk ash to develop good strength geopolymer material is arrived as 600^{o}C. Alhassan

and Mustapha[6] have investigated the effect of Rice Husk Ash (RHA) on the soil with respect to compaction characteristics, California Bearing Ratio (CBR) and Unconfined Compressive Strength (UCS) tests. Results obtained, indicate a general decrease in Maximum Dry Density (MDD) and increase in Optimum Moisture Content (OMC), all with increase in RHA Content (2-8%) at specified cement contents. Paula, *et al*[7] has shown that the rice husk ashes burned at 402ºC is the minimum temperature required for silica release and observed that the compressive strengths of the compounds and the conventional were similar, which indicates a possible use of the rice husk ash as a partial Portland cement substitute. Bakar, *et al*[8] has studied a pre-review of Malaysian rice husk ash as a partial cement replacement in different percentage, grinding time and performance corrosion of RHA blended concrete and concluded that due to its high pozzolanic activity, durability of concrete and the strength of concrete against cracking are enriched. Habeeb and Fayyadh[9] has proved experimentally that the mechanical properties in terms of flexural and tensile strength have been significantly improved with the addition of RHA and the fine RHA exhibited the highest shrinkage value due to the effect of microfine particles which increases its shrinkage values considerably. Sivakumar[10] has evaluated that the rice husk ash acts as a good pozzolanic material and can be blended with cement.

3.0 Experimental Investigation

The materials used are Portland pozzolana cement, Rice Husk Ash (RHA), Natural sand and aggregate chips. The properties of materials are shown in Tables 3.1, 3.2, 3.3 and 3.4.

Table 3.1 Properties of Cement & RHA

S.NO	Description	Values	
		Cement	RHA
1	Specific gravity	3.15	2.33
2	Consistency	31%	38 %
3	Initial setting time	110 min	180 min

Table 3.2 Properties of Fine Aggregate

S.NO	Description	Values
1	Specific gravity	2.59
2	Fineness (by sieve analysis)	2.21
3	Surface Moisture (%)	0 .11
4	Water absorption (%)	0.09
5	Zone	III

Table 3.3 Properties of Aggregate chips

S.NO	Description	Values
1	Specific gravity	2.41
2	Bulk density (Kg/m^3)	1696.88
3	Surface moisture (%)	0.135
4	Water absorption (%)	3.12

Table 3.4 Chemical Composition of Cement & RHA

Content	% Of Composition	
	Cement	RHA
Silica	21.2	78.40
Iron oxide	3.40	0.30
Alumina oxide	5.30	1.04
Calcium Oxide	61.8	2.04
Magnesium Oxide	0.60	0.80
Loss on ignition	2.80	12.92

3.1 Discussion

Table 3.1 shows the result of cement and is found to be that all values lie within the standard values. From Table 3.1**,** it is found that RHA is a light weight material due to its lower specific gravity value. Table 3.2 shows the properties of fine

aggregate, from which it is observed that the sand is confined to Zone III. Table 3.3 shows the properties of Aggregate chips and is found that it lies within the standard values. According to ASTM (1978), if the sum of Iron oxide (Fe_2O_3), Silica (SiO_2) and Aluminum oxide (Al_2O_3) is more than 70% then the material would be declared as a Pozzolanic material. Table 3.4 clearly shows that the sum of those compositions in Rice Husk Ash is more than 75% which indicates that it is a pozzolanic material.

4.0 Mix design

The standard values of strength for light traffic condition is C30, hence the mix design for C30 grade is arrived using IS Method. The Mix proportion arrived is 1:1.9:3.04/0.4(C: FA: CA/w/c ratio). The Paver blocks are cast for the replacements of cement with RHA as 25 % increments. (25%, 50%, 75%). The Quantities of materials used for casting the paver blocks are shown in Table 4.1

Table 4.1 Quantities of materials per m^3

Proportions	Cement(kg)	RHA(kg)	Fine Aggregate(kg)	Aggregate chips (kg)	Water (lit)
A(0% RHA)	375.00	0.00	714.34	1140.76	150
B (25% RHA)	281.25	93.75	714.34	1140.76	150
C (50% RHA)	187.50	187.50	714.34	1140.76	150
D (75% RHA)	93.75	281.25	714.34	1140.76	150

5.0 Testing details

5.1 Compressive strength test

Compressive strength test is the most common test conducted for pavement block. The block is placed horizontally with flat surface facing on the top and placed carefully in between the plates of compression testing machine. The load at which the block fails or crushes is noted. Compressive Strength is given by Load / Area.

5.2 Water absorption test

The ability of a material to absorb and retain water is known as its water absorption.It mainly depends on the volume, size and shape of pores, present in the material.The completely dried pavement blocks is weighed (W_1) and immersed in clean water for 24 hours. The block is then removed from water and then weighed(W_2).

$$\text{Water absorption} = [(W_2-W_1)/W_1]*100$$

6.0 Results and discussion

6.1 Compressive Strength Test Results

The Compressive strength of the Paver blocks with various proportions of RHA at 7th day, 28th day and 56th day is shown in Figure 6.1

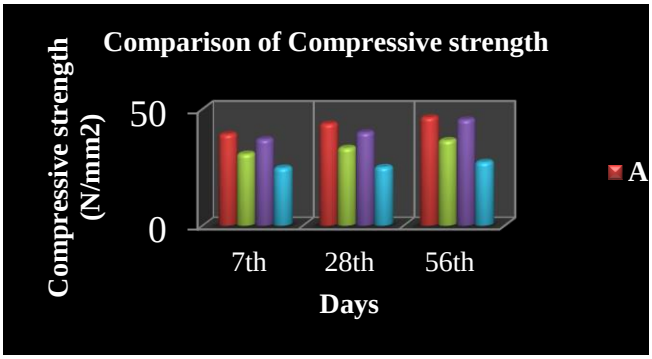

Fig 6.1 Comparison of Compressive strength of Paver blocks with Different Proportions of RHA at 7th , 28th & 56th Day

From the Figure, it is observed that the paver blocks have attained 2/3rd of design strength on 7th day and a maximum strength on 28th day. The percentage of strength attained by the RHA paver blocks when compared to conventional ones(Proportion A) on 28th day is 78.52%, 94.51%, 63.25% and on 56th day is 78.77%, 97.91%, 58.63% for Proportions B,C & D respectively.

6.2 Water Absorption Test Results

The water absorption of Conventional paver blocks and RHA paver blocks are shown in Figure 6.2.

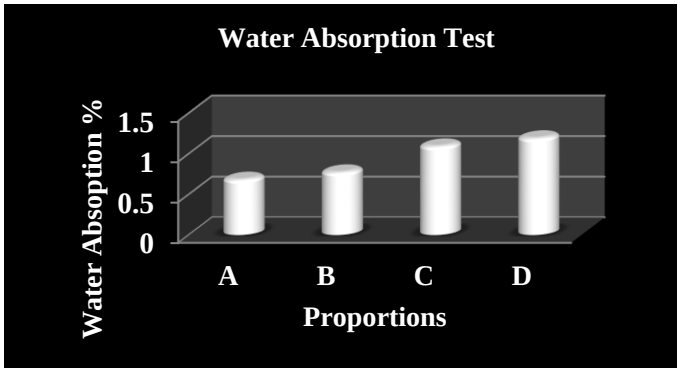

Fig 6.2 Water Absorption Test Results

From the Figure 6.2, it is observed that the water absorption of paver blocks is increased while increasing the content of RHA.

6.3 Cost Comparison

Figure 6.3 shows the cost comparison of Conventional paver blocks with RHA paver blocks.

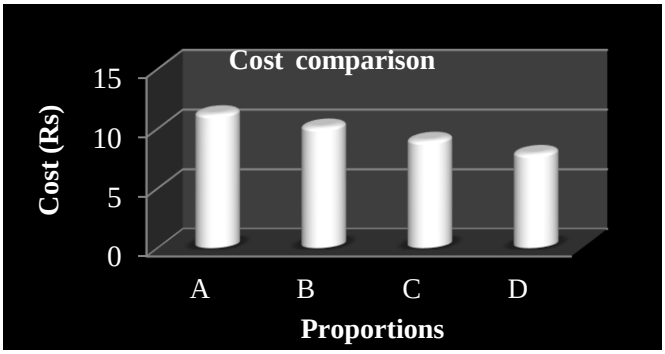

Fig 6.3 Cost comparison of conventional & RHA paver blocks

From the Figure 6.3, it is observed that the cost of the paver block decreases with the increase in the RHA content.

Conclusion

The paver blocks are designed for M30 grade. The compressive strength decreases as the ash content increases. When RHA is used as a replacement material for cement, the strength is achieved only at the later period. At 56th day, the compressive strength for 50% RHA is nearly equal to the conventional paver block and the percentage of strength attained when compared to conventional ones are 78.78%, 97.91% and 58.63% for 25%RHA, 50%RHA and 75%RHA respectively. Hence 50% replacement of cement with RHA is found to be the optimum level. Since the specific gravity of RHA is lower, it is found to be a light-weight material. As RHA is a carbon neutral green product, there are no hazardous effects on the environment while burning it. Moreover, the green house gas emission from the cement production can be cut down by opting for a replacement material like RHA. For optimum replacement level of RHA the cost is reduced by 20% per block when compared to the conventional. Hence the paver block using RHA is found to be economical.

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ISBN: 978-81-956748-3-1

Validation of Passenger Car Unit Estimation Method using Microscopic Traffic Simulation Model

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Abstract: ***Estimation of Passenger Car Unit (PCU) values is important for traffic capacity analysis, level of service measures, saturation flow rate determination and development of traffic flow models. Due to these wide applications, accuracy of PCU values is considered to have significant influence on traffic flow analysis. In developed countries, various methods were devised for estimating and validating PCU values. But these methods are not completely applicable for mixed traffic because of the presence of wide variety of vehicle types, non-lane discipline and intra-class variability of vehicles. Review of earlier research works make it clear that PCU values for various vehicle types estimated through different methods are dissimilar. To find out the accurate method of PCU estimation obtained from various methods, a proper validation method is required. The capacity estimation through speed-flow relationships is the commonly adopted validation. However, for mixed traffic, obtaining the base speed-flow curve is difficult. Moreover, the speed-flow is a macroscopic traffic relationship. Hence, such aggregated traffic relationship may not capture effects of individual vehicles. Hence, this study aims to estimate dynamic PCU values using effective area approach considering the influence of neighboring vehicles under mixed traffic conditions and validate these PCU values by using microscopic traffic simulation model. Simulation based validation of PCU values is suggested considering the robustness of the simulation tools as they can observe the interactions among the different vehicle types and hence, they can be the promising tools for validating the PCU values. Methodology of this study involves development and validation of a microscopic simulation model for ideal section (base model) using the data collected from Bangalore city, India. Logics involved in model development are formulated and implemented in MATLAB programming language using object-oriented programming concepts. Further, for each vehicle type, dynamic PCU values were calculated using effective area and speed for six cases considering subject vehicle, leader and adjacent vehicles. The effective area approach to estimate PCU values is incorporated in the logics of simulation model as well so that estimated PCU values were validated using this simulation model along with the other existing validation methods.***

Keywords: Passenger Car Unit, Effective Area, Neighboring Vehicles, Divided Road, Microscopic simulation, Mixed Traffic

I. INTRODUCTION AND BACKGROUND

Due to widely varying static and dynamic characteristics of vehicles under mixed traffic conditions, each vehicle is unique and cannot be compared with other vehicle types as it demonstrates distinct effects on behavior of traffic flow on varying composition. Hence, expressing traffic flow as number of vehicles passing a given section of road per unit time will be inappropriate. Due to this, a problem arises in designing roads and traffic operations in mixed traffic. To overcome this problem, a uniform measure of vehicles which converts a traffic stream with different types of vehicles into an equivalent traffic stream composed of exclusively passenger cars, with the same operational conditions and quality of service is necessary.

PCU (Passenger Car Unit) or PCE (Passenger Car Equivalent) is a factor used to convert a traffic stream composed of different vehicle types into a hypothetical passenger-car stream.PCU measures the impact that a mode of transport has on traffic variables such as headway, speed, density etc. compared to a single standard passenger car. Highway Capacity Manual (HCM) *(1)* defines PCU as "the number of passenger cars that are displaced by a single heavy vehicle of a particular type under prevailing roadway, traffic and control conditions". But this definition was stated with respect to homogeneous traffic. The Indian Roads Congress (IRC) *(2)* code specifies static values of PCU for different vehicle types in India based on traffic composition.

PCU of each vehicle type is significant in the study of mixed traffic particularly for studies concerning capacity, signal design, parking lots, etc. Many researchers estimated PCU values using several parameters. But, all these studies are mainly related to the estimation of PCU for heavy vehicles under homogeneous traffic and hence, these methods cannot be applied for mixed traffic. Thus, researchers introduced new parameters along with those used in homogeneous conditions for estimating PCU values of different types of vehicles in mixed traffic conditions.

Chandra and Kumar (2003) *(3)* developed an equation to convert other transportation modes into passenger car using mean speed and projected area, on two-lane roads in different parts of India.

Paul and Sarkar (2013) *(4)* developed a conceptual model for determining dynamic PCU using speed and influence area. Kumar et al. (2017) *(5)* focused on PCU estimation using area occupancy as measure of base for different vehicle classes for uninterrupted facility such as multilane urban as well as interurban roads, over a wider range of traffic volumes. Swamy *et al*. (2016) *(6)* derived influence area method considering only leader as surrounding vehicle for PCU estimation. Other than estimation of PCU, a few studies were done on estimation of MCU in those countries where motorcycles are found to be

dominant. Minh et al. (2005) *(7)* used the same formula developed by Chandra and Kumar (2003) *(3)* considering motorcycles instead of passenger cars. Cao et al. (2010) *(8)* modified Chandra's method for the estimation of MCU considering effective area instead of projected area. An attempt was made by Asaithambi and Mahesh (2016) *(9)* to estimate the MCU values for different categories of vehicles considering motorcycle as a standard vehicle in Indian traffic conditions.

PCU values depend on various factors like vehicular, traffic stream and geometric characteristics, all of which are not taken into account in the existing methods. Limited studies examined the dynamic nature of PCU values considering factors such as vehicle speed, vehicle size, vehicle position, lateral and longitudinal gap, influence of neighboring vehicles, etc. Moreover, limited studies used the concept of effective area approach considering the influence of neighboring vehicles to determine MCU values *(7, 8)*. Though, some of the studies considered the influence of leader vehicles, very few researches were done considering the influence of neighboring vehicles to determine PCU. Moreover, to find out the accurate method of PCU estimation obtained from various methods, a proper validation method is required. The capacity estimation through speed-flow relationships is the commonly adopted validation. However, for mixed traffic, obtaining the base speed-flow curve is difficult. Moreover, the speed-flow is a macroscopic traffic relationship. Hence, such aggregated traffic relationship may not capture effects of individual vehicles. Simulation based validation of PCU values is suggested considering the robustness of the simulation tools as they can observe the interactions among the different vehicle types and hence, they can be the promising tools for validating the PCU values. Hence, this study aims to estimate dynamic PCU values using effective area approach considering the influence of neighboring vehicles under mixed traffic conditions and validate these PCU values by using microscopic traffic simulation model with the following specific objectives:

- To estimate the PCU values for different types of vehicles considering effective area and speed for different flow conditions.
- To validate the adopted methodology using microscopic traffic simulation model

II. DATA COLLECTION AND EXTRACTION

Reconnaissance and preliminary surveys were conducted to identify the suitable mid-block sections in urban areas. To study the impact of side frictions on PCU values and capacity, level and straight road section with the presence of bus stop and pedestrian crossings along with ideal section are selected. The traffic data required for this study were collected from urban divided mid-block sections in Bangalore city, which is the third most populous city in India. The traffic on the roads of Bangalore city is highly mixed in nature with widely varying static and dynamic characteristics of vehicles. Data were collected from an ideal urban four-lane divided mid-block sections of length 70 m and 7 m wide located in HAL old airport road, Bangalore city. Video cameras were used for collecting the data on a weekday in the month of April 2018 during peak and off-peak periods of traffic. Figure 1 shows the photographs and layouts of ideal section. Cameras were mounted on separate elevated points to record the videos of the vehicles passing through the sections. The collected videos from ideal section were played in image processing software, Irfanview (Irfanview 4.38) to extract the disaggregate data from video at the rate of 30 frames per second. Gridlines with sufficient scale were plotted in AUTOCAD with obtained (X, Y) image coordinates and overlaid on video by using Ulead Video Studio 10.0 editor. The overlaid grid line video was then converted to frames using Irfanview to extract the image coordinates of each grid block. Image coordinates in terms of pixels for each reference points marked on the road were obtained from Irfanview.

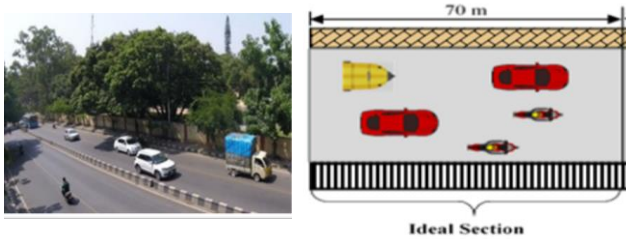


Fig. 1 Photographs and layouts of ideal section

III. DEVELOPMENT OF A TRAFFIC SIMULATION MODEL

An attempt is made in this study to develop a microscopic traffic simulation specifically for an ideal mid-block section of urban divided road (base model). The simulation logics are implemented in MATLAB programming language using object-oriented programming concepts. The major logics involved in model development are explained in detail as follows:

Vehicle Generation: Vehicles are generated using time gap distribution which follows negative exponential distribution. When each vehicle is generated, its type is identified based on vehicular composition, andits desired speed is assigned using normal distribution along with static (e.g. length and width of vehicle) and dynamic characteristics (e.g. acceleration).

Vehicle Placement: Vehicle placement implies positioning of vehicles at the start of simulation stretch in a suitable location across the road width based on the longitudinal and lateral gaps. Second-degree polynomial relationships are obtained from field data to calculate the gaps of each vehicle corresponding to their current speeds. As mostly vehicles travel near the median of the road to maintain their higher speeds, gaps available for vehicle placement are checked consecutively from median to curb. A vehicle is placed near the median if gaps are sufficient, otherwise, gaps are checked for placement in the next position and it shifts laterally. Still if the gaps are inadequate, that particular vehicle is kept in queue and it is checked for placement in the next scan interval.

Vehicle Movement: Vehicle movement logic involves updating vehicular positions and speeds at every scan interval (1 s). In the model, longitudinal movements are governed by Gipps's car-following model *(10)* with vehicle-specific dependent parameters. Rule based discretionary lateral behavior model is used to describe the lateral

movements. If subject vehicle (SV) is not impeded by leader vehicle (LV), SV accelerates and moves at its desired speed, thus the updated speed of SV '*k*' at time *(t+ τ)* is given as:

$$v_k^a (t+\tau) = v_k (t) + 2.5a_k \tau (1-(v_k (t) /V_k)) (0.025+(v_k (t) /V_k))^{1/2} \quad (1)$$

If width of SV overlaps with that of a LV, SV speed depends on the characteristics of LV. Thus, when SV speed is less than that of LV, acceleration of SV depends upon the safe longitudinal gap between SV and LV. When SV has greater speed than LV, it tries to shift laterally by checking the gaps on both sides and ensures that the SV is able to accelerate in its new position; otherwise it remains in its present position and decelerates following the LV. If SV '*k*' decelerates, the updated speed at time *(t+τ)* is given as:

$$v_k^b (t+\tau) = b_{ik} \tau+(b_{ik}^2\tau^2 -b_{ik}(2 (X_i (t)- \alpha_{ik} s_i - X_k (t))- v_k (t)\tau-(v_i (t)^2) b_{ik}^\wedge))^{½} \quad (2)$$

Position of SV '*k*' at time $(t + \tau)$, $X_k (t + \tau)$ is updated using the following equation.

$$X_k (t + \tau) = X_k (t) + 0.5(v_k (t) + v_k (t + \tau)) \tau \quad (3)$$

In equations (1), (2) and (3), $v_k (t)$ = SV speed at time t (m/s), a_k = acceleration rate of SV (m/s^2), τ = reaction time (s), V_k = desired speed of SV (m/s), b_{ik} = deceleration rate of SV 'k' with respect to LV 'i'(m/s^2), $X_i(t)$ = position of LV 'i' at time t (m), $X_k (t)$ = SV position at time t (m), s_i = effective size of LV (m), that is, length of LV plus a safe gap into which SV is not willing to encroach, α_{ik} = sensitivity factor, $v_i (t)$ = LV speed at time t (m/s) and $b_{ik}^\wedge$ = deceleration of LV 'i' as judged by SV 'k' (m/s^2), and $v_k (t+\tau)$ = SV speed at time (t+ τ) (m/s). The developed model is calibrated by revising it by making modifications to the inbuilt parameters, to find whether the model replicates the field conditions (Table 1). The ideal section data collected from HAL road, Bangalore city which is used to develop and calibrate the model is used for validation. Traffic stream speed and mean speeds of different vehicle types are the measures of effectiveness used for calibration and validation. Validation results indicate that the mean absolute percentage error (MAPE) values for mean stream and class-wise speeds are lesser than 10% which is acceptable.

TABLE 1. CALIBRATED PARAMETERS USED IN THE SIMULATION MODEL

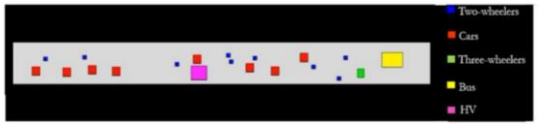
Common Parameters					
Calibration Parameters	Reaction time, τ (s)		Sensitivity Factor, α_a		Deceleration of LV as judged by SV, b_a (m/s^2)
	1		1		-1.4
Vehicle-Specific Parameters					
Calibration Parameters	**TW**	**Cars**	**THW**	**Buses**	**HV**
Acceleration rate (a_i) (m/s^2)	1.6	1.7	1.3	1.4	1.2
Deceleration rate (b_a) (m/s^2)	-1.5	-1.4	-1.6	-1.4	-1.3

The outputs from the model are traffic flow, time gaps, vehicle trajectories, average traffic stream and class-wise vehicular speeds, capacity, and animated output. In animated output (Figure 2), to represent non-lane disciplined traffic, the entire road space is treated as a single component instead of individual lanes. Vehicles are represented as rectangles using different colors and physical sizes *(11)* based on vehicle types.

Fig. 2 Snapshot of Animation of Simulated Disordered Traffic Flow

IV. ADOPTED METHODOLOGY TO ESTIMATE PASSENGER CAR UNIT (PCU)

Capacity values in veh/h need to be converted in terms of PCU/h using a suitable approach. To estimate PCU values for different vehicle types, effective area approach is proposed, considering speed and effective area of subject and surrounding vehicles. The basic formula developed by Chandra and Kumar (2003) is modified in which projected



area is better reflected by effective area considering the influence of surrounding vehicles in disordered traffic. The adopted formula for determining PCU is given by:

$$PCU_k = (V_{car} /V_k) / (A_{car} /A_k) \quad (4)$$

where, PCU_k = PCU for SV '*k*'; V_k, V_{car} = mean speeds (m/s) of SV '*k*' and passenger car, respectively; A_k, A_{car}= mean effective area (m^2) of SV '*k*' and passenger car, respectively. Taking into consideration of surrounding vehicles, different cases (Figure 3) such as presence of only SV (case 1), SV with the presence of one adjacent vehicle (AV) (case 2), SV with the presence of two AVs one on each side (case 3), SV following a LV (case 4), SV with a LV and an AV (case 5), and SV surrounded by LV and two AVs one on each side (case 6) are considered for estimating PCU values. The effective area of SV (A_k) is influenced by size of SV and AV on its right (RAV) and left side (LAV) and is determined using different equations which are incorporated in the simulation model. Effective lateral distance of SV (E_k) which is used for determining effective area is assumed to be a function of width of SV (w_k) and lateral distance of SV (D_k). SV lateral distance depends on the ratio of physical sizesof SV and AV (size ratio). Depending upon the side at which AV is present, SV lateral distance can be classified as lateral distance at right (D_{kr}) or left (D_{kl}). In Figure 3 (cases 2, 3, 5 and 6), D is the lateral gap between SV and AV.

$$D = D_k + D_{adj} \quad (5)$$

Lateral gap (D) is divided based on the ratio of physical sizes of SV(Z_k) and AV (Z_{adj}) to calculate the lateral distance of SV (D_k) and that of AV (D_{adj}) as shown in equation 6**.**

$$D_k /D_{adj} = Z_k /Z_{adj} \quad (6)$$

The lateral distance of SV '*k*' (D_k) is determined as:

$$D_k = (Z_k /Z_{adj}) \times D_{adj} \quad (7)$$

In equations (5), (6) and (7), D_{adj}= lateral distance (m) of AV 'adj'; Z_k= physical size (m^2) of SV '*k*'; Z_{adj} = physical size (m^2) of AV '*adj*'. In addition to AVs, LV also influences SV to a greater extent. Effective longitudinal distance of SV (F_k) is calculated as the sum of longitudinal gap between SV and LV (D_{ki}), and length of the SV (l_k).

Fig. 3 Schematic Sketch of Different Cases Considered for Estimating Effective Area

Note: Effective lateral distance (m) of SV with two AVs, $E_k = D_{kr} + D_{kl} + w_k$; Effective lateral distance (m) of SV with one AV, $E_k = D_{kl} + w_k$ or $E_k = D_{kr} + w_k$; Effective longitudinal distance of subject vehicle (m), $F_k = D_{ki} + l_k$

A. RELATIONSHIP BETWEEN SPEED AND EFFECTIVE AREA

The relationships between the effective area and speeds of all types of vehicles are plotted for peak hour for all five different cases. The trend for case 1 is always a straight line since the effective area for case 1 is the physical area of the vehicle which does not change with speed. Figures 4 - 8 illustrate the relationship between speed and effective area of all types of vehicles for peak hour for five different cases. Only two cases i.e., only leader case and only one adjacent case along with only subject vehicle case are observed for buses and HV as they occupy most of the road width due to their larger sizes. Coefficient of correlation (R^2) is used to determine the goodness of fit of the models. Second degree polynomial relation gives the best R^2 value for all types of vehicles. It indicates that except for case 1, for all the other five cases, the effective area increases with increase in speed providing non-linear equations. As the speed of subject vehicle increases it tend to maintain more gaps with the surrounding vehicles thus resulting in more effective area.

Fig. 4 Relationship between Speed and Effective Area – Two-wheelers

Fig. 5 Relationship between Speed and Effective Area – Three-wheelers

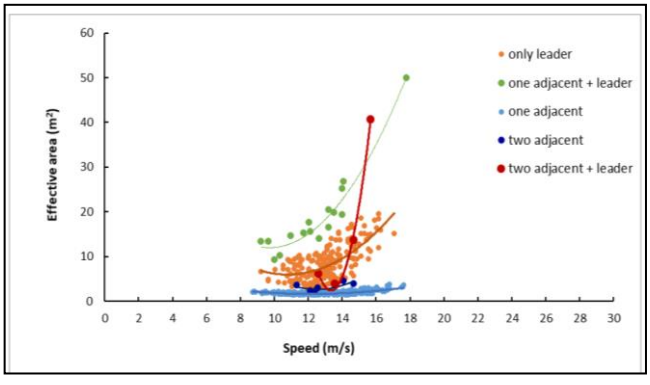


Fig. 6 Relationship between Speed and Effective Area – Cars

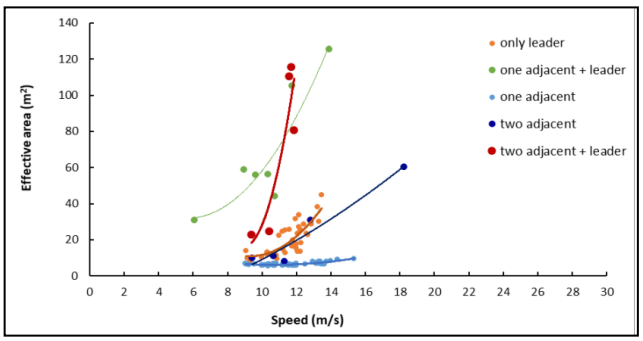


Fig. 7 Relationship between Speed and Effective Area – Buses

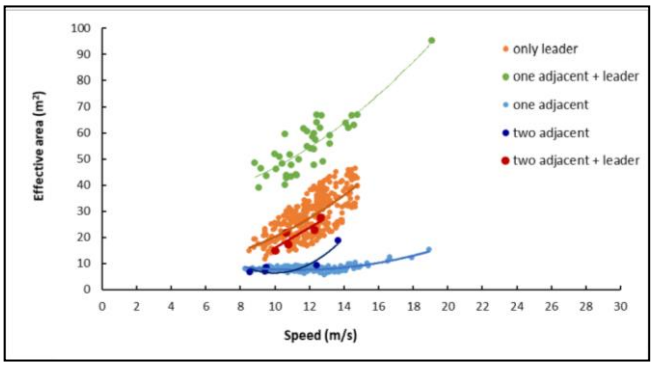
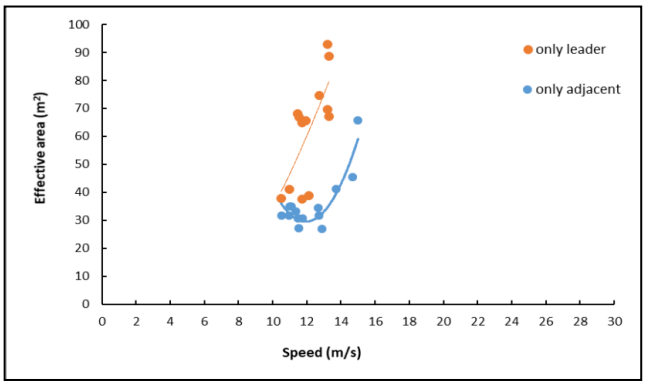
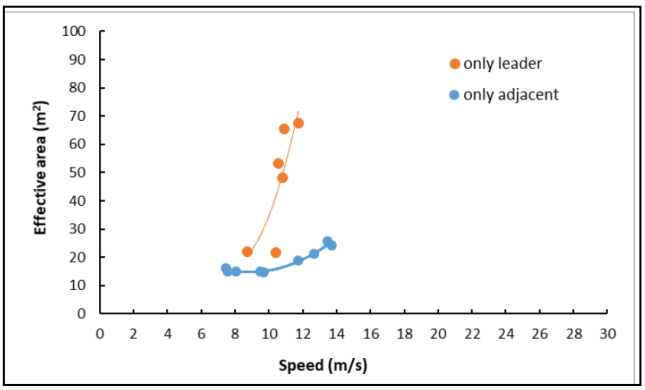


Fig. 8 Relationship between Speed and Effective Area - Heavy Vehicles



B. ESTIMATION OF PCU

Non-linear equations were obtained for all types of



vehicle from the effective area vs speed graph. In these non-linear equations, the independent variable x is mean speed (V_k) and dependant variable y is mean effective area (A_{km}). Second degree polynomial equation gives the best R^2 value for all types of vehicles.

Mean speeds of different types of vehicles are given as input in the equations to obtain the corresponding mean effective area. Mean effective area and mean speed is used to calculate the PCU values for each case of different vehicle types. A single PCU value was obtained by calculating the weighted average of PCUs for different cases for each type of vehicle. Weighted PCU values are calculated as follows:

$$PCU_{km} = (V_{car} / V_{km}) / (A_{car} / A_{km}) \quad (8)$$

where, PCU_k = Weighted PCU value for vehicle type *k*; m= Total number of cases present; PCU_i= PCU value for case i; n_i=Number of samples of case i. The results indicate that two-wheeler and buses have the lowest and highest PCU values, respectively due to their and smaller and larger sizes, respectively. After obtaining PCU values for each vehicle type from the simulation model, PCU values are calculated using effective area approach manually based on the field data (HAL road) for validation.

V. VALIDATION OF ADOPTED METHODOLOGY

In order to check the accuracy of PCU values of each type of vehicles obtained using effective area approach, validation is performed. The same expression with effective area and speed of subject and surrounding vehicles was used to estimate PCU values for different vehicle types from the developed simulation model. Validation is performed by comparing the field obtained and simulated PCU values for different vehicle types. Table 2 gives the comparison of simulated and observed PCU values of different vehicle types with respect to car having PCU value as 1. MAPE values for PCU values for each vehicle type are found to be less than 15%, thus giving satisfactory results.

TABLE 2. COMPARISON OF SIMULATED AND OBSERVED PCU VALUES FOR DIFFERENT VEHICLE TYPES

Vehicle Type	PCU Values		MAPE (%)
	Simulated	Observed	
TW	0.24	0.23	4.34
THW	0.82	0.88	6.80
BUS	4.54	4.37	3.89
HV	4.35	4.17	4.32

VI. CONCLUSIONS

For midblock sections carrying mixed traffic, the widely used method for PCU estimation considers the relative speed and projected area (length × width) of the vehicles, where the projected area of vehicle does not actually represent the effective area occupied by them due to the influence of surrounding vehicles. To overcome this limitation, a methodology is proposed for PCU estimation for urban midblock section carrying mixed traffic. This method accounts the predominant variations of traffic over time. Hence, the estimated PCU values for different types of vehicles considering the influence of surrounding vehicles may prove to be realistic estimates. Besides its application to the urban midblock section of mixed traffic, this method may be applicable to the midblock sections in highways carrying mixed traffic as the non-lane disciplined driver behavior may have influence over the effective area of the vehicles. In most of the studies, the speed-flow or speed-density curve which is a macroscopic traffic relationship, is used for validating the PCU values. Such aggregated traffic relationship may not capture effects of individual vehicles. Hence, a systematic procedure for validation of the estimated PCU values becomes imperative. Simulation based validation of PCU values is suggested considering the robustness of the simulation tools as they can observe the interactions among the different vehicle types and hence, they can be the promising tools for validating the PCU values.

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ISBN: 978-81-956748-3-1

GIS BASED MATERIAL INFORMATION SYSTEMFOR RURAL ROAD CONSTRUCTION IN CHIKKABALLAPUR DISTRICT

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Abstract— At the present scenario the construction of rural roads is very important to supply raw materials to the villages from market and transport agricultural goods to the market from villages. Hence proper paved roads required to accelerate the transportation. Theseroads have to be constructed in specified short period of time. It is required to obtain all the necessary data that includes material index, site condition, test data of materials to be used it is also required to find out the nearest quarrysite and borrow pit area. To carry out the preliminary investigation of site and to conducttest on soil and coarse aggregates, it takes much time. Hence there will be delay in the road project. To overcome this problem the soil samples from different borrow pit area and coarse aggregates from different quarries are collected and in laboratory, various tests are conducted on them and the results of sample are compiled with the help of geographicalinformation system software named Quantum GIS (open source) with geo referencing. Hence the details about soil and aggregates and location can be obtained very easily by quantum GIS. It helps to find out the shortest path between site to borrow pit or quarry site. Hence it reduces the cost of transportation and considerably reduces the time consumption for the construction of road. Hence Quantum GIS software can be efficiently used as a data base for the construction of new roads

Index Words: Aggregates, soil, GIS, Critical path

I INTRODUCTION

An information system is a system composed of people and computers that processes or interprets information. The term is also sometimes used in more restricted senses to refer to only the software used to run computerized data base or to only a computer system.

Information system is a network of hardware and software that people and organizations use to collect, filter, process, create and distribute the data

1.1.1 Components

The components that come together in order to produce an information system

a) Hardware: - The term hardware refers to machinery this includes the computer, CPU andall its supporting equipment's.

b) Software: -The term software refers to computer program and the manuals that supportthem.

c) Data: - Data are facts that are used by programs to produce useful information.

d) Procedure: -procedures are the policies that governs the operation of a computer system.

e) People: - Every system needs people if it is to be useful.

6) Feedback: -It is another component of information system.

II MATERIALS AND METHODOLOGY

A MATERIALS

a. Soil: - It is composed of particles of weathered rock (parent materials) which have been altered by physical, chemical and biological processes with associated erosion. Which is a natural body consisting of layers that are composed of minerals, mixed with at least some organic matter, which differ from their parent materials in their texture, structure, colour consistency, and other characteristics. Soil is the end product of the influence of the climate, parent materials organisms, and time. Soil is composed of particles of weathered rock which have been altered by physical, chemical and biological processes with associated erosion

b. Coarse Aggregate: - Natural granite aggregates with a 7.18 fineness module and the coarse aggregate's specific gravity is 2.67. The flakiness and elongation index are 17% and 28% respectively [6].

c. Water: - Water accessible from local sources that meets the requirements for concreting and curing water as per IS: 456-2000[3].

B METHODOLOGY

To achieve the objectives of the present study, laboratory experiments will be conducted on various soil samples of Chikkaballapur district. Laboratory experiments will be conducted to determine the strength of various soil samples from different places of Chikkaballapur and coarse aggregates collected from the various quarry sites of Chikkaballapur district. Tests like California bearing ratio (CBR) and modified proctor tests will be conducted for soil samples to find out the strength. To conduct different tests

on coarse aggregates and these results will be compiled to the map of Chikkaballapur district by using Q GIS Software.

III RESULTS AND DISCUSSIONS

The results obtained from all the tests are tabulated in the tables 1 and 2 shows the comparison of all the results details

CONCLUSION

Based on the laboratory investigation, the following conclusions can be drawn:

1. The tests conducted on aggregates from different quarries showed that they satisfied all the requirements as per MoRT&H, hence these aggregates can be used for the construction of rural roads such as village roads, other districts roads and major district roads in Chikkaballapur district

2. The tests conducted on various soil samples from various sites of Chikkaballapur district satisfied all the requirements; hence these soil samples can be used for the road construction purposes in rural areas of Chikkaballapur

3. The maps for rural roads on Chikkaballapur district were generated and for sites of various soil sample and aggregates were also mapped.

4. By using road networks of the Chikkaballapur district the shortest path between the construction site and quarry site can be found. This leads to efficient ways of transportation and can lowers the transportation costs and also travelling time.

5. It is seen that the GIS tool can be effectively used for developing Material information system which can be an effective tool for speedy and efficient planning, design and construction of Infrastructure.

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ISBN: 978-81-956748-3-1

Table 1: properties of materials

SL NO	Village name	Taluk	Latitude	Longitude	Group of soil as per US soil classification	Liquid limit (%)	Plastic limit (%)	Specific gravity	Maximumdry density	Optimum moisture content	CBR(%)
1	Dyavarahalli	Gauribidanur	13.467487	77.533845	SP	35	33.3	2.68	1.768	17	10.87
2	Chinchanahalli	Gauribidanur	13.613543	77.638329	SW	35.2	27.6	2.63	1.822	13.5	20.35
3	Thumakunte	Chikkaballapur	13.593129	77.823279	SP	25.5	15.51	2.56	1.893	13.5	22.31
4	Ramaswamyhalli	Chikkaballapur	13.585972	77.82766	SP	42	33.32	2.58	1..879	8.2	11.43
5	S.Venkatapura	Sidlagatta	13.626111	77.904743	SP	41.5	36.32	2.61	1.913	9	13.66
6	Devaramaraluru	Sidlagatta	13.411903	77.924308	SP	35.2	30.09	2.63	1.877	7	13.38
7	Neelapalli	Chintamani	13.503607	78.182842	SP	32	28.3	2.68	1.86	10.5	13.38
8	Gunthurgadde	Chintamani	13.500023	78.155871	SW	47	39.67	2.69	1.9	7.8	24.54
9	Mallepalli	Bagepalli	13.840363	78.030494	SP	21.7	13.61	2.65	1.82	14	15.34
10	Pacharlapalli	Bagepalli	13.896169	77.897685	SW	41	38.8	2.59	1.88	7	20.63

Table 2: properties of materials

SL NO	Village name	Taluk	Latitude	Longitude	Specific gravity	Impact value	Crushing strength	Combined flakiness &elongation indices	Absorptionvalue	Abrasion value
1	Kalludi	Gauribidanur	13.675643	77.248733	2.9	19.35	17.02	28.65	1.69	16.69
2	Gollachinnenahalli	Gauribidanur	13..648368	77.609183	2.89	23.45	19.8	22.74	1.62	10.76
3	Vadrepalya	Chikkaballapur	13.483692	77.739648	2.67	21.18	18.09	24.975	1.54	14.94
4	Kallukunte	Chikkaballapur	13.513313	77.752372	2.65	26.34	16.17	19.23	0.78	18.8
5	Nallaralahalli	Sidlagatta	13.543234	77.836406	2.72	19.065	17.605	25.584	0.98	16.34
6	Kondappagarahalli	Sidlagatta	13.577757	77.886842	2.76	21.17	14.82	20.98	1.308	16.249
7	Bodampalli	Chintamani	13.603227	78.14994	2.66	26.3	19.56	24.7	1.24	18.52
8	I.Kuppalli	Chintamani	13.535818	78.144079	2.9	19.35	17.02	28.64	1.69	16.69
9	Devaragudipalli	Bagepalli	13.769286	77.81433	2.685	20.79	19.43	14.98	1.26	13.2

ISBN: 978-81-956748-3-1

RECENT FLOODS AND LAND SLIDES IN KARNATAKA: CAUSES, EFFECTS AND SOLUTIONS

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Abstract*— In recent years flooding and landslides are becoming most common phenomenon during rainy seasons in various parts of Karnataka. Especially the capital city ofthe state, Bengaluru and some parts in north and southern Karnataka are becoming frequent victims of the floods. The phenomenon of landslides also frequently occurring mainly in the regions of Western Ghats of Karnataka. It has been understood that the reasons behind the occurrence of floods in different parts of the state are not common. Also, since the landslides are reserved for one region, it is necessary to take detail study on that area and should examine seriously. In most of the cases the friction between human and nature is the main cause for natural disaster, but in some cases the natural defects also the main reason of natural disasters like floods and landslides. In case of Karnataka it has been observed that the both reasons are true in case of natural disasters. Some scientific solutions are available for some cases, while for some problems the solutions are there in nature only. Anyways the ultimate solution for these kinds of problems is balancing of ecological and natural resources in a proper manner. It is not easy to balance the natural resources continuously for long time, but there is no other way. Thus, everyone should aware before the situation becomes worst. It is must to maintain the nature harmless. Harmless means not to leave as it is, if it so then that may lead to natural disaster in another way. So, whenever it is essential, natural systems should be modified to balance the resources.

Index Terms: Floods, Infiltration, Karnataka, Landslides, SW monsoon, Western Ghats.

I. INTRODUCTION

From the past two decades it has been observed that the frequent landslides and floods occurring during rainy seasons in most of the parts of Karnataka. Gradual increase in global temperature causes increase in the formation of vapor masses results in excess south west monsoon rainfall [Table-1]. Continuous changes of global environment affecting of the atmospheric water cycle. It was known that about 75% of annual rainfall of Karnataka is from the accounts of SW monsoon [4] [5]. It is not exaggerated that the source of main rivers of Karnataka is the rainfall amounts only at the Western Ghats region. But it feels like that rainfall is not the only reason behind recent floods and landslides.

II. FLOODS AND LANDSLIDES

A flood is the process of large amount of water accumulated and inundates the surfaces. The floods of recent years in Karnataka can be classified into two types.

1. River floods
2. Flash floods

When the large amount of water enters into the river than its capacity at a time, the excess water spread over the banks and inundates the nearby surfaces quickly and forcefully flows and causes river flood [3]. The river flood mainly depends on time of runoff concentration of the catchment, intensity of rainfall and volume of runoff enters into the river within the period of time. Most commonly the areas nearby the banks of Krishna, Kaveri, Thungabhadra, Hemavathi, Sharavati rivers etc are the frequent victims of river floods.

On the other hand, when there is no possibility of infiltration of rain water into the soil, in such areas the rain water accumulates above surface and flooding with high intensity with in short time. Such kinds of floods are known as flash floods. These floods are limited to particular areas. Including Bengaluru many cities, towns and villages are suffering frequently due to flash floods [1].

The process of the portion of soil in the total mass gets separated and collapse is commonly termed as the landslide. These kinds of processes especially take place in mountainous areas. In Karnataka the most affecting areas from landslides are mostly belongs to Western Ghats region like Kodagu, Chikkamagaluru, Hassan, Uttara Kannada, Dakshina Kannada, Mysuru, Nandi hills, Shivamogga.

III. CAUSES

The factors which cause river flood are as follows:

1. Quick flow of surface runoff towards streams or rivers.
2. Loss of forests and vegetation in the river valleys.
3. Lack of precautions during rainy seasons.
4. Large amount of water releasing from reservoir to river continuously for longer period.

The rain occurs in any part of the catchment will be circulated in two ways. One part it will get infiltered into the ground until the soil (pores) becomes saturated. At the condition of saturation, the soil cannot infilter anymore rain into it, thus the excess rain water will flows over the surface [3]. If there are no obstructions for this kind of surface flow, then the water doesn't take more time to reach the streams or rivers.

Flash flood occurs mainly because of two reasons. The first is whenever the intensity of rainfall in any area exceeds infiltration capacity of soil in that area and the second is when the rainfall occurs on impermeable surfaces. As of many observations the various factors causes flash flood in Bengaluru and some other cities are as follows[1][2];

1. Uncontrolled and Unscientific urbanization.
2. Development of residential layouts in low laying areas.
3. Conversion of natural land into impermeable surfaces in the name of development.
4. Encroachment of lakes and storm water carrying canals and drainages.
5. Lack in maintenance of existing drainage systems.

The reason behind landslides in Karnataka is mainly due to some natural loopholes than man made mistakes [4].

For examples;

1. Since the western ghat is a soil mountain its top layer soils are loosely bounded.
2. The Western Ghats obstructs south west monsoon; thus, it results in larger orographic rainfall in that area.
3. Since the soil resources of the ghat is a mixture of laterite soil, basalt and quartz, it has porosity, thus leads to high infiltration.
4. While going into the deep from the surface there is a huge layer of clayey and granite, which can hold the water in their pores but cannot allow it to flow.
5. When the infiltered water continuously entering into the pores it increases the pore pressure. When the pore pressure exceeds the soil matrix bond capacity, the bonding between the soil matrixes will get destroy and it causes collapse of the portion of soil mass.
6. Damage of natural water conduits' which carries infiltered water inside ground due to unscientific development work at ghat sections.

It has been observed that one day high intensity rain fall only cannot cause landslides. Previous hundreds years of rain water which continuously stores in the pores of soils causes increase of pore pressure and decrease of soil bearing strength.

IV. EFFECTS

In India from past 65 years about Rs.3,78,000 crores of wealth and lakhs of people lost their lives due to flood havoc. In the recent severe flood havoc of 2019, it was noticed that many deluges and landslides happened at various parts in 22 districts and 109 taluks of Karnataka. As per the data released by Karnataka State Natural Disaster Management Board, 61 people dead, 15 people disappeared, about 40000 houses got damaged, about 2000 villages becomes severe victims, 869 animals dead, 6,97,000 people became homeless and about 6.9 hectares crop vanished due to 2019's flood havoc [6]. On the same year due to landslides in some parts of Western Ghats many roads, houses, agriculture lands were vanished. Many small streams, falls and conduits are disappeared and few new streams and falls were appeared, due to this the runoff system of those area only changed.

V. SOLUTIONS

River floods can be control by applying some natural and scientific methods. Natural method means by growing trees and plants in the catchment valleys can delays and reduce the quantity of flow towards streams, also the supply of runoff to the streams will be there for more days. Scientifically means by increasing the storage capacity of

existing reservoirs, increasing the maximum water levels in the dams and constructing chain of small check dams and small reservoirs throughout the length streams, the river floods can be reduced and also water can be safely stored.

In large cities like Bengaluru, since the natural resources almost destroyed like anything, the flash floods can be controlled only by scientific methods. The one thought which is the flash flood can be easily controlled by infilteringthe storm water which occurs above road surface through the road side drainages into the soil. Applying pervious concrete slabs to the base of roadside drainages at 10-15 m intervals will allow the storm water to pass through it into the soil. Providing 1 to 2 foot of coarse aggregate under pervious concrete could be more efficient. This could be the most effective and economic solution for control of urban flash flood [1].

To control landslides in the sensitive regions like Western Ghats, first all unscientific development works in the region should be stopped and restricted. It is better to construct residential buildings in flat area than sloping areas or valleys in this region. Should take care while implementing any development works without disturbing ground water zone and natural water conduits. Retaining walls should be constructed wherever it is necessary. Trees which consume more water in short time like eucalyptus should be plant at the areas under loose soil and high porosity.

VI. CONCLUSION

As like manmade faults, nature's contribution also very much significant in the processes of frequent natural disasters likes floods and landslides. Depending upon context their influences will varies. Significant quantity of rain water from the catchment reaching the river early is the main cause of river flood. By implementing natural methods like constructing of small reservoirs along river length, increasing dam height and growing trees and plants in the banks and valleys of rivers can control or reduce river flood. The flash floods can be controlled only by scientifically. By applying pervious concrete slabs in storm water carrying roadside drainages can infilter rain water which fall on impervious surfaces like roads, pathways etc., as well as ground water resources can be improved. In case of landslides even the influence of human activities is very less as compared to natural defects the care should be taken while implementing development works in the sensitive region like Western Ghats that it should not affect nature's system. It is our thought that, growth eucalyptus in the regions of Western Ghats where frequent landslides happening can reduces landslides.

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Table-1: KSNDMC data of SW rainfall (2018-20) in various parts of Karnataka.

Sl.no	Zone	Year	Normal RF in mm	Actual RF in mm
1	Western Ghats	2020	1556	1448
		2019	1556	1834
		2018	1556	1858
2	Coastal	2020	3101	3458
		2019	3101	3734
		2018	3101	3104
3	Northern Inland	2020	479	560
		2019	479	506
		2018	479	311
4	Southern Inland	2020	369	512
		2019	369	411
		2018	369	333

ISBN: 978-81-956748-3-1

EXPERIMENTAL STUDY ON PARTIALLY REPLACING CONCRETE USING HYPO SLUDGE AND COPPER SLAG

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Abstract— Owing to globalization industries are developing rapidly throughout the whole world. Since construction industry is the back none of all other industries, during the last century concrete has developed into the most important building constituent in the world. In recent years, remarkable efforts have been taken in the domain of concrete engineering and technology to research and study the utilization of by products and waste materials in production of concrete. A large bulk of hypo sludge and copper slag changes into wastage every year these waste materials are not reusable and recyclable due to their physical and chemical structure. Using paper waste and copper slag wastage could be an effective measure in maintaining the environment and improving the properties of concrete. The present work is an experimental investigation to check the suitability of using paper waste paper waste and copper slag as a substitute for coarse aggregate in the construction of concrete. Concrete mixes with different percentage (10%, 20%, 30%, 40%, 50%) of hypo sludge and (5%, 10%, 15%, 20%, 25%) of copper slag were prepared for the investigation and also by using in various concrete mixes with different percentage of hypo sludge and copper slag. Test on fresh and hardened concrete were conducted on each mix and compared with the conventional concrete mix.

Key Words: Hypo sludge, Copper slag, Fresh and Hardened concrete, Paper Waste

I. INTRODUCTION

Utilization of industrial waste, construction waste, agricultural waste, commercial waste in a concrete play a vital role in minimizing disposal problems. Over 300 million of industrial waste are being produced per annum by chemical and industrial process in India. These mineral poses problems of disposal, health hazards and aesthetic problems. Hypo sludge is a waste material produced from paper industry that can used as a cement replacement material in concrete since the lime content in sludge in large. Copper slag is a waste material produced from copper manufacturing process and this can be used as a replacement material for fine aggregate. The demand for sand is the major problem for conventional construction recently. We need a best alternate construction material to fulfill the sand demand. Industrial waste as partial replacement of fine aggregate (sand) and it can be effectively used in structural concrete. Concrete is an artificial conglomerate stone made essentially of Portland cement, water, sand and coarse aggregates. The mixture of the materials results in a chemical reaction called hydration and a change in the mixture from plastic to a solid state. The worldwide consumption of sand as fine aggregate in concrete production is very high, and several developing countries have encountered some strain in the supply of natural sand in order to meet the increasing needs of infrastructural development in recent years.

Concrete is the widely used structural material in the world today. The demand to make this material lighter has been the subject of study that has challenged scientists and engineers alike. The challenge in making a lightweight concrete is decreasing the density while maintaining strength and without adversely affecting cost. Introducing new aggregates into the mix design is a common way to lower a concrete's density. Normal concrete contains four components, cement, crushed stone, river sand and water. The crushed stone and sand are the components that are usually replaced with lightweight aggregates. The use of alternative both fine and coarse aggregate has become necessity for the construction industry because of the economic, environmental and technological benefits derived from their use. In developing countries where abundant agricultural and industrial wastes are discharged, these wastes can be used as potential material or replacement material in the construction industry. This will have the good advantage of reduction in the cost of construction material.

II LITERATURE SURVEY

Jayaraj et.al (2013), has done experimental investigation on strength of concrete and optimum percentage of the partial replacement by preparing a mix M20 grade was designed as per Indian Standard method and the same was used to prepare the test samples. In the test performed, the optimum compressive stress obtained by utilizing paper waste 30% replacement. The compared values of cost show gradual decrement in total cost of per cubic meter concrete. When government implement the projects for temporary shelters for who those affected by natural disaster, this material can be used for economic feasibility.

JeyeshkumarPitroda et.al (2013), they focused on investigation of strength of concrete and optimum percentage of the partial replacement by replacing cement via 10%, 20%, 30% and 40% of Hypo Sludge. Keeping all this view, the aim of investigation is the behavior of concrete while adding of waste with different proportions of Hypo sludge in concrete by using tests like compression strength and split strength.

Rehab Shah and J. Pitroda (2013), studied the results of the cement mortar of mix proportion 1:3 in which cement is partially replaced with Hypo Sludge as 0%, 10%, 30% and 50% by weight of cement. Test results indicate the decreases in the strength properties of mortar with Hypo Sludge for strength at 7 & 28 days as partial replacement with the cement in the cement mortar 1:3. So it can be used in non-structural elements in the low range compressive strength where strength is not required and low cost temporary structure is prepared.

RiteshPatil and M. Jamnu (2014), study the various mechanical properties of concrete containing hypo sludge. Hypo sludge was used as a replacement to cement. Replacement percentages used during the present study were 10%, 15%, 20%, 25%. Compressive strength of cubes was found on 3 days, 7 days and 28 days. The 28th day flexural strength and split tensile strength of the specimens was found on the respectively beams and cylinders. It is found that replacement of hypo sludge have beneficial effects on the mechanical properties of concrete.

Balamurugan and Dr. P. Perumal (2014), study the Use of Quarry Dust to Replace Sand in Concrete – An Experimental Study his experimental study presents the variation in the strength of concrete when replacing sand by quarry dust from 0% to 100% in steps of 10%. M20 and M25 grades of concrete were taken for study keeping a constant slump of 60 mm. The compressive strength of concrete cubes at the age of 7 and 28 days were obtained at room temperature. Also the temperature effect on concrete cubes at 100oC on 28th day of casting was carried out to check the loss of strength.

Michael Nirmal. X. (2015), Characteristic Study of Concrete by Replacing Conventional Natural Aggregates with Recycled Coarse Aggregate and Manufactured sand (M-Sand). In this experiment results that strength about 50-50% replacements of RCA and M-sand reaches the maximum strength about 23.96% than compared to the conventional concrete. Hence the usage of RCA and M-sand are recommended as an alternate material to achieve the Optimum strength with optimum percentages of quantity.

Shanmuganathanet.al., (2007) reviewed and mentioned that large amounts of copper slag are generated as waste worldwide during the copper smelting process. Copper slag can be used in many applications such as concrete, landfills, Ballasts, bituminous pavements, tiles etc. The characteristics and utilization of copper slag have been reviewed (Gorai et.al.,(2003). The apprehension of environmental hazard from the view point of leaching of heavy metals from the slag and its long-term stability in extreme environmental conditions is studied by Shanmuganathanet.al., and reported from their sulphuric acid leaching results that the heavy metals present in the slag are very stable and ha spoor leach ability. They suggested that the slag is safe to be considered for use in a wide variety of applications such as for Portland cement, building materials such as tiles and bituminous pavement constructions. The slag samples are non-toxic and pose no environmental hazard.

R.R. Chavan& D.B Kulkarni (2013) conducted experimental investigations to study the effect of using copper slag as a replacement of fine aggregate on the strength properties and concluded that Maximum Compressive strength of concrete increased by 55% at 40% replacement of fine aggregate by copper slag and flexural strength increased by 14% for 40% replacement.

AyanoToshiki et.al (2000) studied the problems in using copper slag as a concrete aggregate. Excess bleeding is one problem which is attributed to the glassy surface of copper slag. Another is the delay of setting time of concrete which is more than a week sometimes and they concluded that the delay of setting time does not have a negative influence on durability.

III METHODOLOGY AND MATERIAL PROPERTIES

3.1. CEMENT

The binding materials used in concrete are Portland pozzolana cement. This cement is of 53 grades conforming to IS 456-2000 and is having desired properties. The compressive strength of cement is checked by casting cube and testing under compressive testing machine and the tensile strength of cement is checked by casting beam and testing under tensile testing machine.

This cement should be cool and stored in dry cool place. The specific gravity of cement should be determined by adopting standard procedure.

3.2. COARSE AGGREGATES

The coarse aggregate for the works should be river gravel or crushed stone. Angular shape aggregate of size is 20mm and below. The aggregate which passes through 75 mm sieve and retain on 4.75 mm are known as coarse aggregate.

3.3. FINE AGGREGATES

Aggregate which is passed through 4.75 IS Sieve and retained on 75 micron (0.075mm) IS Sieve is termed as fine aggregate. Fine aggregate is added to concrete to assist workability and to bring uniformity in mixture.

ISBN: 978-81-956748-3-1

3.4. HYPO SLUDGE

Paper pulp produced in mill was investigated to work in concrete as an alternative for land disposal. Paper pulp was replaced in concrete by cement in the ratio of 5%, 10%, 15% and 20% by weight in M20 and M30 grade mix concrete. Compression test, split tensile strength test and flexure test were carried on the concrete after replacement by paper pulp. Tests were carried out on concrete till 28 days. As a result an increment of flexure and split tensile strength was observed till 10% replacement of paper pulp sludge, further increase in percentage of paper pulp sludge observed a decline in the values of flexure and split tensile strength.

Paper fibers can be recycled up to a finite limit, till they became of low strength which produces paper of degraded quality. Every ton of recycled paper produces 300 kg of sludge which becomes almost uneconomical to dispose by land filling. Dry paper pulp sludge contains magnesium oxide, alumina, calcium oxide and silica. Concrete when prepared with replacement of paper pulp at 10%, 20% show small decrease in compressive strength. Most suitable proposition of mix is in between 5% and 10%. As paper pulp is bulky so it consumes water when mixed in concrete which ultimately results in increase of water absorption of concrete. Use of paper pulp can become economical by decreasing in costs of disposal by land filling.

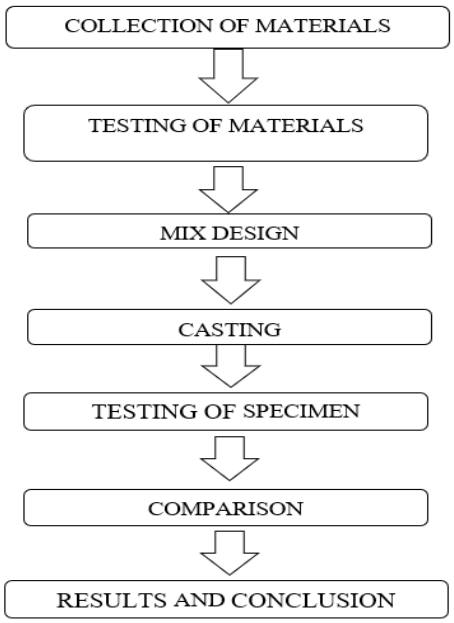
3.5. COPPER SLAG

Copper slag is a by-product obtained during the copper smelting and refining process. In copper slag, CaO content is in the order of 0.15 to 3.30%. It indicates that the lime content is very low. Slag also exhibits pozzolanic properties since it contains low CaO. Since most of the properties of CS are similar to that of river sand, it can be used as a replacement material for sand/fine aggregate.

3.6. WATER

The water should be fit for drinking. The water should not have high concentrations of sodium and potassium and there is a danger of alkali-aggregate reaction.Generally, water satisfactory for mixing is also suitable for curing purposes. However, it is essential that curing water should be free from substances that attack hardened concrete like free CO2 etc.

METHODOLOGY



IV TESTING ON INGREDIENTS

4.1. SPECIFIC GRAVITY

4.1.1 SPECIFIC GRAVITY OF CEMENT

The specific gravity of cement is to be found in the laboratory by using pyconometer and other accessories. Value of specific gravity of cement is obtained as 3.14.

4.1.2 SPECIFIC GRAVITY OF COURSE AGGREGATES

The specific gravity of coarse aggregate usually called coarse aggregate is the ratio of the weight in air of the given volume of dry coarse aggregate at a stated temperature to the weight in air is equal volume of distilled water at a stated temperature.

The specific gravity of coarse aggregate is to be found in the laboratory by using pyconometer and other accessories. Value of specific gravity of coarse aggregate is 2.68.

4.1.3. SPECIFIC GRAVITY OF FINE AGGREGATES

The specific gravity of soil grains (or solids) usually called soil is the ratio of the weight in air of the given volume of dry soil solids at a started temperature to the weight in air of an equal volume of distilled water at a started temperature.

The specific gravity of sand is to be found in the laboratory by using pyconometer and other accessories. Value of specific gravity of sand is 2.64.

ISBN: 978-81-956748-3-1

4.2. WATER ABSORPTION

The water absorption of aggregate is determined by measuring the increase in weight of a dry sample when immersed in water for 24 hours. The ratio of the increase in weight to the weight of dry sample expressed as percentage is known as absorption of aggregate. The water absorption of aggregate is to be found in the laboratory. Values of water absorbing capacity of coarse aggregate are 0.4 %.

4.3 INITIAL SETTING TIME AND FINAL SETTING TIME

4.3.1 INITIAL SETTING TIME:

The period elapsed between the times when is water added to the cement and the time that the paste starts losing its plasticity. The needle may penetrate only to a depth of 33-35mm from the top is taken as initial setting time.

4.3.2 FINAL SETTING TIME:

The period elapsed between the instant of addition of water and the paste has completely lost its plasticity.

4.3. SETTING OF CEMENT

When water is mixed with cement, the paste so formed remains pliable and plastic for a short time. During this period it is possible to disturb the paste and remit it without any deleterious effects.

As the reaction between water and cement continues, the paste loses its plasticity. This early period is the hardening of cement is referred to as ‘setting’ of cement.

4.4 FINENESS MODULUS

Fineness modulus is a ready index of coarseness of fineness of material. Fineness modulus is an empirical fact or obtained by adding the cumulative percentage of aggregate retained on standard sieves ranging from 80mm to 150µ and dividing thus sum by an arbitrary number 100 and coarse is the material by means of sieve analysis.

The period elapsed between the instant of addition of water and the paste has completely lost its plasticity.

4.5 MOISTURE CONTENT

Free moisture is both fine and coarse aggregate affects the quality of concrete in more than one way. In case of weigh batching, determination of free moisture content of the aggregate is necessary and then correction of w/c ratio to be effected in this regard.

V MATERIAL PROPERTIES

5.1. PROPERTIES OF CEMENT

The properties of cement tested were listed below in table 5.1

PROPERTIES OF CEMENT		
S No	Particulars	Values
1	Specific gravity	3.14
2	Fineness of cement	8%
3	Initial setting time	30 min
4	Final setting time	24 hours

Table 5.1 properties of cement

5.2. PROPERTIES OF COARSE AGGREGATES

The properties of coarse aggregate tested were listed below in table 5.2

PROPERTIES OF COARSE AGGREGATES		
S. No	Particulars	Values
1	Specific gravity	2.64
2	Water absorption	0.4%
3	Fineness modulus	3.01
4	% of voids	50%
5	Moisture content	0%

Table 5.2 properties of coarse aggregate

5.3. PROPERTIES OF FINE AGGREGATES (RIVERSAND)

The properties of fine aggregate (River Sand) tested were listed below in table 5.3

PROPERTIES OF FINE AGGREGATES (RIVERSAND)		
S. No	Particulars	Values
1	Specific gravity	2.85
2	Fineness modulus	3.27
3	% of voids	54 %
4	Water absorption	1.1 %
5	Moisture content	2 %

Table 5.3 properties of fine aggregate

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VI RESULT AND DISCUSSION

6.1 COMPRESSIVE STRENGTH OF CEMENT

COMPRESSIVE STRENGTH OF CEMENT GRADE			
Types of cement	7 days N/mm2	14 days N/mm2	28 days N/mm2
53 grade ordinary Portland cement	30	45	55

Table 6.1 compressive strength of cement

6.2. COMPRESSIVE STRENGTH TEST FOR M30 GRADE CONCRETE

NO	Compressive strength in N/mm2		
	7days	14 days	28 days
1	23.50	28.50	35.50
2	22	29	34
Average	23	29.50	36

6.3. COMPRESSIVE STRENGTH IN CONCRETE AT 7 DAYS BY USING HYPO SLUDGE AND COPPER SLAG

% of Hypo sludge	% of Copper slag	Compressive strength in N/mm2	Average compressive strength in N/mm2
15	45	29.3	29
		26.3	
		31.4	
20	50	28.1	30.64
		35.32	
		28.5	
25	55	31.4	29.3
		29.3	
		27.2	

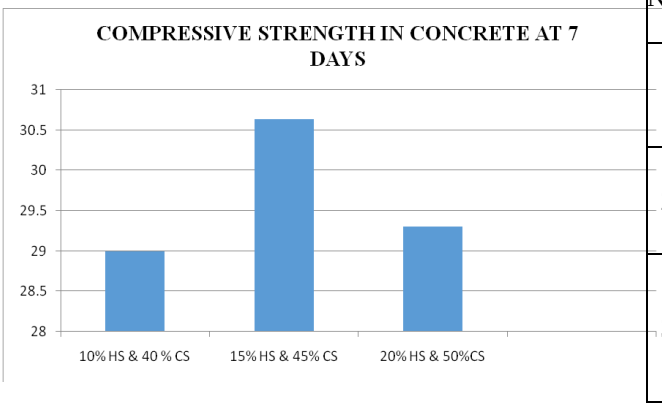

Fig 6.1: compressive strength in concrete at 7 days

6.4. COMPRESSIVE STRENGTH IN CONCRETE AT 14 DAYS BY USING HYPO SLUDGE AND COPPER SLAG

SL NO	% of Hypo sludge	% of Copper slag	Compressive strength in N/mm2	Average compressive strength in N/mm2
1	15	45	32.3	28.58
			31.4	
			22.04	
2	20	50	29.1	33.45
			33.6	
			37.6	
3	25	55	35.6	31.23
			29.7	
			28.3	

TABLE 6.4

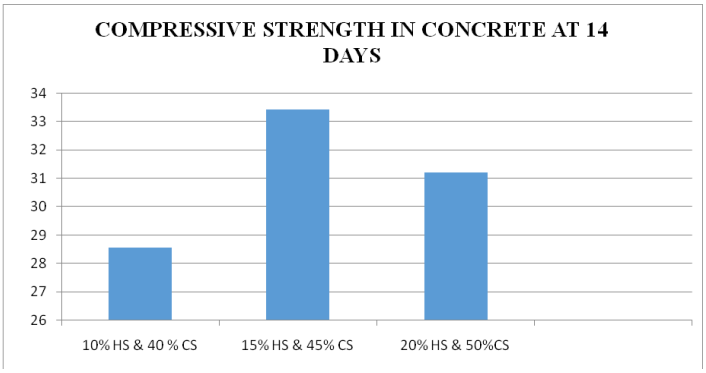

Fig : 6.2 compressive strength in concrete at 14 days

6.5. COMPRESSIVE STRENGTH IN CONCRETE AT 28 DAYS BY USING HYPO SLUDGE AND COPPER SLAG

SL NO	% of Hypo sludge	% of Copper slag	Compressive strength in N/mm2	Average compressive strength in N/mm2
1	15	45	38.7	36.33
			39.9	
			34.39	
2	20	50	38.8	38.97
			39.7	
			38.4	
3	25	55	38.4	35.9
			31.9	
			37.4	

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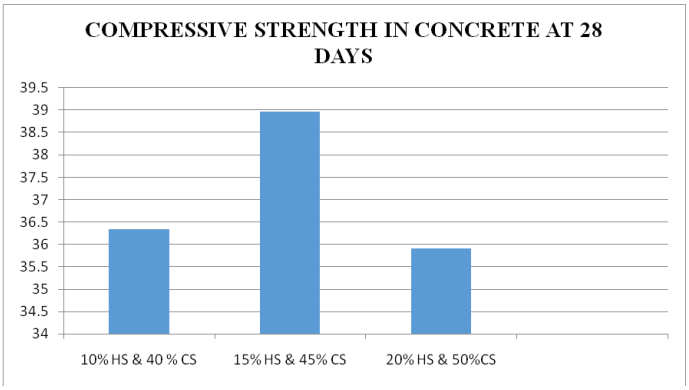

Fig : 6.3 compressive strength in concrete at 28 days

6.6 SPLIT TENSILE STRENGTH

6.6.1. SPLITTING TENSILE STRENGTH

The tensile strength of concrete is one of the basic and important properties. Splitting tensile strength test on cylinder is a method to determine the tensile strength of concrete. The concrete is very week in tension due to its brittle nature and is not expected to resist the direct tension. The concrete develops cracks when subjected to tensile forces.

Thus it is necessary to determine the tensile strength of concrete to determine the load at which the concrete members may crack. This is an indirect test to determine the tensile strength of cylindrical specimens. Splitting tensile tests were carried out on cylinder specimens of size 150mm diameter and 300 mm length at the age of 28 days curing, using compression testing machine

Concrete cylinders of size 150 x 300 mm were cast using with and without sea sand. The maximum load at failure reading was taken and the average split tensile strength is calculated using the equation.

Split tensile strength (N/mm2) = $\frac{2P}{\pi LD}\frac{2P}{\pi LD}$

Where, P = Ultimate load at failure (N)

L = Length of specimen (mm)

D = Diameter of cylindrical specimen (mm)

6.6.2. SPLIT TENSILE STRENGTH IN CONCRETE AT 7 DAYS BY USING HYPO SLUDGE AND COPPER SLAG

SL. NO.	% of hypo sludge	% of copper slag	Split tensile strength in N/mm2	Average split tensile strength in N/mm2
1	15	45	2.82 2.97	2.89
2	20	50	3.96 3.68	3.82
3	25	55	2.97 3.6	3.2

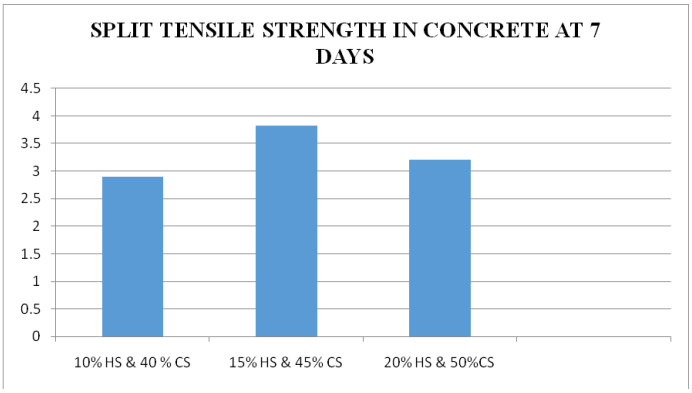

Fig : 6.4 split tensile strength in concrete at 7 days

6.6.3 SPLIT TENSILE STRENGTH IN CONCRETE AT 28 DAYS BY USING HYPO SLUDGE AND COPPER SLAG

SL. NO.	% of hypo sludge	% of copper slag	Split tensile strength in N/mm2	Average split tensile strength in N/mm2
1	15	45	4.31 5.38	4.84
2	20	50	5.18 5.38	5.27
3	25	55	5.48 4.96	5.22

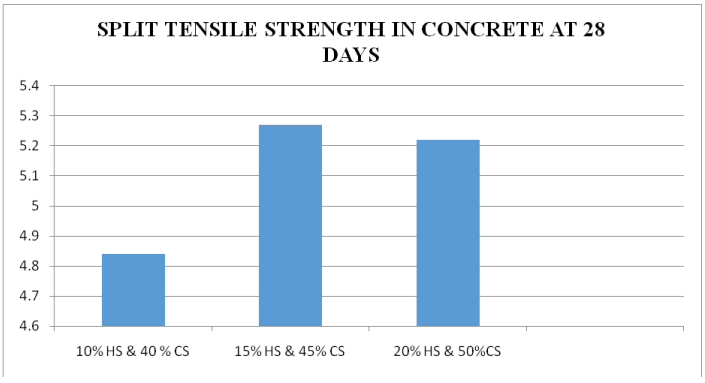

Fig :4.5split tensile strength in concrete at 28 days

6.7 FLXURAL STRENGTH

6.7.1 FLEXURAL STRENGTH TEST

Beams of size 500 mm x 100 mm x 100 mm were cast using with and without sea sand. The maximum load at failure reading was taken and the average flexural strength is calculated using the equation.

$$\text{Flexural strength } F = \frac{3PI \;\; 3PI}{2bd^2 2bd^2}$$

F = Flexural strength in N/mm2

P = Maximum load in N

I = Distance between central lines of supporting rollers in mm

b = Average width of beam in mm

d = Average Thickness in mm.

6.7.2. FLEXURAL STRENGTH IN CONCRETE AT 28 DAYS BY USING HYPO SLUDGE AND COPPER SLAG (WITHOUT REINFORCEMENT)

SL. NO.	% of hypo sludge	% of copper slag	Flexural strength in N/mm2	Average flexural strength in N/mm2
1	15	45	6.9	6.9

6.7.3 FLEXURAL STRENGTH IN CONCRETE AT 28 DAYS BY USING HYPO SLUDGE AND COPPER SLAG (WITHT REINFORCEMENT)

SL. NO.	% of hypo sludge	% of copper slag	Flexural strength in N/mm2	Average flexural strength in N/mm2
1	15	45	7.4	7.4

CHAPTER 7

CONCLUSION

Following are the conclusions derived from the study and the testing of concrete. Hypo sludge and copper slag was used as a replacement material for cement because of both materials having Silica and Magnesium properties which improves the setting and workability properties of concrete.

Thus, the environmental effects, illegal extraction of sand and cost of fine aggregate can be significantly reduced. Copper slag is satisfying the requirements of fine aggregate such as strength, gradation, shape, Angularity etc. Copper slag can be produced to fall in the desired Zone per our requirement. This can ensure the quality of concrete. The mechanical properties of copper slag depend on the source of its raw material.

Hence selection of hypo sludge and copper slag is very important for obtaining quality cement and fine aggregate. Compressive strength obtained for standard mortar cubes and nominal mix concrete that the strength properties of copper slag are adequate.

From the test results, it is concluded that the hypo sludge and copper slag can be used as a replacement for cement and fine aggregate. It is found that 50% replacement of fine aggregate by copper slag and 20% replacement of cement by hypo sludge gives maximum result in strength than the conventional concrete.

The results proved that the replacement of 50% of fine aggregate by copper slag and 20% of cement by hypo sludge induced higher compressive strength, higher split tensile strength, higher flexural strength. Further increasing the % of hypo sludge and copper slag in concrete it shows decrease in strength.

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ISBN: 978-81-956748-3-1

Analysis and Design of soft storey Building with and without bracing using Staad pro

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Abstract*— The growth of multi storey and tall buildings around the world during the past decade has been tremendous. This may be attributed to the factors of rapid urbanization and industrialization. Often these high-rise buildings are expected to accommodate both industrial and commercial purposes, one of such demands include soft storey. Soft storey is highly demanded for showrooms and wok platforms in commercial and industrial buildings. But these soft storeys are highly vulnerable to lateral forces like seismic force as they lack in stiffness. Since these soft storeys are unavoidable, the building is expected to be stiffened using external sources like bracings to compensate the soft storey effect. The present study focuses on the analysis and design of soft storey buildings with and without bracings and the effect on the building based on their position in the building. A comparative study between two types of arrangements; type I: structure without bracings of soft storey (at 1st, middle and top storey), type II: structure with bracings of soft storey (at1st, middle and top storey) is carried out. Seismic load Analysis of multi storied building models is carried out in STAAD.Pro (V8i). Different seismic parameters like storey shear, storey displacement is studied. It is observed that soft storey at 1st, middle stories is not safe in structure type I. It is recommended to place the soft storey in the top portion of the building and the stiffness is to be increased by applying bracings to soft storey to reduce the risk of damage or collapse of the building due to lateral loads.

Key Words: component, formatting, style, styling, insert

I INTRODUCTION

Reinforced-concrete framed structure in recent time has a special feature i.e. the ground storey is left open for the purpose of social and functional needs like vehicle parking, shops, reception lobbies, a large space for meeting room or a banking hall etc. Such buildings are often called open ground storey buildings or soft story buildings. When a sudden change in stiffness takes place along the building height, the story at which this drastic change of stiffness occurs is called a soft story.

If a storey is less than 70% stiff than that of the storey exactly above or less than 80% stiff as average three storey above it (As per IS 875(Part-1)-2002). Due to lesser stiffness in this storey the lateral forces due to earthquake must be resisted by columns and if these columns are weak then this will lead to the severe damage or collapse of the building. The basic fundamental earthquake resistant design concept is the strong columns-weak beams criteria, so as to ensure safety of the occupants, i.e., during earthquake the beams yield before the columns get collapsed.

III.BRACINGS

In construction, cross bracing is a system utilized to reinforce building structures in which diagonal supports intersect. Cross bracing can increase a building's capability to withstand seismic activity. Bracing is important in earthquake resistant buildings because it helps keep a structure standing. Cross bracing is usually seen with two diagonal supports placed in an X shaped manner; these support compression and tension forces. Depending on the forces, one brace may be in tension while the other is slack. It helps make buildings sturdier and more likely to withstand lateral forces. . This method of construction maximizes the weight of the load a structure is able to support. It is a usual application when constructing earthquake-safe buildings. A bracing system serves to stabilize the main girders during construction, to contribute to the distribution of load effects and to provide restraint to compression flanges or chords where they would otherwise be free to buckle laterally.

B METHODOLOGY

1. Source of plan (G+5, 7, 10).
2. Analyze the soft storey building under seismic effect.
3. Compare the behavior of those structures under seismic effect with zone factor V.
4. Analysis is done force structure.
5. Code is assigned as IS:456-2000.
6. The parameters are designed to the structure.
7. Commands to be given are,
   i. Concrete design
   ii. Define parameters
   iii. Common to develop, design and analysis model of G+5, G+7, G+10 structures in Study of seismic load applied to structure as per IS:875 and 1893

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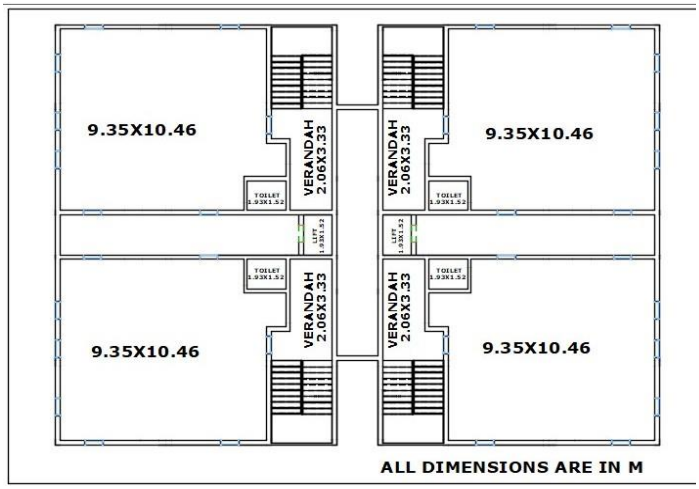
III DRAFTING



ANALYSIS USING STAAD-PRO

STAAD.Pro is a structural analysis and computer design program which was originally developed in 1997 by Research Engineers International at Yorba Linda, CA. In late 2005 Bentley Systems purchased Research Engineers International. The commercial version STAAD.Pro is one of the most widely used applications for structural analysis and design. The commercial version STAAD.Pro is among the most common ly used applications for structural analysis and design. It meets ot her building standards relating to steel, concrete. The following were the steps that were involved in the analysis of the building using STAAD.Pro.

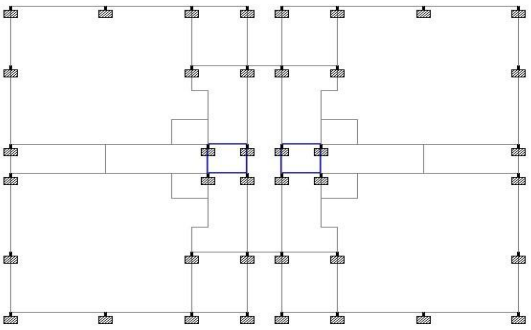


Figure 3.2 STAAD Pro Plan

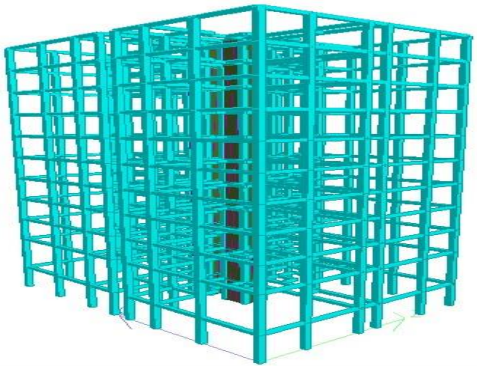


Figure 4.6 Property of G+10 soft storey structure without bracings

Figure 4.7 Property of G+10 soft storey structure with bracings

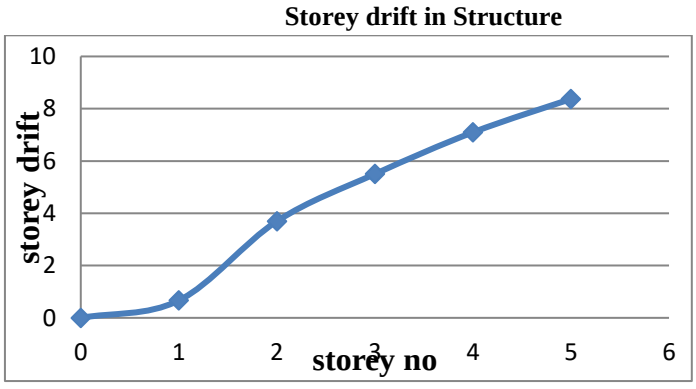
RESULTS AND DISCUSSION:

Ordinary moment resisting frame structure having G+5, G+7, G+10 storey (with and without bracings) is analysed for gravity and lateral loads for the different seismic zones in India. The analysis is carried out using STAAD PRO and data base is prepared for different storey levels as follow

Effect of storey drift in structure with storey heights in zone III

STOREY		MAXIMUM STOREY DRIFT IN SEISMIC ZONE III (mm)
NO	HEIGHT	
1	5	0.665
2	3	3.696
3	3	5.503
4	3	7.097
5	3	8.372

Table: 5.1 Maximum storey drift in seismic zones (mm) in building-I



Graph 5.1 Storey Number Vs Storey Drift

The graph is plotted as storey no in X-axis and storey drift in Y-axis. It is observed that the graph is irregular and the storey drift is more observed when storey 1 is kept as 5m in zone III and the maximum value is 8.372mm.

STOREY	MAXIMUM STOREY DRIFT IN SEISMIC ZONE III (mm)

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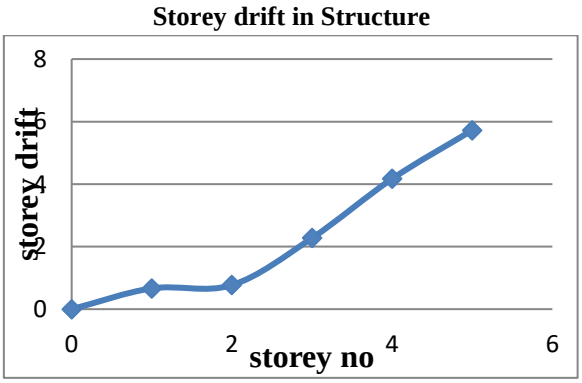
NO	HEIGHT	
1	5	0.895
2	3	0.769
3	3	2.274
4	3	4.170
5	3	5.723

Table: 5.2 Maximum storey drift in seismic zones (mm) in building-II

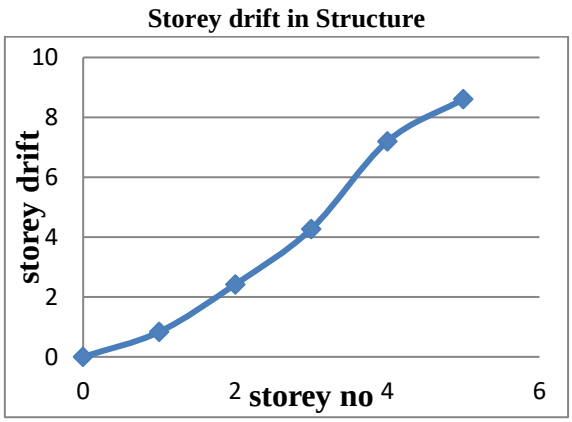


Graph 5.2 Storey Number Vs Storey Drift

The graph is plotted as storey no in X-axis and storey drift in Y-axis. It is observed that the graph is irregular and the storey drift is more observed when storey 1 is kept as 5m in zone III and the maximum value is 5.723mm.

STOREY		MAXIMUM STOREY DRIFT IN SEISMIC ZONE III (mm)
NO	HEIGHT	
1	3	0.834
2	3	2.422
3	5	4.272
4	3	7.196
5	3	8.608

Table: 5.3 Maximum storey drift in seismic zones (mm) in building-III

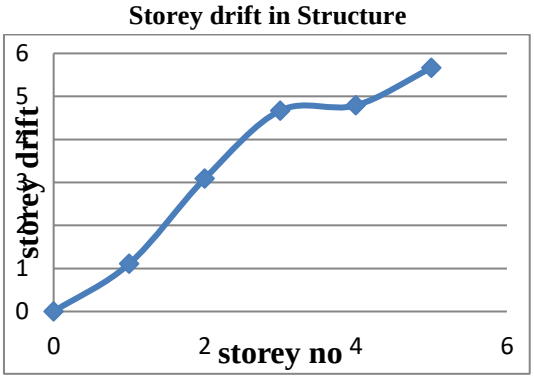


Graph 5.3 Storey Number Vs Storey Drift

The graph is plotted as storey no in X-axis and storey drift in Y-axis. It is observed that the graph is irregular and the storey drift is more observed when storey 3 is kept as 5m in zone III and the maximum value is 8.608mm.

STOREY		MAXIMUM STOREY DRIFT IN SEISMIC ZONE III (mm)
NO	HEIGHT	
1	3	1.109
2	3	3.089
3	5	4.670
4	3	4.790
5	3	5.662

Table: 5.4 Maximum storey drift in seismic zones (mm) in building-IV

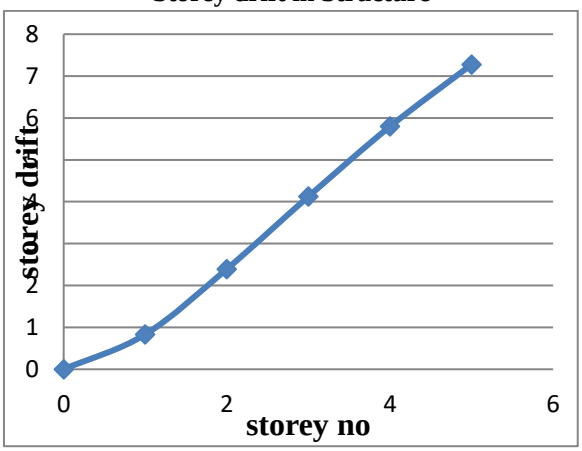


Graph 5.4 Storey Number Vs Storey Drift

The graph is plotted as storey no in X-axis and storey drift in Y-axis. It is observed that the graph is irregular and the storey drift is more observed when storey 3 is kept as 5m in zone III and the maximum value is 5.662mm.

STOREY		MAXIMUM STOREY DRIFT IN SEISMIC ZONE III (mm)
NO	HEIGHT	
1	3	0.832
2	3	2.394
3	3	4.123
4	3	5.796
5	5	7.275

Table: 5.5 Maximum storey drift in seismic zones (mm) in building-V



Graph 5.5 Storey Number Vs Storey Drift

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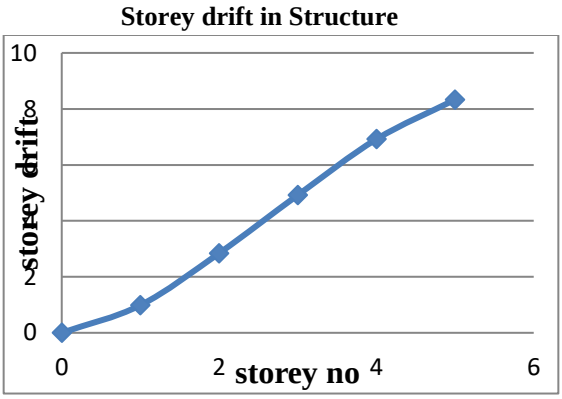
The graph is plotted as storey no in X-axis and storey drift in Y-axis. It is observed that the graph is irregular and the storey drift is more observed when storey 5 is kept as 5m in zone III and the maximum value is 7.275mm.

STOREY		MAXIMUM STOREY DRIFT IN SEISMIC ZONE III (mm)
NO	HEIGHT	
1	3	0.986
2	3	2.843
3	3	4.919
4	3	6.917
5	5	8.330

Table: 5.6 Maximum storey drift in seismic zones (mm) in building-VI



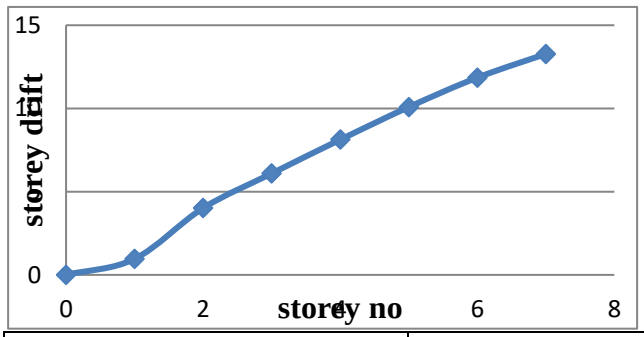
Graph 5.6 Storey Number Vs Storey Drift

The graph is plotted as storey no in X-axis and storey drift in Y-axis. It is observed that the graph is irregular and the storey drift is more observed when storey 5 is kept as 5m in zone III and the maximum value is 8.330mm.

STOREY		MAXIMUM STOREY DRIFT IN SEISMIC ZONE III (mm)
NO	HEIGHT	
1	5	0.960
2	3	4.014
3	3	6.093
4	3	8.124
5	3	10.083
6	3	11.851
7	3	13.272

Table: 5.7 Maximum storey drift in seismic zones (mm) in building-VII

Storey drift in Structure



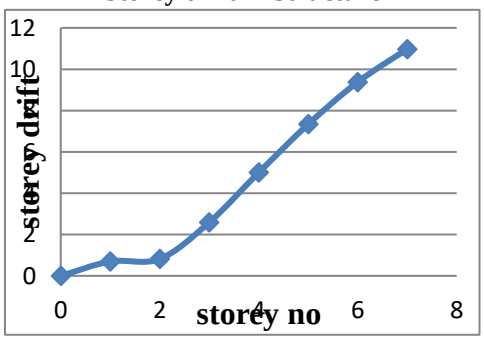
Graph 5.7 Storey Number Vs Storey Drift

The graph is plotted as storey no in X-axis and storey drift in Y-axis. It is observed that the graph is irregular and the storey drift is more observed when storey 1 is kept as 5m in zone III and the maximum value is 13.272mm.

STOREY		MAXIMUM STOREY DRIFT IN SEISMIC ZONE III (mm)
NO	HEIGHT	
1	5	0.697
2	3	0.818
3	3	2.588
4	3	4.998
5	3	7.337
6	3	9.380
7	3	10.971

Table: 5.8 Maximum storey drift in seismic zones (mm) in building-VIII

Storey drift in Structure



Graph 5.8 Storey Number Vs Storey Drift

The graph is plotted as storey no in X-axis and storey drift in Y-axis. It is observed that the graph is irregular and the storey drift is more observed when storey 1 is kept as 5m in zone III and the maximum value is 10.971mm.

STOREY		MAXIMUM STOREY DRIFT IN SEISMIC ZONE III (mm)
NO	HEIGHT	
1	3	0.914
2	3	2.668
3	3	4.710
4	5	6.946
5	3	10.560
6	3	12.506

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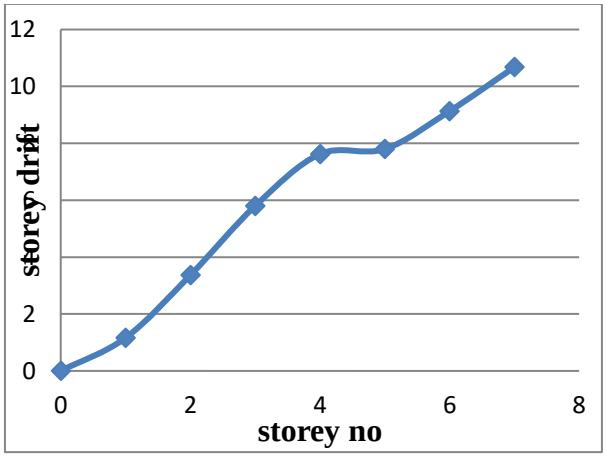
7	3	13.973

Table: 5.9 Maximum storey drift in seismic zones (mm) in

STOREY		MAXIMUM STOREY DRIFT IN SEISMIC ZONE III (mm)
NO	HEIGHT	
1	3	0.929
2	3	2.702
3	3	4.741
4	3	6.858
5	3	8.936
6	3	10.857
7	5	12.514

building-IX

Storey drift in Structure



Graph 5.10 Storey Number Vs Storey Drift

The graph is plotted as storey no in X-axis and storey drift in Y-axis. It is observed that the graph is irregular and the storey drift is more observed when storey 4 is kept as 5m in zone III and the maximum value is 10.675mm.

Table: 5.11 Maximum storey drift in seismic zones (mm) in building-XI

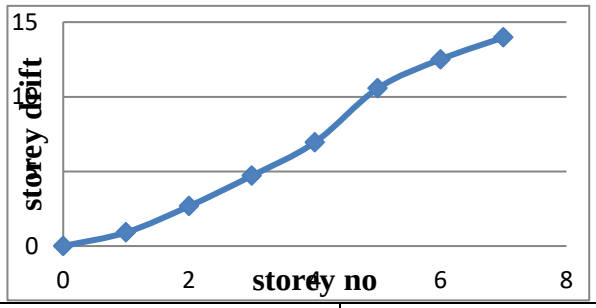
Storey drift in Structure

Graph 5.11 Storey Number Vs Storey Drift

The graph is plotted as storey no in X-axis and storey drift in Y-axis. It is observed that the graph is irregular and the storey drift is more observed when storey 4 is kept as 5m in zone III and the maximum value is 12.514mm.

STOREY		MAXIMUM STOREY DRIFT IN SEISMIC ZONE III (mm)
NO	HEIGHT	
1	3	1.021
2	3	2.972
3	3	5.226
4	3	7.594
5	3	9.959
6	3	12.142
7	5	13.663

The graph is plotted as storey no in X-axis and storey drift in Y-axis. It is observed that the graph is irregular and the storey drift is more observed when storey 4 is kept as 5m in zone III and the maximum value is 13.973mm.



STOREY		MAXIMUM STOREY DRIFT IN SEISMIC ZONE III (mm)
NO	HEIGHT	
1	3	1.162
2	3	3.366
3	3	5.798
4	5	7.623
5	3	7.797
6	3	9.130
7	3	10.675

Table: 5.10 Maximum storey drift in seismic zones (mm) in building-X

Storey drift in Structure

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Table: 5.12 Maximum storey drift in seismic zones (mm) in building-XII

Storey drift in Structure

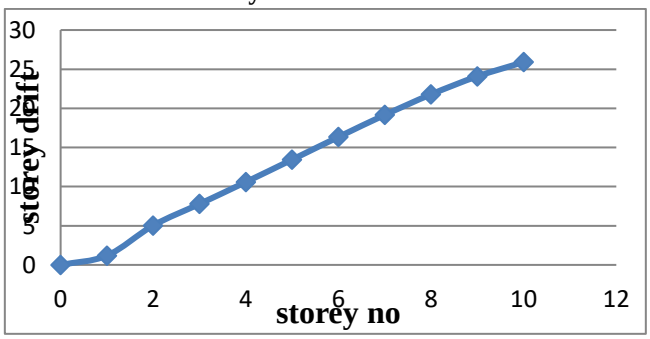
Graph 5.12 Storey Number Vs Storey Drift

The graph is plotted as storey no in X-axis and storey drift in Y-axis. It is observed that the graph is irregular and the storey drift is more observed when storey 4 is kept as 5m in zone III and the maximum value is 13.663mm.

STOREY		MAXIMUM STOREY DRIFT IN SEISMIC ZONE III (mm)
NO	HEIGHT	
1	5	1.188
2	3	5.038
3	3	7.786
4	3	10.582
5	3	13.450
6	3	16.337
7	3	19.155
8	3	21.785
9	3	24.079
10	3	25.902

Table: 5.13 Maximum storey drift in seismic zones (mm) in building-XIII

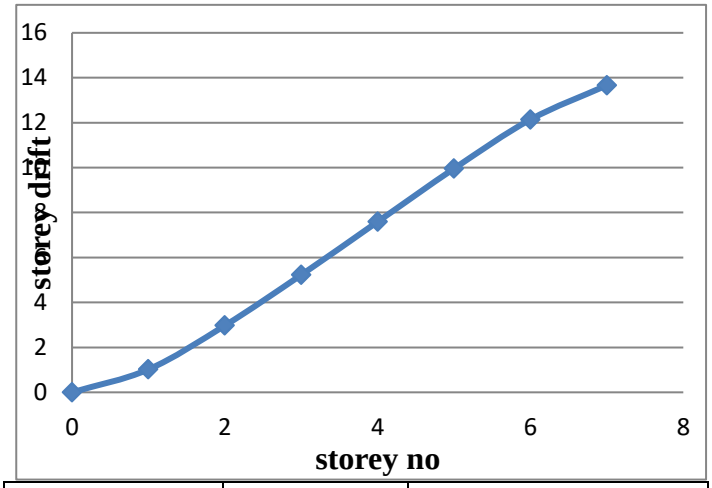
Storey drift in Structure



Graph 5.13 Storey Number Vs Storey Drift

The graph is plotted as storey no in X-axis and storey drift in Y-axis. It is observed that the graph is irregular and the storey drift is more observed when storey 4 is kept as 5m in zone III and the maximum value is 25.902mm.

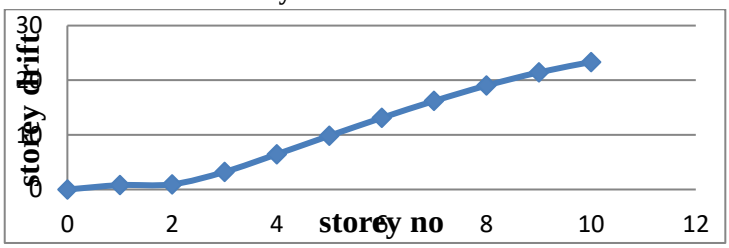
STOREY		MAXIMUM STOREY DRIFT IN SEISMIC ZONE III (mm)
NO	HEIGHT	
1	5	0.799
2	3	0.946
3	3	3.215
4	3	6.455
5	3	9.818



6	3	13.096
7	3	16.193
8	3	19.011
9	3	21.430
10	3	23.328

Table: 5.14 Maximum storey drift in seismic zones (mm) in building-XIV

Storey drift in Structure



Graph 5.14 Storey Number Vs Storey Drift

The graph is plotted as storey no in X-axis and storey drift in Y-axis. It is observed that the graph is irregular and the storey drift is more observed when storey 4 is kept as 5m in zone III and the maximum value is 23.328mm.

STOREY		MAXIMUM STOREY DRIFT IN SEISMIC ZONE III (mm)
NO	HEIGHT	
1	3	1.109
2	3	3.289
3	3	5.867
4	3	8.672
5	5	11.736
6	3	16.780
7	3	19.786
8	3	22.446
9	3	24.741
10	3	26.560

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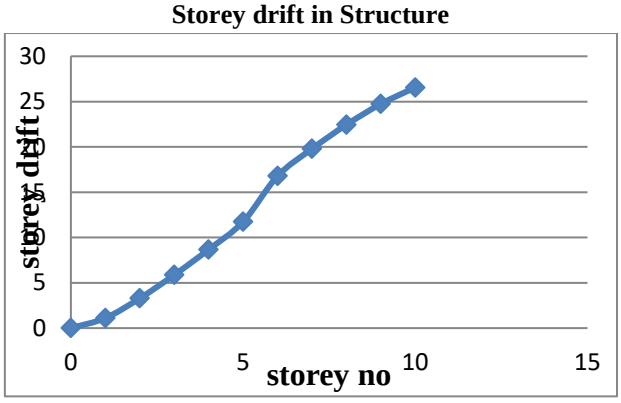
Table: 5.15 Maximum storey drift in seismic zones (mm) in building-XIV

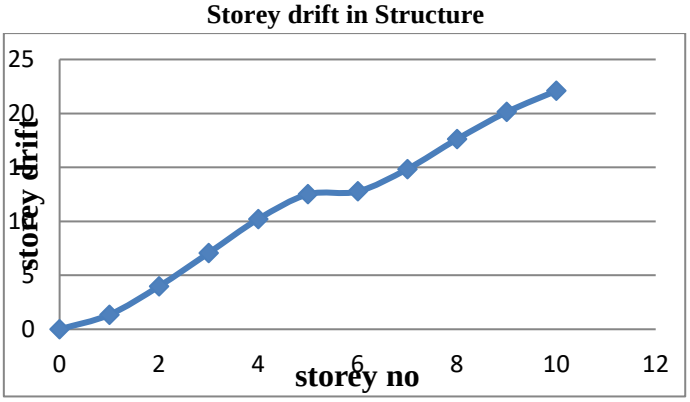


Graph 5.15 Storey Number Vs Storey Drift

The graph is plotted as storey no in X-axis and storey drift in Y-axis. It is observed that the graph is irregular and the storey drift is more observed when storey 4 is kept as 5m in zone III and the maximum value is 26.560mm.

STOREY		MAXIMUM STOREY DRIFT IN SEISMIC ZONE III (mm)
NO	HEIGHT	
1	3	1.344
2	3	3.977
3	3	7.067
4	3	10.210
5	5	12.502
6	3	12.767
7	3	14.843
8	3	17.612
9	3	20.124
10	3	22.089

Table: 5.16 Maximum storey drift in seismic zones (mm) in building-XIV

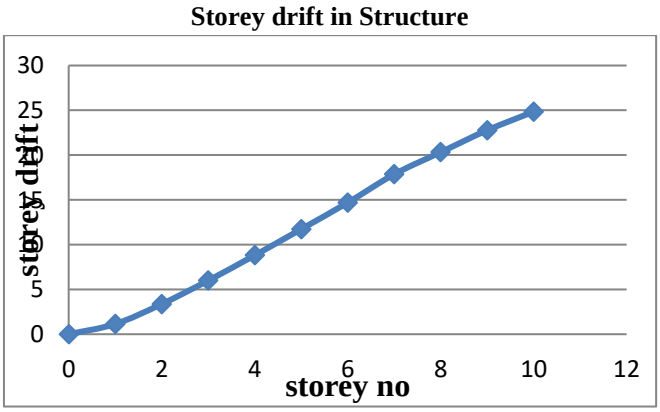


Graph 5.16 Storey Number Vs Storey Drift

The graph is plotted as storey no in X-axis and storey drift in Y-axis. It is observed that the graph is irregular and the storey drift is more observed when storey 4 is kept as 5m in zone III and the maximum value is 26.560mm.

STOREY		MAXIMUM STOREY DRIFT IN SEISMIC ZONE III (mm)
NO	HEIGHT	
1	3	1.134
2	3	3.362
3	3	5.987
4	3	8.804
5	3	11.727
6	3	14.682
7	3	17.852
8	3	20.317
9	3	22.767
10	5	24.840

Table: 5.17 Maximum storey drift in seismic zones (mm) in building-XIV



Graph 5.17 Storey Number Vs Storey Drift

The graph is plotted as storey no in X-axis and storey drift in Y-axis. It is observed that the graph is irregular and the storey drift is more observed when storey 4 is kept as 5m in zone III and the maximum value is 24.840mm.

STOREY		MAXIMUM STOREY DRIFT IN SEISMIC ZONE III (mm)
NO	HEIGHT	
1	3	1.199
2	3	3.551
3	3	6.320
4	3	9.297
5	3	12.399
6	3	15.562
7	3	18.704
8	3	21.708
9	3	24.370
10	5	26.172

Table: 5.18 Maximum storey drift in seismic zones (mm) in building-XIV

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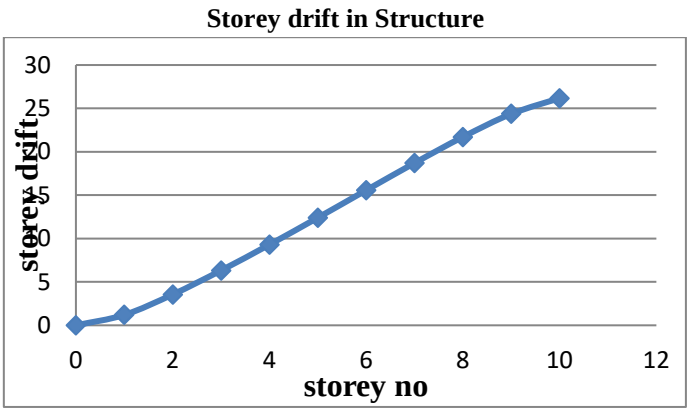

Graph 5.18 Storey Number Vs Storey Drift

The graph is plotted as storey no in X-axis and storey drift in Y-axis. It is observed that the graph is irregular and the storey drift is more observed when storey 4 is kept as 5m in zone III and the maximum value is 26.172mm.

CONCLUSION

Based on the results in chapter 5, from the seismic load analysis of G+5, G+7, G+10 braced and unbraced building models it is observed that the maximum values of Shear Force, stress, bending moment, and storey drift are

1. Soft storey shear force for G+10 unbraced structure (from the figure 4.1) – 5.54KN and braced structure (from the figure 4.2) –1.1KN .
2. Storey max stress for G+10 unbraced structure (from the figure 4.3) – 93.67N/mm^2 and braced structure (from the figure 4.4) – 93.64N/mm^2.
3. Soft storey bending moment for G+10 unbraced structure (from the figure 4.7) -15.4KNm, 14.9KNm and braced structure (from the figure 4.8) -3.14KNm and 2.85KNm.
4. Storey drift of Building-V (for a G+5 structure soft storey at 5th floor without bracings) - 7.275mm and storey drift of Building-VI (with bracings) - 8.330mm.
5. Storey drift of Building-XI (for a G+7 structure soft storey at 7th floor without bracings) - 12.514mm and storey drift of Building-XII (with bracings) -13.663mm.
6. Storey drift of Building-XVII (for a G+10 structure soft storey at 10th floor without bracings) -24.840mm and storey drift of Building-XVIII (with bracings) -26.172mm.

From the results it is recommended to place the soft storey in the top portion of the building and the stiffness is to be increased by applying bracings to soft storey to reduce the risk of damage or collapse of the building due to lateral loads.

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ISBN: 978-81-956748-3-1

Effect of blast furnace slag on the fracture performance of self compacting concrete (SCC)

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Abstract*— *Self-Compacting Concrete (SCC) is high fluidity concrete mixture designed to achieve consolidation under its own weight. The high fluidity of SCC makes it ideal for achieving the compaction in sections with congested reinforcement and reduces the dependence on the quality of workmanship available on the site. Use of SCC can help in minimize hearing-loss related damages, induced by vibrating concrete, in the construction workers. On the other hand, researchers are attempting to reduce the cement content in the concrete mix by partially replacing the cement with other industrial by-product pozzolanic materials e.g. Fly ash (FA), Silica fumes, Ground Granulated Blast Furnace Slag (GGBS), etc. The addition of these pozzolanic materials reduces the consumption of cement in the concrete mix without affecting its physical properties and promotes the environmental conservation and global warming reduction efforts. Fracture toughness of the concrete is important to study the behavior of concrete with inherent microscopic flaws under static or dynamic loading. The fracture toughness of concrete is the resistant of material from fracture failure, starting from pre-existing crack. The durability of concrete structure is also depends on the sub-critical crack growth. In this paper experimental studies are carried out to evaluate the Mode - I facture properties of SCC in which cement is partially replaced by (GGBS) in various proportions for M50 grade concrete. The proportions in which cement replaced are 20%, 30%, 40% of GGBS and 20% of FA. The Compressive Strength behavior and Mode-I fracture toughness of beam under four-point bending test is studied at different curing durations.

1. Introduction

Self-compacting concrete has been described as “the most revolutionary development in concrete construction for several decades”. Originally developed in japan to offset a growing shortage of skilled labour, it has been proved to be beneficial from the following points.

- Faster construction
- Reduction in site man power
- Better surface finish

Self-compacting concrete is also called as self-consolidating concrete. Recognizing the lack of uniformity and complete compaction of concrete by vibration, University of Tokyo, Japan carried out the research in1980’s to develop SCC. By 2000, SCC became more popular in Japan for fabrication product and ready mixed concrete. SCC can be placed easily in form work Without vibration causing no segregation and can be placed using than gravity forces only. Self- compacting concrete increases the reliability of structures and reduces the labour required at construction site. It is a technique for high execution concrete with prevalent deformability and unrivalled isolation resistance. Recently, it has been utilized for restoration works in Canada and Switzerland to re-establish of scaffold projections, burrow segments, dock tops, holding dividers and parking structures. Several other European countries recognized the significance and potential of SCC developed in japan. During 1989, they founded European Federation of Natural Trade Associations representing producers and applicators of specialist building products (EFNARC). Self-compacting concrete has started growing rapidly. In 2001, EFNARC, making use of broad practical experience of all members of European federation with SCC, has drawn up specification and guidelines to provide a frame work for design and use of high. Quality SCC, most of the information particularly test method, specification and guidelines for self-compacting concrete given by EFNARC.

2. Summary of Literature Review

- A new mix design methodology for the mix design of self-compacting concrete with various proportions of GGBS concrete is discussed.
- Experimental and numerical studies on mechanical properties, such as strength, elastic modulus, creep and shrinkage, of SCC and the *corresponding* of NC are reviewed.
- The review has shown that although sufficient data have been obtained to give confidence in the general behavior of SCC, and future studies are needed to focus on specific or confirmatory data for new mix design of SCC
- The literature review shows that Workability of SCC increase with increases in GGBS replacement level.
- Fracture toughness of SCC is higher with mineral admixtures in the mix as compared to SCC without mineral addition.
- The result obtained by WFM method when fracture energy increases then the compressive strength of concrete is also increases.

3. Objectives and Scope

- Comparison of compressive strength of self-compacting concrete with different amount of blast furnace slag.
- Study of the fracture characteristics and ductility of self-compacting concrete with different amount of blast furnace slag.
- Microstructural changes in the fractured surface of specimen fabricated using self-compacting concrete with different amount of blast furnace slag.

4. Research Significance

1. To reduce the consumption of cement in concrete

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2. To reduce the overall cost of RCC construction.
3. To reduce the fracture behavior of self-compacting concrete

5 Methodology

1. Literature Review
2. Testing of Material
3. Compression Testing of cubes after 7, 14, 28, 90, days of water curing
4. Casting of beam for Mode – I fracture Testing
5. Mode – I fracture testing of beams after 28 and 90 days of water curing
6. Analysis of results
7. Discussion and Recommendations

6. Experimental Set Up

- The specimen is supported on steel rollers which were again supported by steel blocks
- Loading of all the beams is done by using hydraulic jack
- The loading Jack is manually operated for loading and unloading
- The applied load is measured by pre-calibrated proving ring of capacity 10 tons
- At each load increment, three observations, viz, CMOD, deflection and strain at different levels of beam will be noted.
- By using load vs. CMOD, load vs. deflection curves will be plotted to calculate the mode – I stress intensity factor.

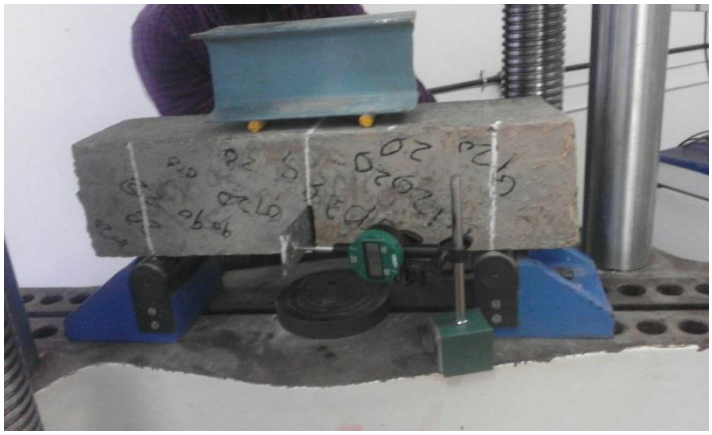

Figure 6.1 Experimental Set Up

7. Results and Discussion

Compressive Strength Test Results (28 days)

Content	28 Days (MPa)	% Change
Conventional SCC	51.5	---
SCC with 20% GGBS	54.2	5.2
SCC with 30% GGBS	52.4	1.75
SCC with 40% GGBS	48	-6.80
SCC with 20% Fly ash	44.2	-14.17

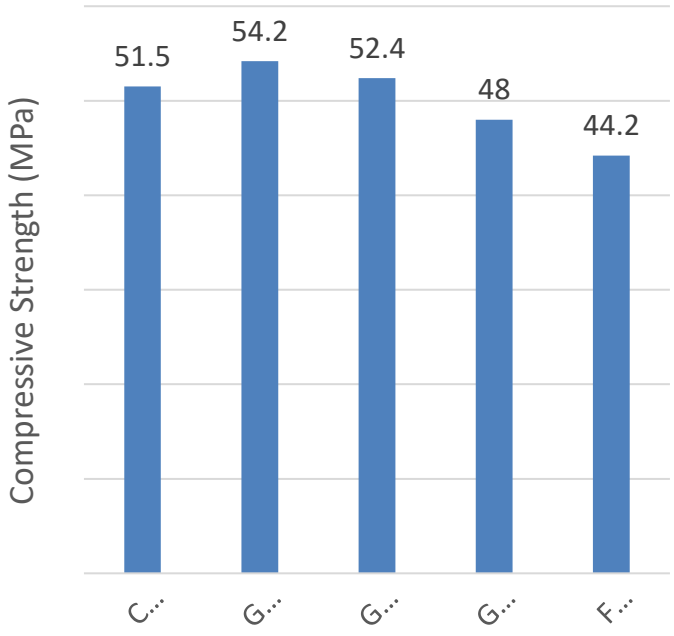

Figure 7.1 Compressive Strength Test Results

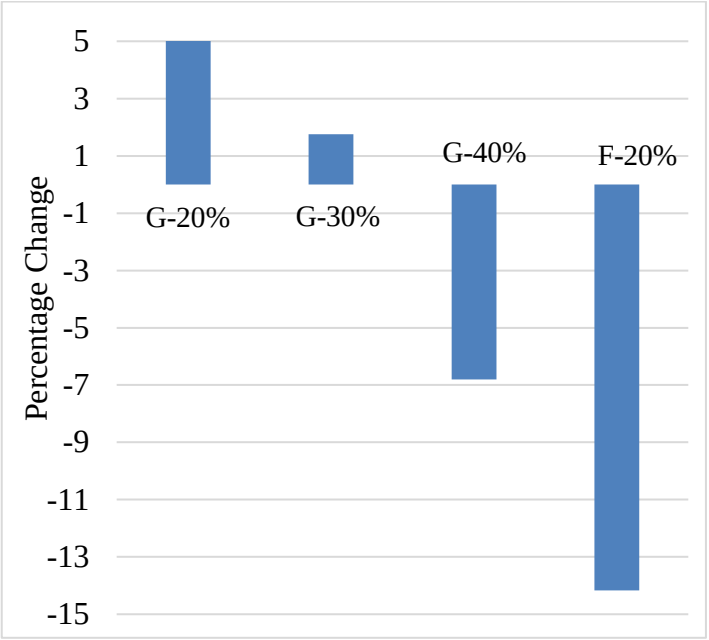

Figure 7.2 Percentage Change

Compressive Strength Test Results (90 days)

Content	28 Days (MPa)	% Change
Conventional SCC	53.25	--
SCC with 20% GGBS	57.54	8.05
SCC with 30% GGBS	55.36	3.96

SCC with 40% GGBS	49.48	-7.07
SCC with 20% Fly ash	46.23	-13.18

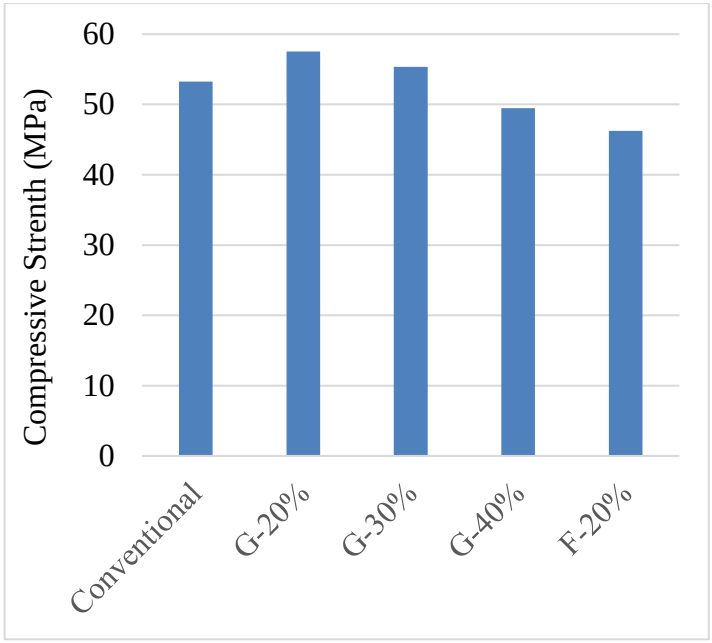

Figure 7.3 Compressive Strength Test Results

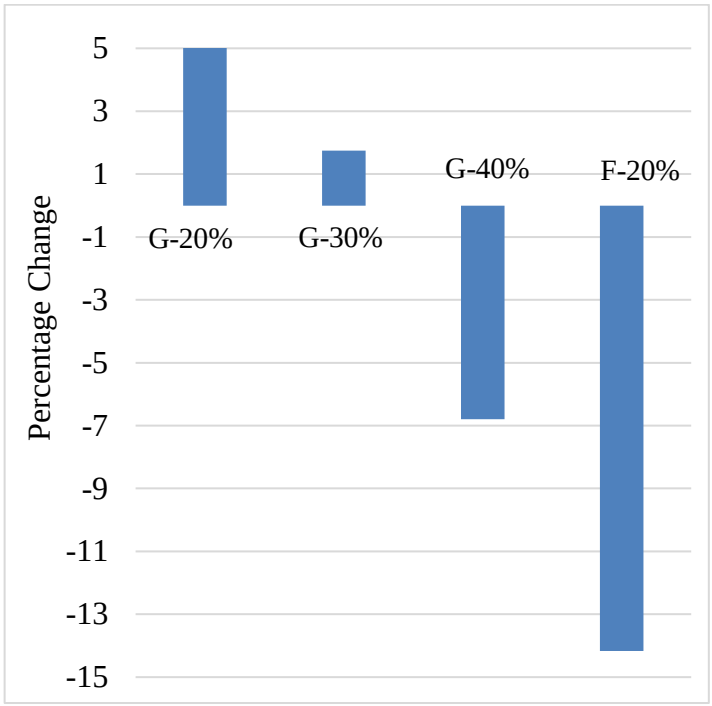

Figure 7.4 Percentage Change

K_{Ic} Value After28 Days of Water Curing

Content	Load (kN)	K_{Ic}	% Change
Conventional SCC	7.5	0.423	
SCC with 20% GGBS	10.5	0.592	39.35
SCC with 30% GGBS	9.5	0.535	26.47
SCC with 40% GGBS	8.5	0.479	13.23
SCC with 20% Fly ash	6	0.338	-20.0

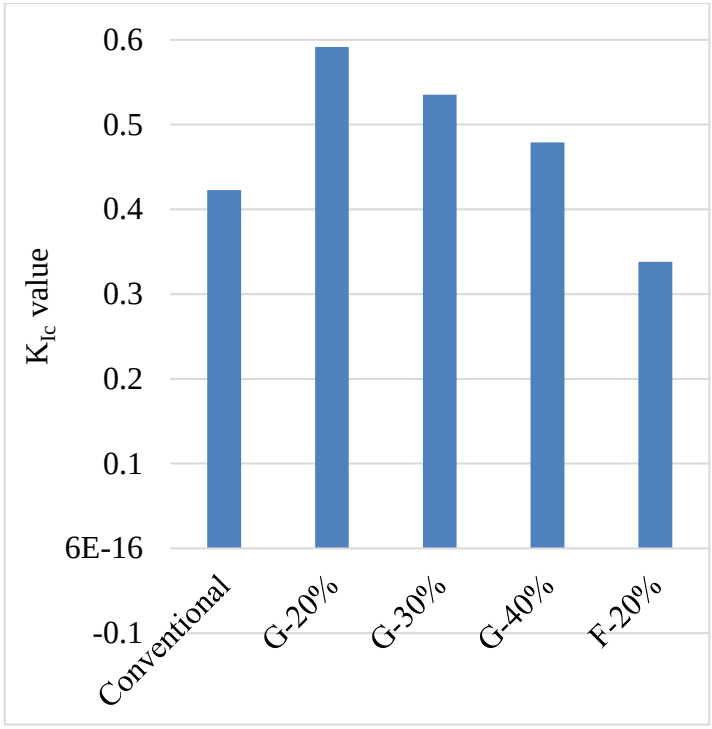

Figure 7.5 K_{Ic} Value After28 Days of Water Curing

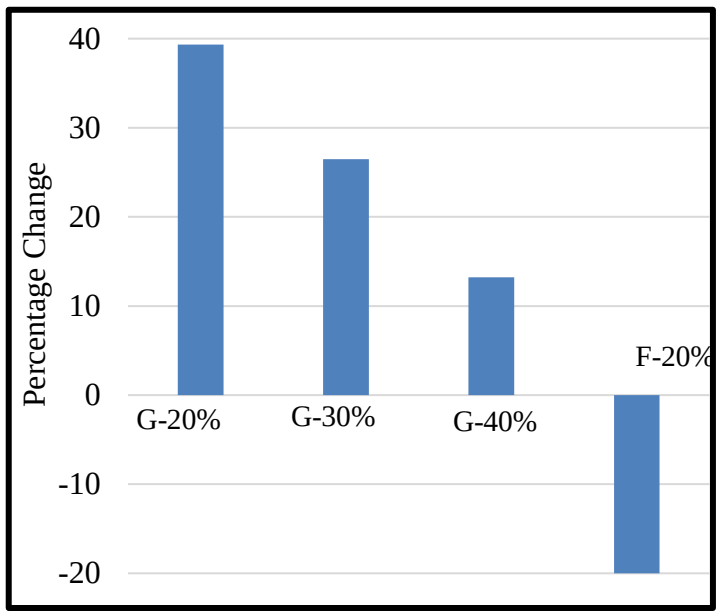

Figure 7.6 Percentage Change

K_{Ic} Value After 90 Days of Water Curing

Content	Load (kN)	K_{Ic}	% Change
Conventional SCC	9	0.507	--
SCC with 20% GGBS	11	0.620	22,28
SCC with 30% GGBS	10.5	0.592	16.76

SCC with 40% GGBS	10	0.563	11.04
SCC with 20% Fly ash	8	0.450	-11.24

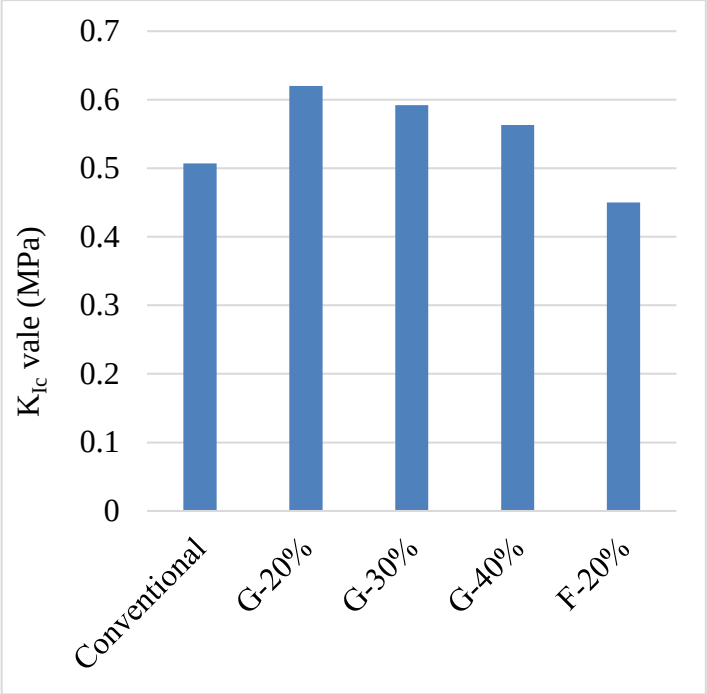

Figure 7.7 K_{Ic} Value after 90Days of Water Curing

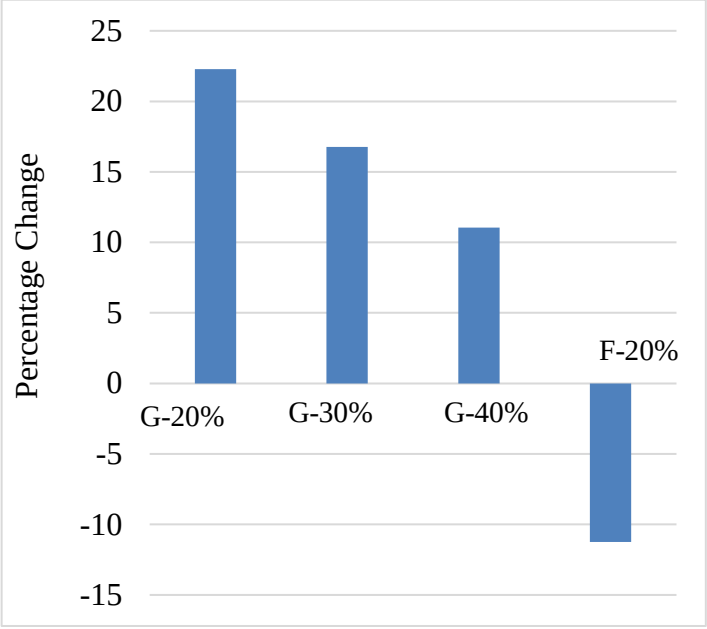

Figure 7.8 Percentage Change

8.Conclusion

- The compression strength of the cube increases when 20%, 30% of cement is replaced with GGBS as compared to conventional concrete cubes.
- When 40% of cement is replaced with GGBS the compressive strength reduces (by-6.80% drop). Where 20% fly ash replaces the cement it gives poor compressive strength (by-14.17% drop)
- The K1c of beam increases when 20%, 30% and 40% of cement is replaced by GGBS as compared to conventional concrete. At 20% fly ash replacement level, the K1c value get reduced as compared to conventional concrete

9. References

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ISBN: 978-81-956748-3-1

Study on Strength Development of High Strength Concrete Reinforced with Hybrid Fiber

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Abstract:
In this paper, an experimental study was conducted on high strength concrete [HSC] reinforced with steel fibres and hybrid fibers consisting of steel fiber, coir fiber and palm fibre. A volumetric fraction of 1% was maintained. High strength concrete is made by partial replacement of silica fume [10% by weight of cement]. Super plasticizer was added to obtain the required degree of workability. The compressive strength and split tensile strength were determined to study the effect of fibre on the properties of high strength concrete. The results indicate the concrete made with combination of three fibres shows a more strength development rather than individual fibre or combination of two fibres.

Keywords: Steel fibre, Palm fibre, Coir fibre, High strength concrete

1. Introduction

1.1. General

High Strength Concrete (HSC) is used increasingly for a range of structural applications, and standards in a number of countries are being revised to accommodate the improved material. The use of this material is not without problems, however, as HSC is often also more brittle than conventional concrete. This problem of brittleness can be solved in various ways, e.g. improvement in ductility can be provided by fibre reinforcement. Fibres may be used individually are combination of different fibres.

Fibre Reinforced Concretes (FRC) have mostly been used in non-structural applications such as slabs-on-grade, floors and architectural concrete and typically less than 1% by volume of fibres are used [5]. It is often prohibitive - for reasons of cost as well as in order to ensure acceptable workability and homogeneity - to include larger contents of fibres, but it has been tried with success in a few cases, and in these cases other properties besides ductility can be improved as well [11]. Concrete made with fibre increase mechanical property (6). Using different combination of fibres in concrete is increasing the concrete properties quite higher than the concrete made with single fibres (4). During the last few decades the “waste” materials have seen a transformation to the status of “by-products”. And that are sought for construction and other applications. Several residual material properties are suited for concrete production. It can reduce the energy to make concrete and it is also a more economical concrete than the conventional one (19).

This research is undertaken on the use of silica fume as cement replacement (10%) and fibers as an adding material in high strength concrete-making. In this study, the mineral admixtures (Silica fume) expected to strengthen the (ITZ) Interfacial Transition Zone in cement concrete. This reaction will improve the concrete properties and proposed to use metallic and natural fibres to reduce plastic shrinkage in high strength concrete.

1.2. Research significance

The objective of this study is to investigate the strength property of various fibres reinforced concrete, containing individual steel fibres, combination of metallic and natural fibre (steel fibre, coir fibre and palm fibre) and combination of natural fibre (coir fibre and palm fibre). The total dosage of fibres was maintained at a volumetric fraction of 1.0%. A comparative evaluation of various mixes was studied based on their hardened properties such as; compressive strength and split tensile strength.

2. Experimental program

2.1. Materials

The cement used in all concrete mixes was ordinary Portland Cement (OPC)-53 Grade which corresponds to IS12269-1987. Silica fume (SF) was obtained from Elkem Materials and was used as partial replacement for cement. The properties of OPC and silica fume are given in the table 1 and table 2 respectively.

ISBN: 978-81-956748-3-1

Table 1: Chemical composition of ordinary Portland cement

Properties	OPC 53 values
1) Lime saturation factor	0.9
2) Alumina Modulus	1.23
3) Insoluble residue (%)	0.25
4) Magnesia (%)	1.1
5) Sulphuric anhydrideSO3 (%)	1.5
6) Loss on ignition (%)	0.8
7) Chloride (%)	0.002
8) C3A Content	7
9) Humidity (%)	65±5

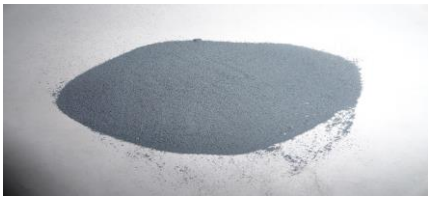

Fig 1. Silica fume

Table 2: Chemical composition of silica fume

SiO_2 (silicon dioxide, amorphous)	Min. 85.0%
H_2O (moisture)	Max. 1.0 % (when packed)
C (carbon)	Max. 2.5 %
LOI (Loss on Ignition)	Max. 4.0 %

The sand used was local natural sand with specific gravity of 2.55 and fineness modulus of 2.68. The coarse aggregate with a maximum size of 20 mm and specific gravity, fineness modulus were 2.93 and 7.29 respectively.

The super plasticizer (SP) used was SP430, obtained from Fosroc Chemicals; used to obtain desired workability of concrete mixes. The fibres used in the study were corrugated steel, coir and palm and their properties are presented in the table 3, table 4, and table 5 respectively.

Table: 3 Characteristics of Steel fibre

Fibre properties	Quantity
Average fibre length (mm)	**50**
Diameter (mm)	1
Aspect ratio	50
Tensile strength (MPa)	1100
Specific Gravity	7.85

Table: 4 Characteristics of Palm fibre

Fibre properties	Quantity
Average fibre length (mm)	50
Average fibre width (µm)	21.13
Specific gravity	2.14
Tensile strength (MPa)	21.2

Table: 5 Characteristics of Coir fibre

Fibre properties	Quantity
Average fibre length (mm)	50
Average fibre width (µm)	203
Density (g/cm^3)	1.25
Tensile strength (MPa)	304

ISBN: 978-81-956748-3-1

(a) **(b)** **(c)**

Fig2. (a) Steel Fibre, (b) Palm fibre, (c) Coir fibre

Table 6: Mix proportions

Mix ID	Cement (kg/m^3)	S.F (kg/m^3)	Water (kg/m^3)	S.P (%)	Sand (kg/m^3)	Aggregate (kg/m^3)	W/B	Steel Fibre (%)	Palm Fibre (%)	Coir Fibre (%)
R	405	45	145	2.0	612	1248	0.35	-	-	-
R1	405	45	145	2.4	612	1248	0.35	1	-	-
R2	405	45	145	2.4	612	1248	0.35	0.5	0.5	-
R3	405	45	145	2.4	612	1248	0.35	0.5	-	0.5
R4	405	45	145	2.4	612	1248	0.35	0.5	0.25	0.25
R5	405	45	145	2.4	612	1248	0.35	0.25	0.5	0.25
R6	405	45	145	2.4	612	1248	0.35	0.25	0.25	0.5
R7	405	45	145	2.4	612	1248	0.35	-	0.5	0.5

2.2. Mix proportions

The mix proportions are presented in table 6. A total of 8 mixes were prepared using water binder ratio of 0.35 and the silica fume replacement was 10%. The amount of cement, silica fume, sand, aggregate, and free water kept constant. The amount of superplasticizer varied from 2.2% to 2.4% by weight of binder content to maintain appropriate slump. Control mix R was designed as per IS 10262-2009 to achieve a target compressive strength of 58 MPa. The steel fibre was added to the mix according to the volumetric fraction of 1% for the mix R1. The 1% hybrid mix of fibre was composed of, steel and palm fibre (0.5% + 0.5%) in mix R2, steel and coir fibre (0.5% + 0.5%) in mix R3 and palm and coir fibre(0.5% + 0.5%) in R7.similarly,

ISBN: 978-81-956748-3-1

the hybridization of three different fibres steel, palm and coir fibre was used to prepare mixes R4 to R6. The total amount of hybrid fibres in all mixes was maintained at a volumetric fraction of 1%.

2.3. Casting details

Fresh concrete was cast in steel moulds and compacted on a vibrating table. The specimen prepared in this study were; 150 mm cubes for compressive strength as per IS 516-1999 (13) and 150 mm x 300 mm cylinder for split tensile strength as per IS 5816 – 1999 (14).

2.4. Test Methods

Six specimens each were casted and tested in the case of compressive strength and split tensile. The normal moist curing was adopted for 28 days. The cube specimens were left in the molds for 24 hour. After remolding, the specimens were transferred into the water for curing until the age of test. The strength test was performed on a universal testing machine.

3. Results and Discussion

Results for compressive strength and split tensile strength of various fibre concretes at 28 days are presented in the table 7.

Table 7: Strength Results

Mix ID	Compressive strength (MPa)	Split tensile strength (MPa)
R	55.6	2.75
R1	58.6	2.91
R2	58.9	3.29
R3	58.4	3.28
R4	65.2	3.61
R5	66	3.36
R6	64.1	3.34
R7	57.6	3.3

3.1. Compressive strength

Form the results for compressive strength; it is evident that an enhancement in strength compared to control concrete occurs for the steel fibre concrete and all hybrid fibres concretes.

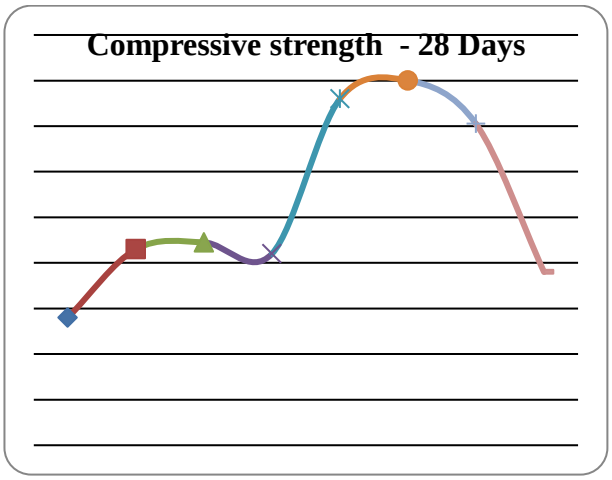

Figure 3: compressive strength for all mixes

The use of a 1% volume of steel fibre (R1) was found to reveal a compressive strength of about 5.39% higher than that of the control mix (R). The increase in strength for mix R2 with hybrid content of 0.5% steel fibre + 0.5% palm fibre by volume was 5.93% than that of mix R. Whereas the mix containing steel fibre, palm fibre and coir fibre (R4,R5,R5) had a higher compressive strength than that of control mix (R) by about 17.26%, 18.70% and 15.28% respectively .

3.2. Split tensile strength

Split tensile strengths of hybrid fibres concrete were found to be higher compared to reference and mono-steel fibre concrete.

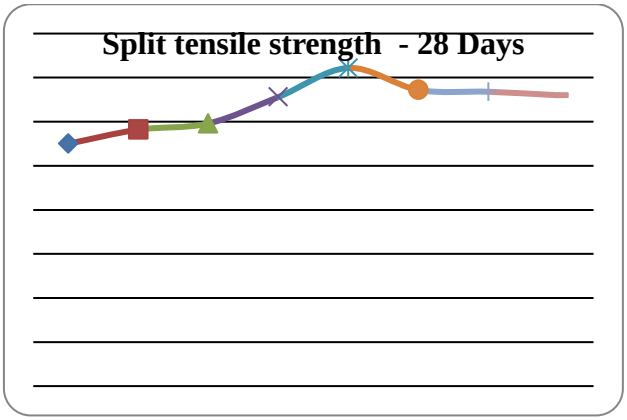

Figure 4: Split tensile strength for all mixes

The use of a 1% volume of steel fibre (R1) was found to reveal a split tensile strength of about 5.88% higher than

that of the control mix (R). The increase in strength for mix R2 with hybrid content of 0.5% steel fibre + 0.5% palm fibre by volume was 19.64% than that of mix R. Whereas the mix containing 0.5% steel fibre + 0.25% palm fibre + 0.25% coir fibre (R4) had a higher split tensile strength than that of control mix (R) by about 31.27%.

4. Conclusions

The study on the high strength concrete reinforced with various volume fractions of hybrid fibres revels the following:

1. The compressive strength results shows that the use of hybrid fibres of steel fibre, palm fibre and coir fibre gives the highest increase in compressive strength of concrete compared to control mix due to an improvement in mechanical bonding in matrix

2. The hybridization of 0.5% steel fibres with 0.5% of palm fibres increases the splitting tensile strength by about 19.64%. whereas the hybrid fibres of 0.5% steel + 0.25% palm + 0.25% coir increases the split tensile strength by about 31.27%.

3. Among the all mixes the R4 (0.5% steel + 0.25% palm + 0.25% coir) is found to be a best hybrid combination.

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ISBN: 978-81-956748-3-1

STUDY ON PROPERTIES OF FILLER SLABS USING COCONUT SHELLS

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***Abstract*— Right now India has taken a major activity in creating the framework to meet the necessities of globalization within the development industry. Considering building component like piece, more concrete is squandered within the pressure zone, since the malleable strengths are taken by the steel fortification. To overcome this wastage of concrete in pressure zone, a modern cost-effective strategy called as Filler slab strategy is utilized. Moo cost and lightweight filler substance like coconut shell, that will decrease the dead weight in expansion to the whole cost of this chunk to a few degrees. Being naturally responsible, the utilization of squander substances may be a Crucial step in making a maintainable future. The coconut shell, which is as a rule arranged as a rural squander can be utilized as filler fabric to partially reduce the utilization of concrete within the pliable locale without influencing the quality parameters. Taking after a recuperating period of 28 days, there's an adaptation in compression and flexural strength of concrete using coconut shell as filler material compared to conventional concrete.**

Keywords*— *Filler Slab Technique, Sustainable, coconut shell, Compression and Flexural Strength of Concrete.

1 INTRODUCTION

Concrete being the most elevated expended fabric on soil after water (cement industry alliance, Australia), is delivered and utilized at a huge scale within the development industry. thoughts to decrease the utilization of concrete without compromising the quality of development will not as it was led to taken a toll compelling building but moreover decrease carbon outflows when looked at a huge scale. numerous inventive procedures and prudent strategies are being proposed and filler piece innovation is one such inventive and cost-effective innovation where a dead stack of the chunk is decreased by replacing the concrete. concrete is nice in withstanding compressive forces and steel is nice in withstanding malleable strengths. the most point behind the utilize of filler-slab innovation is to condense a considerable parcel of concrete underneath the unbiased pivot since all concrete within the pressure zone does not include to the malleable properties. this concrete is supplanted with lightweight, dormant and reasonable filler without ignoring the quality and structural strength of the structure.

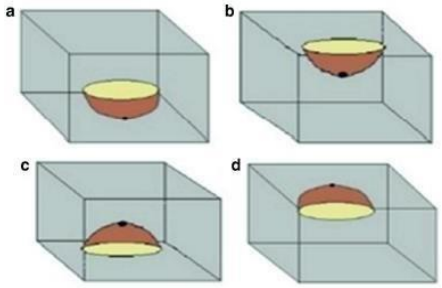
2. FILLER SLAB

By decreasing the amount and weight of concrete, the chunk gets to be less costly, but the quality should stay the same as the customary piece. In numerous of the areas, to diminish the warm affect within the building amid hot climate at an financial taken a toll, the filler-slab innovation acts as an fabulous thermal insulator and brings down the temperature interior the building. To preserve a maintainable environment, the materials to be chosen were to be of a squander or discarded material, which can offer assistance in reusing the squander. After investigating numerous materials just like the mine squander and numerous other squanders, three filler materials were brief recorded which fulfilled the criteria and were chosen as filler materials for plan and investigation of a filler piece not change any of the current assignments.

The filler piece is based on the guideline that for rooftops which are basically bolstered, the upper portion of the chunk is subjected to compressive strengths and the lower portion of the piece encounter pliable powers. Concrete is exceptionally great in withstanding compressive strengths and steel bears the stack due to ductile powers. Hence, the lower pliable locale of the piece does not require any concrete but for holding the steel fortifications together. Subsequently, in a routine RCC piece parcel of concrete is squandered and it needs additional support due to included stack of the concrete which can something else be supplanted by low-cost and light weight filler materials, which can diminish the dead weight as well as the taken a toll of the chunk to 25% (as 40% less steel is utilized and 30% less concrete).The filler chunks too result in less loads getting exchanged to the load-bearing dividers and the establishments.

The air gap in between the tiles makes it a good heat insulator and the ceiling looks very nice and attractive as well. To maintain a sustainable environment, the materials to be chosen were to be of a waste or discarded material, which can help in reusing the waste. After researching many materials like the mine waste and many other waste, three filler materials were short listed which satisfied the criteria and were chosen as filler materials for design and analysis of a filler slab.

ISBN: 978-81-956748-3-1



OBJECTIVES

- To decrease the total concrete usage in the tensile region with coconut shell (CS) and to reduce the slab weight as much as possible without compromising the strength parameters.
- The study aims to find the usage of coconut shell in the filler slab to enhance the strength characteristics and to make concrete lightweight by overcoming the disposal challenges of agricultural waste.
- To make it cost effective and environment friendly.
- To reduce the self-weight of concrete slab without compromising the strength parameters using coconut shell.

The main aim behind the use of filler-slab technology is to condense a substantial portion of concrete below the neutral axis since all concrete in the tension zone does not add to the tensile properties. This concrete is replaced with lightweight, inert and inexpensive filler without neglecting the quality and structural strength of the structure.

COCONUT SHELLS AS FILLER MATERIAL

The consumption of concrete is raising high. The production of cement raises the carbon footprint and causes depletion of non-renewable resources. Researchers are formulating new technologies to save the resources, energy for the next generations, to reduce disposal problems and to make the product or structure economical. For this purpose, recycled waste and treated natural materials, etc., are used as a substitute for cement, aggregates, or reinforcement. This paper presents studies conducted to analyze the performance of a coconut shell as a filler.

The material used in the present study was naturally available, cost-free, and nontoxic material. In this project, we are proposing to use the coconut shells of the same size, thickness and other visible characteristics as a filler material in the slab without crushing or powdering it.This experiment is possible to take place since the load in the tension zone is mostly carried by the reinforcement bars, thus partially replacing the concrete in the tension zone of the slab will not affect its strength parameters.

From the previous studies it has been observed that coconut shell has been used in partial replacement as aggregates, that is, fine aggregate as ash powder and coarse aggregate as crushed ones. In this project, we are proposing to use the coconut shells of the same size, thickness and other visible characteristics as a filler material in the slab without crushing or powdering it. This experiment is possible to take place since the load in the tension zone is mostly carried by the reinforcement bars, thus partially replacing the concrete in the tension zone of the slab will not affect its strength parameters.

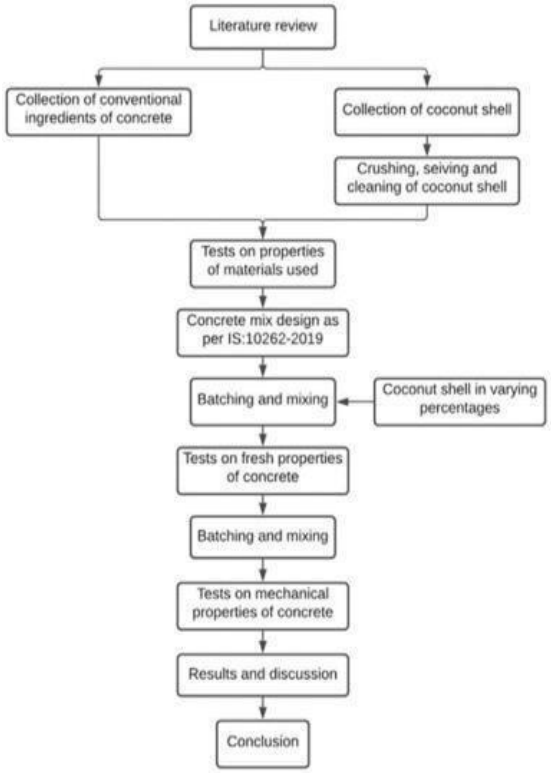
3. MATERIALS USED

Various materials such as Cement, M-sand, Coarse aggregate, coconut as filler material and reinforcement steel will be used in this study. Cement is used as a binder which binds, sets and hardens the other materials in contact M-sand is simply nothing but crushed granite rocks into finer particles. Coarse aggregate are gravel stones of bigger size than M-sand. The size to be used in concrete should generally lie between 10 - 20mm. Reinforcement steel are hot round bars, provided with deformation patters to give a better bonding between the steel and concrete. These, steel are used in concrete to provide tensile strength. Reinforcement steel are hot round bars, provided with deformation patters to give a better bonding between the steel and concrete. These, steel are used in concrete to provide tensile strength.

4. CONSTRUCTION OF FILLER SLABS

The shuttering of the slab is placed and held stiff. This is followed by the reinforcing bars are placed over the shuttering as per design of the slab. These bars are tied using binding wire at every cross section of the bars and cover is provided at the bottom of the bars by using cover clocks. Filler blocks are then placed over the shuttering proving a cover between the reinforcement as shown. Concrete of a grade is prepared and poured On completing, de-shuttering should be done after 7 days and curing must be done for 28 days to attain its strength.

5. METHODOLOGY



The following steps are being followed in the project and a flow chart is being shown:

1. Experimental procedure in finding the properties of the basic materials and the filler materials.

2. Casting and testing of granite dust cylinders by using various measures of stabilizer to find the optimum stabilizer content.

3. Designing two-way slabs and introducing filler materials in the tension zone between the reinforcement spacing by proving optimum cover.

4. Using the basic properties obtained through experimentation and other literatures, modelling is done using software.

5. Results are extracted upon analyses. These results are compared with the conventional slab.

6. Cost comparison between the filler slab and conventional slab is done

6. MATERIALS AND ITS PROPERTIES

Coconut shells are a hard, fibrous cellulosic agro-waste produced from a coconuts quasi-part. According to a comparative study, concrete made using coconut shells has a higher compressive strength than concrete made with oil palm shells. This concretes ultimate bond strength is considerably greater than the theoretical bond strength. Due to their outstanding characteristics, coconut shells have demonstrated tremendous promise as concrete admixtures. Coconut shell concrete provides more warning before failure than ordinary concrete, demonstrating the importance of coconut shells in concrete ductility. Concrete with coconut shells may assist customers since it provides warning signs before breakdown. At 1.05–1.20 and 1.40–1.50, respectively, the averaged specific gravity and apparent specific gravity was lower than the typical aggregate's specific gravity. As a consequence, further study is needed to improve or extend the use of coconut shells in concrete as a composite material or additive.

ELEMENT COMPOUND OF COCONUT SHELL ARE:

SiO2	45.05
Al2O3	15.6
Fe2O3	12.4
P2O5	–
CaO	0.57
TiO2	–
MgO	16.2
Na2O	0.45
K2O	0.52

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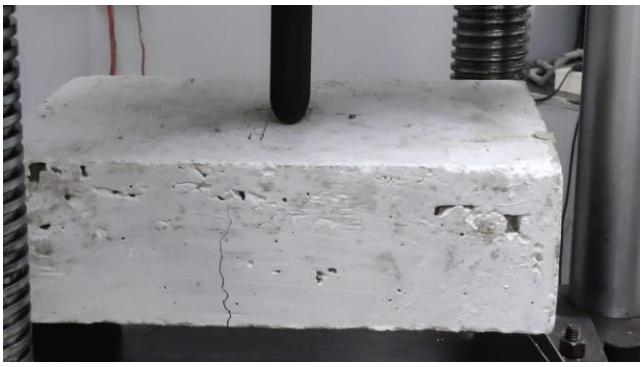
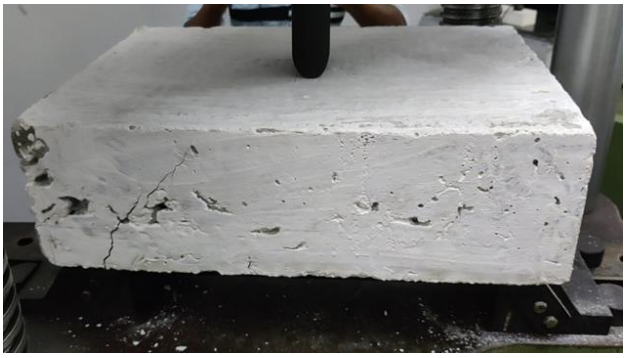
Cl	–
MnO	0.22
C	–
ZnO	0.3

TESTING OF SLABS

1. Testing Of Conventional Concrete Slab



2. Testing Of Conventional Concrete Slab



7. RESULTS AND DISCUSSION

a. CONVENTIONAL CONCRETE SLAB

CONVENTIONAL CONCRETE SLAB		
LOAD (KN)	DEFLECTION (MM)	
	SAMPLE 1	SAMPLE 2
5	0	0
10	1.3	2.3
15	1.9	2.7
20	2.4	3
25	2.9	3.3
29	3.2	3.6

Table:1 conventional concrete slab

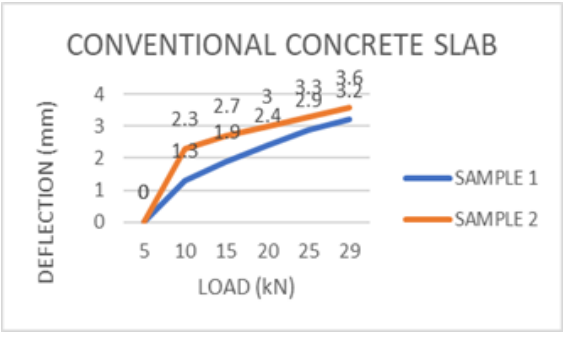


Fig:1 CONVENTIONAL CONCRETE SLAB

b. FILLER SLAB WITH COCONUT SHELL

FILLER SLAB WITH COCONUT SHELL		
LOAD (KN)	DEFLECTION (MM)	
	SAMPLE 1	SAMPLE 2
5	0	0.2
10	1.3	3.5
15	2	3.8
20	2.6	4
25	2.9	4.3
30	3.2	4.7
35	3.5	5
42	3.8	5.5

Table:2 FILLER SLAB WITH COCONUT SHELL

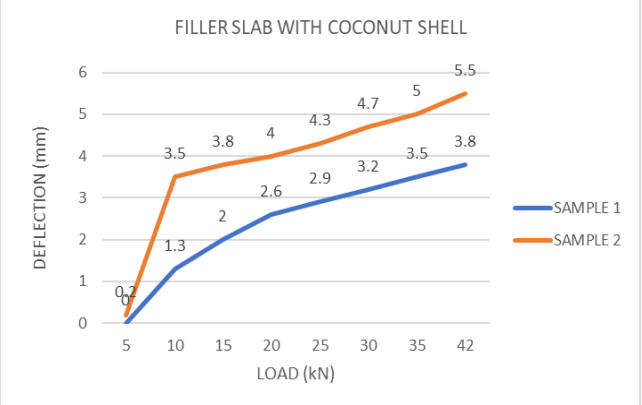


Fig:2 filler slab with coconut shell

8. CONCLUSION

- The weight of conventional concrete slab is 40.3 Kgs whereas the weight of filler slab with coconut shell is 37.31 Kgs. Hence the self-weight of the structure can be minimized.
- The ultimate load for conventional concrete slab is 29 KN with the deflection of 2.75mm the ultimate load for filler slab with coconut shell is 42 KN with the deflection of 4.65 mm
- Thus, the filler slab with coconut shell can be utilized with some limitations in the construction industry.
- The filler slab with coconut shell is cost effective when compared with conventional concrete slab

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ISBN: 978-81-956748-3-1

Soil stabilization using Lime and GGBS

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Abstract*— In developing countries like India, due to the remarkable development in road infrastructure, Soil stabilization has become the major issue in construction activity. Stabilization is not only a method of altering or modifying of one or more soil properties to improve the engineering characteristics and performance of a soil, but also processing available materials for the production of low-cost design and construction. Expansive soils are known for their low plasticity and low shear strength. These soils present significant geotechnical and structural engineering challenges all over the world, with costs associated with expansive behavior estimated to run in to several billions annually. Expansive soils are the soils that experience significant volume change associated with changes in water content which means they are volumetrically unstable due to seasonal moisture variation. Their strength decreases and compressibility increases tremendously on wetting. By keeping the above problem in view, the cohesive natured clayey soil was chosen and checked for compaction properties along with other general soil characteristics by varying the content of ground granulated blast furnace slag, which is waste by-product released during the processing of iron and steel metals. From the present study, it deduced that there is a significant decrease in compressibility characteristics of the clay with the increase in GGBS and lime content. Ultimately, the composite soil which is stabilized with GGBS and lime content proves to be good construction material for complex civil engineering structures such as embankment, earthen dams and runways. The usage of GGBS and lime for soil stabilization is not only economical, but also beneficial to the environment by putting an industrial wasteto good use.

Keywords – Soil Stabilization, Expansive Soil, Ground Granulated Blast Furnace Slag (GGBS)

I INTRODUCTION

Improvement in site soil engineering properties is called soil stabilization .Soils containing significant levels of silt and clay have changing geotechnical characteristics they swell and become more plastic in the presence of water ,shrink whe dry and expand when exposed to frost. The mineralogical properties of the soil will determine their degree of reactivity with lime and the ultimate strength that the stabilized layers will develop.Use of lime significantly changes characteristics of soil to produce long term strengt and stability particularly lime changes with respect to the action of water and frost.

columns are weak then this will lead to the severe damage or collapse of the building. The basic fundamental earthquake resistant design concept is the strong columns-weak beams criteria,

so as to ensure safety of the occupants, i.e., during earthquake thebeams yield before the columns get collapsed.

Lime is an excellent choice for short-term modification of soil properties. Lime can modify almost all fine-grained soils, but the most dramatic improvement occurs in clay soils of moderate to high plasticity. Modification occurs because calcium cations (***KAT****-eye-ənz*) supplied by hydrated lime replace the cations normally present on the surface of the clay mineral, promoted by the high pH environment of the lime-water system.

Lime substantially increases soil resilient modulus values (by a factor of 10 or more in many cases). In addition, when lime is added to soil, users see substantial improvements in shear strength (by a factor of 20 or more in some cases), continued strength over time, even after periods of environmental or load damage (autogenous healing), and long-term durability over decades of service even under severe environmental conditions.

Lime stabilization is not difficult to carry out. After proper mix design and testing is performed, in-place mixing is usually used to add the appropriate amount of lime to soil, mixed to an appropriate depth. Pulverization and mixing is used to thoroughly combine the lime and soil. For heavy clays, preliminary mixing may be followed by 24 to 48 hours (or more) of moist curing, followed by final mixing. For maximum development of strength and durability, proper compaction is necessary. Correct curing is also important. If sulfates are present at levels greater than 0.3 percent, special procedures are required.

B METHODOLOGY

Scarification and initial pulverization: after the soil pass has been brought to line and grade , the subgrade can be scarified to the specified depth and width then partially pulverized. It is desirable to remove non soil materials larger than 3 inches such as stumps roots , turfs and aggregates.

Lime spreading: the soil is generally scarified and the slurry is applied by distributor , lime is in slurry form is less concentrated than dry lime.To prevent run off and consequent non uniform lime distribution, the slurry into the soil immediately after each spreading

Preliminary mixing and watering: preliminary mixing is required to distribute the lIMEthroughout the soil and to initially pulverize the soil to prepare for the addition of water to initiate

the chemical reaction for stabilization. During this process or immediately after water should be added to ensure the complete hydration and qualitystabilization project.

Final mixing and pulverization: to accomplish complete stabilization , adequate final pulverization of the clay fraction and thorough distribution of the lime throughout the soil are essentialand 1893

MATERIALS USED:

- SOIL
- LIME POWDER(5%,10%,15%,20%)
- GGBS (2%,4%,6%,8%)

PHYSICAL PROPERTIES OF

SOIL

- Soil color: brownish black color
- % of gravel:0.53
- % of sand: 21.70
- % of fines: 75

TESTS CONDUCTED FOR SOIL:

- Specific gravity test
- Plastic limit
- Liquid limit
- California bearing ratio

LIME POWDER +GGBS	CBR VALUE
5%LIME POWDER+2% GGBS	10.22
10% LIME POWDER+4% GGBS	14.11
15% LIME POWDER+6% GGBS	15.34
20% LIME POWDER+8% GGBS	18.56

- Compression test

TESTS CONDUCTED FORSOIL	VALUES OF SOIL WITHOUT ADDITIVES
SPECIFIC GRAVITY	2.8
PLASTIC LIMIT	28.7%
LIQUID LIMIT	52%
CBR TEST	5.9

SPECIFIC GRAVITY TEST

SOIL+% OF LIME POWDER	% OF GGBS	SPECIFIC GRAVITY
SOIL+5%	2%	2
SOIL+10%	4%	1.8
SOIL+15%	6%	1.8
SOIL+20%	8%	1.7

A DECREASE IN SPECIFIC GRAVITY OF SOIL IS NOTEDWHEN LIME AND GGBS IS BEING ADDED TO THE SOIL

LIQUID LIMIT

SOIL+% OF LIME POWDER	% OF GGBS	LIQUID LIMIT
SOIL+5%	2%	50
SOIL+10%	4%	47.2
SOIL+15%	6%	45
SOIL+20%	8%	43

A DECREASE IN LIQUID LIMIT IS BEING NOTED.

PLASTIC LIMIT

SOIL+LIME POWDER%	GGBS%	PLASTIC LIMIT
SOIL+5%	2%	31.2
SOIL+10%	4%	34
SOIL+15%	6%	35
SOIL+20%	8%	38

A INCREASE IN PLASTIC LIMIT IS

NOTED.CALIFORNIA BEARING RATIO

CONCLUSION

Comparing with the conventional soil the addition of Soil

+GGBS+Lime powder has improved the strength of soil by 20%. It can be adopted as a soil stabilization technique with the above experimented ratios.

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ISBN: 978-81-956748-3-1

USE OF PALM OIL FUEL ASH IN PAVER BLOCKS

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ABSTRACT - Paver block industry consumes considerably large quantities of natural resources in addition to generating toxic gases, such as CO2, in the atmosphere. In order to achieve more sustainability in this sector, research should focus on using alternative renewable resources such as palm oil waste for paver block production purpose. Palm oil fuel ash (POFA) is a by-product obtained during the burning of waste materials such as palm kernel shell, palm oil fiber, and palm oil husk; it can be utilized to partially replace cement in a paver block mix. This paper presents a review of the applications and effects of POFA on paver properties as reported by previous studies that have been conducted to find out POFA properties and its effects under various conditions. Chemical and physical properties of the resulting paver block have been illustrated depending on the POFA characteristics in several sources. Many studies have shown that paver block containing POFA has better compressive strength, durability, and other properties than concrete containing Ordinary Portland Cement (OPC) only. Other researchers have shown more advantages of POFA replacement in concrete in specific proportions, especially minimizing CO2gas emissions and thus improving environmental conditions. Cement is the most widely used binding material in paver blocks. Due to its high cost and heat liberation property, attempts have been made to replace cement in paver blocks using agricultural or industrial waste. This study involves partial replacement of cement in paver blocks by palm oil fuel ash (POFA) which is an agro-waste generated in palm oil industry. POFA is a pozzolanic material which has economical and technical advantage when used in paver blocks. In the present study compressive strength, flexural strength and split tensile strength test was conducted on hardened blocks by replacing cement with 10%, 20% and 30% of POFA and compared the results with control mix (0%POFA). The grade of concrete adopted was M15.

I INTRODUCTION

Concrete industry presents a challenge to the global environment as it consumes significantly large quantities of natural resources in addition to generating toxic gases, such as CO2. In order to achieve more sustainability in the building construction sector, researchers in this field need to focus on using alternative renewable resources, such as palm oil waste. Malaysian Palm Oil Board (MPOB) in 2012 reported that the plantation area of palm oil covers about 5.07 million hectares in Malaysia. The United States Department of Agriculture reported that the production of palm oil in years 2016 and 2017 was estimated to be 64.5 million metric tons. Southeast Asian countries are the main palm oil producers. Palm oil fuel ash (POFA) is one of the significant materials produced as a byproduct of the palm oil industry, which is obtained by burning the waste materials such as palm oil fiber, kernels, empty fruit bunches, and shells in the power plants to generate energy. POFA can be utilized to partially replace cement in concrete production.

The quantity of POFA being produced is increasing with time due to the increase in the production of palm oil. Leaving this waste material without any further utilization is in itself an environmental challenge. Malaysia is one of the largest exporters and producers of palm oil all over the world. Production of POFA in Malaysia alone is approximately 10 Million tons/year. Whereas, just 104 tons/year of POFA are being produced in Thailand, which continue to increase with time.

Recently, there has been an increasing interest in the use of industrial and agricultural waste materials in the construction industry, especially during the concrete preparation. There is an urgent need for disposal of harmful residual agricultural and

industrial products which has become a threat for human life. In recent years, many studies have emerged that indicate to use the agricultural residues in the concrete industry. From environmental perspective, agricultural waste materials have been investigated by many researchers and have been shown to have better properties in concrete than the cement materials, whereas the latter also generates a high amount of CO2, which is harmful for environment.

Due to the fact that POFA is a geopolymer, it is environmentally friendly and consumes less amount of energy than traditional materials during production. In Malaysia, more than 1000 tons of POFA have been dumped into lagoons and landfills without exploiting the use of this material in other industries. In terms of cost saving, using POFA as partial cement replacement will reduce the cost of cement production as well as transportation of the same from cement plants to the stores. Moreover, this will improve the environment by mitigating and reducing waste materials in landfills.

POFA is also one of the ash family of materials resulting from the burning of waste materials such as palm kernel shell and palm oil husk. POFA is usually disposed in landfills, which results in the increased amount of ash deposits every year and now has become a burden. Therefore, it is needed to devise new ways to benefit from these waste materials and avoid the potential risks.

In the 1990s, Tay started studying the properties of palm oil fuel ash as a concrete material. The study was conducted by replacing Portland cement with POFA ranging between 10 and 50%. It was noted that the compressive strength of the specimens decreased when between 20 and 50% of cement was replaced by POFA. Since then, many studies have been conducted to enhance the concrete properties, for example, Awal and Hussin discovered that POFA has a significant impact to prevent and reduce the sulfate attack.

In 2011, Kroehong et al. conducted a study to find out the effects of POFA fineness on pozzolanic reaction of cement paste. The Ground Palm Oil Fuel Ash (GPOFA) and Ground River Sand (GRS) were used to replace the Portland cement by GPOFA or GRS at 10%, 20%, 30% and 40% by weight of cementitious materials, whereas the water to binder ratio (W/B) was 0.35 for the mixes of cement pastes. It was concluded that the effects of POFA on the cement paste and concrete mixtures increase when POFA is of higher fineness. In 2015, Rajak et al. conducted research to determine the morphological characteristics of hardened cement pastes which contain Nano-POFA with particle sizes ranging between 20 nm and 90 nm. It was discovered that Nano-POFA particles have a significant effect on pozzolanic reactions in the pastes because of the filling effect. In Thailand, P. Chindaprasirt et al. used the POFA and Rice-husk Bark Ash (RBA) to determine the water permeability and strength of concrete replacing the cement in the concrete by various percentages ranging between 20%, 40%, and 55% by weight. It was concluded that replacing 20% of ordinary Portland cement by POFA and RBA leads to increasing the compressive strength and workability, while the value of compressive strength decreases when the replacement quantity increases up to 40% due to the increased requirement of water.

The above discussion leads to the objectives of the present paper to review the state of the use of POFA in the production of concrete. In this regard, the process of the preparation of ground and nano POFA has been reviewed first. This has been followed by a review of the chemical and physical properties of POFA itself.

The effects of the use of POFA in concrete on the properties of fresh concrete and hardened concrete have been discussed in the latter half of the paper. Finally, at the end, a section of discussion and conclusions has been provided that includes a few directions for the future research in this field.

II MATERIALS AND METHODOLOGY

A. PREPARATION OF POFA

Production of POFA is due to heating of significant amounts of palm oil fiber, shell, and empty palm fruit bunches, these wastes are employed at the palm oil mills as a main source of energy. The by-product which constitutes about 5% of total waste weight is called POFA. In the palm oil mills, the waste materials are burnt at high temperature, which reaches up to 1000^{o}C , and thus used as fuel to generate electricity.

In Malaysia, more than 3 million tons of POFA is produced every year, while in Thailand, production of POFA is more than 100,000 tons annually. Instead of using electricity from familiar energy

ISBN: 978-81-956748-3-1

sources that causes many environmental issues and requires high cost, waste materials produced from palm oil mills can be used to generate electricity by heating up the boilers in the palm oil factories.

POFA constitutes about 5% of the total waste materials after burning shells and fibers to generate electricity in palm oil mills. Out of 4 kg of raw palm oil, only 1 kg is palm oil and the rest is production residues which represent dry biomass.

Palm oil fronds and palm oil trunks are about 75% of the total waste; this waste is left to be recycled and used as plant fertilizer for future plant strengthening, while the remaining proportion, which is 25% and includes empty fruit bunches, mesocarp fiber, and palm kernel shells can be used to generate electricity in palm oil mills by combustion of these wastes under high temperature ranging between 800 and 1000^{o} C.

Preparation of POFA can be achieved in different ways depending upon the burning process and raw materials used. Noorvand et al. studied initial POFA preparation by putting dried samples in an oven at the temperature of 105 ± 5^{o}C for 24 h. While another study by Tangchirapat et al. obtained POFA through combustion of waste materials at the temperatures of up to 1000^{o}C, followed by using sieve (1.18 mm opening) in order to remove the large foreign particles. In a new study by Zeyad et al. to prepare ultrafine POFA, three steps were adopted. The first step was to dry POFA to remove moisture in the oven at 105 ± 5 ^{o}C, then passing dry POFA through number 300 sieve in order to remove foreign and coarse particles and also to dispose of kernels and fibers which failed to burn.

The second step was grinding POFA particles to get a sufficient fineness followed by combustion in gas furnace at high temperature of up to 500 ± 50 ^{o}C to remove unburned carbon and obtain POFA with high fineness. The third step was conducting further grinding of POFA similar to the previous step to get UPOFA.

B. CHEMICAL COMPOSITION OF POFA

Chemical Composition	% in POFA
Silica	20.10
Iron	8.106
Potassium	3.784
Sodium	0.070
Magnesium	1.800
Calcium	4.058
Aluminium	2.376
Sulphur	0.160

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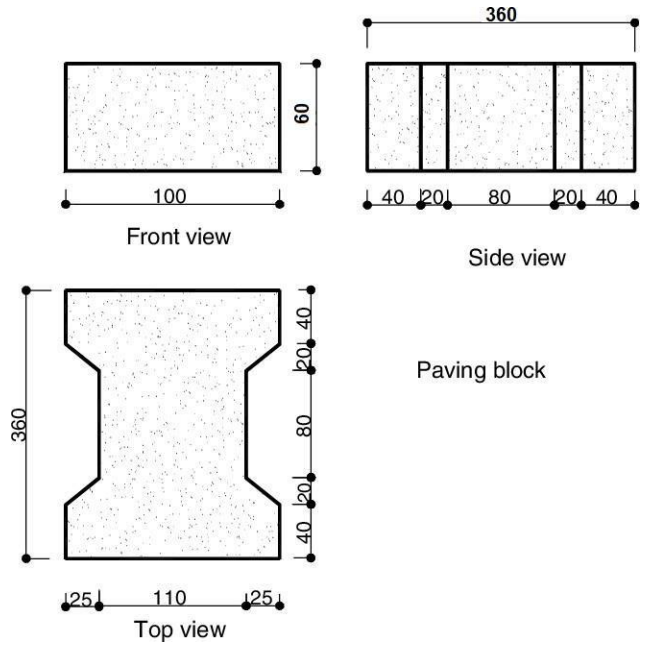
PAVER BLOCK DIMENSION



C. INITIAL TESTS ON POFA

Table shows the results for initial tests conducted onPOFA such as Normal consistency test, Setting time, Specific gravity and Sieve analysis.

D. FACTORY VISIT

Visited the V. M. S. Precast Concrete factory in Malur (Kolar dist.) on 15TH April, 2022. Had a detailed discussion with the manager and employees to study the methodology and procedure. Their production is up to 800-1000 blocks per day of different sizes and shapes. They use 1:2:4 mix ratio. Grade 53 superfast cement is used. High quality fine mSand and stone chips of upto 10mm size. Ethyl acetate is used as admixture for fast setting. Synthetic colouring chemical is also used. They have plastic and rubber moulds of various shapes and sizes. Mixing is done in the mixer followed by vibration and then allowed for setting.

Sl. No.	Name of Test/Aim	Result
1	NORMAL CONSISTENCY TEST FOR CEMENT WITH POFA: To determine, the standard consistency of a given cement mixed with POFA sampleby vicat apparatus.	The normal consistency of cement sample = 32% • Cement with 10% POFA = 34% • Cement with 20% POFA = 36% • Cement with 30% POFA = 38%
2	SETTING TIME OF CEMENT WITH POFA: To determine the initial & final setting time of given cement +POFA sample by vicat apparatus.	The initial setting time of the cement sample with0% POFA is found to be 35 minutes • 10% POFA = 36 minutes • 20% POFA = 34 minutes • 30% POFA = 33 minutes
3	SPECIFIC GRAVITY TEST FOR PALM OIL FUEL ASH: To determine the specific gravity value forPOFA	Specific Gravity of POFA sample is = 2.14
4	SIEVE ANALYSIS OF PALM OIL FUEL ASH: To determine the particle size by sieve analysis of POFA	Uniformity coefficient: Cu = 4.35 Coefficient of Curvature: Cc = 2.19

ISBN: 978-81-956748-3-1

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E. PREPARATION OF SPECIMENS

Grind the POFA particles to fine material. Sieve these ground particles using standard sieves and use the material retained in 90μm, 75μm and the pan. Perform initial tests for cement on POFA in lab. Prepare mould to the dimension as shown in next slide. Prepare the mix with ratio 1:2:4 (Cement : mSand : Stone chips). Replace cement with POFA in percentages ranging from 0% to 50%. Follow M15 mix design. Pour the different mixes into the labelled moulds and cast under pressure and factory. Cure the prepared paver blocks accordingly. Perform lab tests for post-casting.

Cement concrete is a mixture of Portland cement, aggregates (sand and stone chips) and water. Aggregates passing through 4.7 mm IS sieve are known as fine aggregates and the aggregates retained on this sieve are coarse aggregates.The process of manufacture of cement concrete paving blocks involves the following steps:

a) Proportioning

b) Mixing

c) Compacting

d) Curing

e) Drying

A concrete mix of 1:2:4 (cement:sand:stone chips) by volume may be used for cement concrete paving blocks with water to cement ratio of 0.62. The concrete mix should not be richer than 1:6 by volume of cement to combined aggregates before mixing. Fineness modules of combined aggregates should be in the range of 3.6 to 4.0. All the raw materials are placed in a concrete mixer and the mixer is rotated for 15 minutes.

The prepared mix is discharged from the mixer and consumed in the next 30 minutes. Vibrating table may be used for compacting the concrete mix in the moulds of desired sizes and shapes. After compacting the blocks are demoulded and kept for 24 hours in a shelter away from direct sun and winds. The blocks thus hardened are cured with water to permit complete moisturization for 14 to 21 days. Water in the curingtanks is changed every 3 to 4 days.

After curing, the blocks are dried in natural atmosphere and sent for use. The concrete paving blocks gain good strength during the first 3 days of curing and maximum gains in strengths are secured in the first 10 to 15 days of curing. After curing, blocks are allowed to dry in shade so that the initial shrinkage of the blocks is completed before they are used in the work. A drying period of 7 to 15 days would normally complete the drying shrinkage after which they can be used.

III RESULTS AND DISCUSSIONS

A. WATER ABSORPTION

One of the physical properties of cement mortar and concrete paste is the ability to absorb water. A few studies have been conducted to examine the water absorption of concrete containing POFA as a replacement of cement material. One of these studies in 1990 showed that absorption of water increased whenever the quantity of POFA content increased in concrete mixture.

Islam et al. showed that absorption of water in concrete containing POFA as a replacement of cement with proportion range between 10 and 70% increases because of the delayed hydration and tendency of POFA to absorb water. In a recent study to determine water absorption for concrete containing POFA, tests were conducted at two ages of 28 and 90 days. Firstly, the disc specimens were dried at 105 ± 5C for 2 days and left at room temperature before being immersed in water for curing purpose. Absorption of water was determined through observing the weight of the samples at 30 min and 72 h. Lau et al. noted that increase of temperature of sintering leads to decrease in the water absorption of light weight concrete containing POFA and lime treated sewage sludge. Mixing waste polypropylene (PP) with POFA was done by Mohammad husseini et al., who investigated the durability properties of sustainable concrete compound, which consisted of POFA and PP (carpet fiber). They noted that mixing POFA and PP in concrete assists to decrease the slump value, the water absorption and chloride penetration. In a study by Yahaya, it was claimed that POFA with pulverized fuel ash PFA used as replacement of concrete by 10%, 20%, and 30% has ability to enhance concrete porosity due to minimizing voids within concrete microstructure and thus producing concrete with high density.

ISBN: 978-81-956748-3-1

It is known that some of the materials have good absorption of water due to the microstructure properties of their composites, and it is generally agreed upon those materials containing finer particle have improved resistance to water transportation through them. Therefore, further studies should be conducted using nanomaterials as cement replacement such as Nano POFA, NanoFA, and Nano GRBA.

B. WORKABILITY

Workability is a significant characteristic to determine the concrete quality. Decrease of concrete workability occurs due to higher amount of unburned carbon in POFA, especially when the replacement level of cement is high. Slump test is generally used to identify the workability; Awal and Shehu studied the slump of concrete which contains different percentages of POFA in various concrete mixtures; they found that whenever the percentage of POFA is increased in concrete mix, the workability also increases and the slump value decreases. On the other hand, Tay and Show noted that workability of concrete decreases with increased amount of POFA percentages in the concrete mortar.

They concluded that no segregation in concrete sample occurs when the compacting factor value is more than 0.93. In a recent study by Noorvand et al. to assess the desired workability, nanosilica was utilized with concrete containing POFA in order toreduce the quantity of super plasticizer in concrete mortar.

Aldahdooh et al. concluded that the workability of concrete increases when using ultra fine POFA particles instead of OPC. The workability increases because of the lower carbon content and the lower loss of ignition (LOI) of the ultra-fine POFA. Concrete containing unburned carbon leads to decrease in the workability of concrete. Islam et al. studied the behavior of concrete containing POFA. They noted that the concrete workability will be reduced when replacement level of POFA is more than 30%. Also, the

slump is not influenced if the POFA content is less than 20%, compared with Palm oil shell to produce lightweight aggregate concrete (LWAC) without POFA. Other studies, such as have concluded that increasing the amount of POFA replacement will result in decreasing the concrete workability level due to the increase in water demand. Yusuf et al. investigated impact of H2O/Na2O molar ratios on the UPOFA and ground blast furnace slag GBFS. They noted that using Na2O in UPOFA and GBFS has positive impact on the workability of concrete, while it has negative impact on the compressive strength of the concrete sample. Another study by Ariffin et al. used sodium hydroxide and sodium silicate, NaOH and Na2So3, as alkaline solution that have been mixed together for 5 min; in addition, super plasticizer was used to achieve required workability ranging between 80 and

100 mm. They noted that the concrete paste had low workability making it not suitable to be cast in molds. Salami et al. reported that to achieve the required workability, water should be added to fresh concrete containing POFA. Muthusamy et al. used POFA as cement replacement in various percentages with oil palm shell OPS as a coarse aggregate in order to benefit from the waste materials generated from palm oil industry, and mitigate the hazardous impacts to the environment. They noted that using POFA with 20% to 30% achieved the best results in terms

of workability and compressive strength. Slump tests were conducted by Bashar et al. to investigate the concrete workability; the slump value was recorded zero due to the use of high

quantity of POFA, which caused absorption of high quantity of water resulting in decreasing the concrete workability. Awal and Mohammadhusseini used 20% POFA as replacement of cement and various proportions of waste carpet fiber (WCF) ranging between 0.25% and 1%. They noted that the slump value decreases from 210 mm for the mix without fiber to reach 25 mm with the addition of only 1% fiber into the concrete mix. The addition of 20% of POFA also improved the workability by reducing slump value. Islam et al. conducted a study to examine the extent of concrete incorporating oil palm shell as coarse aggregate and POFA with GGBS as binder replaced in concrete. They concluded that the addition of fibers to concrete results inreducing the concrete workability due to large surface area and theability to absorb high quantity of water. It is noted that there is alack of studies in literature that focus on evaluating the workability of concrete made by combining POFA and other

plastic materials in order to fully benefit from the effects of plasticproperties on the workability.

C. HEAT OF HYDRATION

Awal and Shehu noted an increase in the concrete temperature value containing 50%, 60% and 70% of POFA compared to 100% OPC in the beginning. However, the total temperature increase reduced in concrete containing POFA and thus the occurrence of peak temperature was delayed. On the other hand, Lim at el. Conducted a study on the impact of high volume Nano POFA on the hydration temperature and microstructure properties of cement mortar. They concluded that a high volume of Nano POFA reduces the heat of hydration of cement mortar; it can also be used to treat thermal cracking resulting from large temperature increase in impact of Nano POFA along with other Nano composites of waste materials on the heat of hydration of cement. Therefore it is needed to study the use of high volume mixing Nano POFA and Nano fly ash and find out how it affects the heat of hydration. In addition to the potential utilization of POFA as cement replacement in cold climates, it will also help understand its effects on the heat of hydration of cement in climatechange conditions.

D. DRYING SHRINKAGE

Drying shrinkage is responsible for cracks occurring because of the loss of water from concrete paste, and it occurs particularly in dry and hot weather. Many studies have been conducted to find out the impact of POFA as cement replacement on drying shrinkage in concrete. Farzadnia et al. investigated the effects of adding various dosages of Nano silica on short-term drying shrinkage of cement mortars containing POFA as partial replacement of cement during the first 28 days. They noted that the concrete samples with 30% POFA as cement replacement showed increased compressive strength by 15% during 7 to 28 days of treatment, while drying shrinkage decreased by 7.5%. At the same time, the hydration volume of concrete mix increased. A significant result from a study by Lau et al. is the shrinkage index. They used POFA, lime treated sewage sludge, and sodium silicate to produce lightweight aggregate; all these materials had been sintering under three temperatures of 1160, 1180 and 1200 _C. The researchers noted that the fire condition and adding more binder affects the shrinkage index and water absorption. The shrinkage index can be defined as the percentage for changing in

pellets' diameter before and after burning as illustrated in equation below. Shrinkage index ¼ d2 _ d1 d1 _ 100 ð1Þ where d1 is pellets diameter before burning and d2 is pellets diameter after burning. However, adding some materials to the concrete mix is expected to change the drying shrinkage value. Other materials can be used instead of Nano silica, such as Nano clay and Nano alumina to control the drying shrinkage of concrete.

E. COMPRESSIVE STRENGTH

Most of the researchers have conducted their studies to improve the compressive strength of concrete containing POFA. For example, Muthusamy and Zamri concluded that 20% of POFA as cement replacement is the optimum level for compressive strength of concrete at 28 days. In another study by Islam et al., it was found that 10% of POFA is the optimum level to replace cement in the concrete mix. The values of the compressive strength of concrete mixtures containing different percentages of POFA as cement replacement as reported in the literature. It may be disadvantageous to use POFA in excessive proportions if the structure is expected to face adverse conditions such as earthquakes. In a recent study by Zeyad et al., it was shown that ultrafine POFA replacing cement can achieve compressive strength higher than control samples, which may reach more than 90 MPa at 28 days. In 2007, Tangchirapat et al. used three types of POFA in concrete; the first type was original POFA called OP, the second type was median particles (15.9 m) called MP, and the third type was small particles (7.4 m) called SP. They reported that the compressive strength of concrete containing OP was much lower than in case of OPC, while compressive strength of concrete containing 10% MP, and concrete containing 20% SP was better than normal concrete at 90 days. Application of Nano POFA with particle size less than 100 nm has better characteristics than normal cement mortar as filler and binder in cement mortar, in addition more than 80% cement replacement by Nano POFA in concrete mix can be used to achieve compressive strength more than normal concrete. Another study investigated the potential of using high volume of POFA and OPC in sustainable concrete with various proportions in addition to the effects of these quantities on the chemical and physical properties. Incorporation of 10–20% of POFA as filler in lightweight foamed concrete improves the compressive, flexural, and tensile strength if compared with lightweight

foamed concrete containing 100% sand. On the other hand, Awal and Mohammadhusseini conducting their research by incorporating POFA and waste carpet fiber (WCF) as replacement of cement in various proportions of WCF and 20% POFA. The compressive strength was reported to range between 38.1 and 49.1 MPa at the age of 91 days. Some researchers have conducted their studies by adding Nano silica to the unground POFA, for example Noorvand et al., to improve the Mechanical properties of concrete, such as increasing the compressive strength and decreasing water absorption of cement mortar. More research is required in this regard to improve mechanical properties of concrete using waste materials, which are freely available and cost less, such as combination of Nano POFA as cement replacement with egg shells.

IV CONCLUSION

A review of the literature on the use of POFA as cement replacement in the concrete production emphasizes the importance of this practice towards sustainability. On the one hand, cement and concrete industry has been reported to consume large amounts of energy, utilize great quantities of natural resources and generate significant proportion of the CO2 in the atmosphere. Any technology aimed at reducing the use of cement in the preparation of concrete is going to be beneficial on all these three fronts i.e. energy economy, resources sustainability, and environmental friendliness. On the other hand, large quantities of agricultural/industrial waste byproducts are being dumped in the landfill sites without treatment or re-use. The management of these wastes is a significant environmental challenge. The use of these waste materials in the production of concrete can not only result in the efficient solid waste management of the same but it will also help reduce the use of cement realizing all the benefits mentioned above. Many researchers have studied the potential of using POFA as partial cement replacement in concrete. The significant information gathered from reviewing the present state of this practice can be summarized as:

- Palm oil fuel ash (POFA) is obtained as a byproduct when waste materials are burnt in palm oil mills to produce electricity.
- Grinding procedures can be applied to obtain finer varieties of POFA such as Ground POFA (GPOFA), Ultrafine POFA (UPOFA), and Nano POFA.
- In its original size, the microstructure composition of POFA is weak and highly porous. Reducing the particle size to micro and nano, however, significantly improves the performance of POFA. The finer varieties of POFA react well with the other constituent materials and produce stronger concrete.
- POFA satisfies the ASTM C618 requirements to be used as a binder pozzolanic material in concrete production.
- POFA is rich in SiO2 and therefore, is a good pozzolanic material. With the addition of Calcium, it can produce extra Calcium- Silicate-Hydroxide (C-S-H) gels, which increase the density and durability of the cement mortar.
- Addition of Nano Silica along with POFA increases the compressive strength of concrete and reduces the water absorption.
- The use of POFA in concrete improves the resistance to the chloride and sulfate attacks.
- The compressive strength of concrete containing POFA decreases at temperatures in excess of 500 _C.
- The specific gravity of POFA ranges between 2.6 and 1.89, which is less than the specific gravity of cement resulting in the production of lighter concrete when cement is partially replaced by POFA.
- POFA has a high content of unburnt Carbon resulting in decreasing the workability when high amount of POFA is used as cement replacement. This necessitates the use of a super plasticizer.
- The use of POFA as a secondary cementitious material can help reduce the drying shrinkage in concrete.
- POFA can also be used as partial cement replacement to produce self-compacting concrete.
- The finer the particle size of POFA, the higher is the compressive strength of the resulting concrete. However, the finer varieties of POFA have higher specific gravity than the coarser varieties.
- The use of POFA tends to delay the hydration process and increase the absorption of water.
- A high volume of Nano POFA reduces the heat of hydration of cement mortar. It can also be used to treat thermal cracking resulting from large temperature increase in mass

mortar.

- Researchers have reported various proportions ranging from 10% to 20% of cement replacement by POFA to beoptimum for the compressive strength of concrete.The use of ultrafine POFA has been reported to produceconcrete strength up to 90 MPa at 28 days.
- The use of Nano POFA has also been reported to producestrengths more than normal concrete.
- Incorporation of 10–20% of POFA as filler in lightweight foamed concrete improves the compressive, flexural, and tensile strength compared with lightweight foamed concrete containing sand only.

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ADVANCEMENT OF INFRASTRUCTURE IN URBAN DEVELOPMENT

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Abstract: In this day today's life we are facing problems like Floods due to heavy rain, failure in waste disposal in effective way, Traffic congestion, Negative environmental impact and animal abuses etc. To surmount this issues, we have taken up certain measures to implement new concepts and renovations to the existing infrastructures in urban areas. We have come up with an advanced roadway design, advanced drainage systems to supress the heavy rain that causes floods, artificial intelligence in traffic control, management of waste disposal in effective and efficient way by recycling into biogases and manure for agriculture purposes, better green infrastructure for both humans and animals to breath good air and better town planning and illegal real estate constructions. We have measured and tested all the parameters by collecting data from BBMP and local available testimony to find out the issues concerning urban development.

Keywords: Floods in Bengaluru, Waste disposal, Garbage issues, Traffic congestion, Cutting down of trees, Animal abuse, and Illegal real estate constructions.

1. INTRODUCTION

URBAN DEVELOPMENT, also known as regional planning, town planning, city planning, or rural planning, is a technical and political process that is focused on the development and design of land use and the built environment, including air, water, and the infrastructure

Dumping of garbage: this problem increases due to Failure of Municipal authority due to shortage of staff and machinery or simply due to corruption, Lack of awareness of common people as well as statesmen Unavailability of effective law, amended for present situation or failure in implementation of law

Unavailability of supporting road network and effective public transport system. Recently virtual jetty on Sagar island in West Bengal became a big example of planning failure due to no development of connecting roads and bridges.

State's negligence to environmental factors: Recently Govt. of India and the State Govt. of West Bengal both are trying to build an ambitious project on Bengal coast including proposed Tajpur Port, Haripur Nuclear power plant and tourism hub, but all these activities will destroy the fishing activities. In addition to coastal and marine environmental destruction, it will destroy the supply line of cheap protein source to the bengal people.

2. STUDY AREA

passing into and out of urban areas, such as transportation, communications, and distribution networks and their accessibility.

Failures of urban development

1. Population pressure
2. Increase in number of commuters
3. Drainage Problem
4. Dumping of garbage
5. Unavailability of supporting road network and effective public transport system
6. State's negligence to environmental factors.

Urban planning fails due to following factors:

P**opulation pressure:** In third world countries, development is centered on big cities and adjacent rural areas remain backward. So whenever a new urban project comes into existence, rural inflow increases and outnumbers the capacity of the urban project.

Increase in number of commuters: Number of daily commuter's increases due to above mentioned reasons. It exerts pressure on water supply, drainage and other resources.

Drainage Problem: In and around Kolkata, urban sprawling occurs on immature delta region, which is flood plain area lower than the levee of river Hugli (Ganges) in the west and river Bidyadhari in the east. Here water logging is a chronic problem.

2 ACRE'S OF RESIDENTIAL LAND WITH DC APPROVED

Near old madras road, Seegehalli to Medahalli main road, Seegehalli, KR Puram, Bengaluru-560049.

3. IDEOLOGY

Town planning

To transform Bengaluru to an ideal global destination with high quality infrastructure, better quality of life by ensuring sustainable and planned development based on effective monitoring, regulation, through participatory and innovative approach. Plan, regulate, control, monitor and facilitate urban development in Bangalore Metropolitan Area, to ensure sustainable and orderly growth.

Principles of Town Planning

a2. Green Belt

Green belt is non-development zone on the periphery of the town. It prevents the haphazard sprawl of the town restricting its size. In essence, a green belt is an invisible line designating a border around a certain area, preventing development of the area and allowing wildlife to return and be established. Greenways and green wedges have a linear character and may run across the town and not around the town.

a3. Housing

Housing has to be carefully studied and designed to suit the local population. Care should be taken to see that there is no development of slums since it would be responsible for degrading the life of the citizens. There are various types of housing styles. When a landuse plan is made, zones for

Town planning cannot be studied in isolation. It involves the study of various subjects such as engineering, architecture, surveying, transportation planning etc. The intention of the town planning is to satisfy the needs of our future generations and prevent the haphazard growth of the town. Some of the guiding principles of town planning are as follows.

a1. Zoning

The town should be divided into suitable zones such as commercial zone, industrial zone, residential zone, etc. and suitable rules and regulations should be formed for the development of each zone.

independent housing, midrise buildings, high rise buildings are allocated.

a4. Public Buildings

Public buildings should be well grouped and distributed throughout the town. Unnecessary concentration of public buildings should be avoided. Factors such as parking facilities, road widths have to be taken into consideration while allocating the space for public buildings.

a5. Recreation Centres

Recreation centres have to be given importance while designing a town. They are necessary for the recreational activities of the general public. They include parks for walking and cycling, amusement parks etc.

a6. Road Systems

Road network hierarchy is very important. The efficiency of any town is measured by the layout of its roads. A nicely designed road system puts a great impression in the minds of people, especially the visitors to the town. The provision of a faulty road system in the initial stages of town formation proves to be too difficult and costly to repair or to re-arrange in future.

a7. Transport Facilities

The town should be provided with suitable transport facilities so that there is minimum loss of time from place of work to the place of residence. Efficiency in transport facilities includes both public and private networks. Public transportation network includes access to buses, trains, trams and trolleybuses. Efficiency in using the public transport will determine the success of that town in terms of design.

GREEN INFRASTRUCTURE & WASTE MANAGEMENT

METHODOLOGY:

-Taking down the information of problems faced by people of the layout

-finding a solution in lesser cost

-analyising and applying it in order to improve and promote the layout.

INTRODUCTION

Green infrastructure is an approach to water management that protects, restores, or mimics the natural water cycle. Green infrastructure is effective, economical, and enhances community safety and quality of life.

It is based on the principle that protecting and enhancing nature and natural processes are consciously integrated into spatial planning and territorial development.

PROBLEMS FACED:

SURVEY:

Towards the end of 2018, India conducted a nationwide survey which showed that Karnataka had the worst air quality in the whole of the south of India. It was reported that polluted air was responsible for 95 deaths out of every 100,000people. The national average is 90 per 100,000. Over 50 per cent of deaths attributable to air pollution are younger than 70 years old. These figures take into account both the ambient and outdoor levels of pollution ranging from indoor heaters and cooking stoves, industrial pollution and that created by the construction industry by the demolition and building of replacement properties. Pollution from the large amount of vehicles and dust, too.The latest statistics indicate that there are more deaths caused by air pollution than caused by smoking tobacco products, which was formerly the worst cause.

The average ambient PM2.5 exposure (referring to the size of being less than 2.5microns in diameter) was 90 µg/m³ in 2017 and put India as the most polluted country in the entire world. The highest being in the capital city of Delhi followed closely by other cities located in the north of the country.

LIFE EXPECTIANCY

One of the more daunting pieces of information to be discovered was that if the level of air pollution were less than the recommended levels, then life expectancy could be extended by 1.4 years in Karnataka and 1.7 years overall.More and more people are becoming interested in the quality of the air they breathe. Heart and lung doctors, medical professionals, researchers and the general public are all showing more concern than a few years ago. The Healthy Air Coalition monitors over 40 air quality monitors across the city of Bengaluru ,and it is their intention to make this data available to anyone who is concerned about the quality of air that they breathe. Upper respiratory infections, cases of childhood asthma and CPD (Chronic Pulmonary Disease) are increasing at an alarming rate as are heart attacks in younger people. It has been suggested that there is a link between these rises in health problems and the poor quality of air, but it has not been established by any authority.

Solution

b1. Reducing Climate Change

If people are good at something, then it is building up excess carbon dioxide in the atmosphere. Harmful CO2 contributes to climate change, the biggest current problem the world has to deal with. Trees, however, help fight it. They absorb CO2 removing it from the air and storing it while releasing oxygen. Annually, an acre of trees absorbs the amount of carbon dioxide equal to driving your car 26 000 miles. Trees are our main survival tools; only one tree can produce enough oxygen for four people.

b2. Purifying Air

Have you ever felt that feeling of „cleaner air“ in the woods or by the seaside? Well, you were right because it is well known that trees do purify the air. They absorb pollutant gases such as nitrogen oxides, ozone, ammonia, sulfur dioxide. Trees also absorb odors and act as a filter as little particulates get trapped in leaves. A mature acre of trees can yearly provide oxygen for 18 people.

b3. Cooling Down the Streets

Every year we listen to the shocking global warming news. For instance, the average temperature in Los Angeles has risen by 6F in 50 years, and the average global temperature grew by 1.4 F. This happens as tree coverage declines. Removing trees and replacing them with heat absorbing asphalt roads and buildings makes cities much warmer. Trees are cooling cities by up to 10 F by providing shade and releasing water.

b4. Natural Air Conditioning

Did you know that strategically placed trees around your home can significantly cut air conditioning needs? Not only will this make your wallet thicker, but it will also reduce carbon dioxide and emissions from power plants. Architects and environmentalists sat together and came up with the great solution – green roofs. Green roofs are an amazing way to incorporate vegetation to your home and provide environmental benefits for your community while saving money on cooling bills.

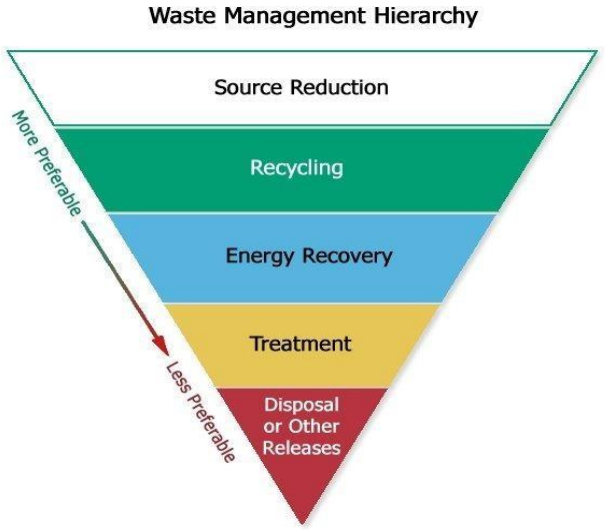
b5. Saving Water

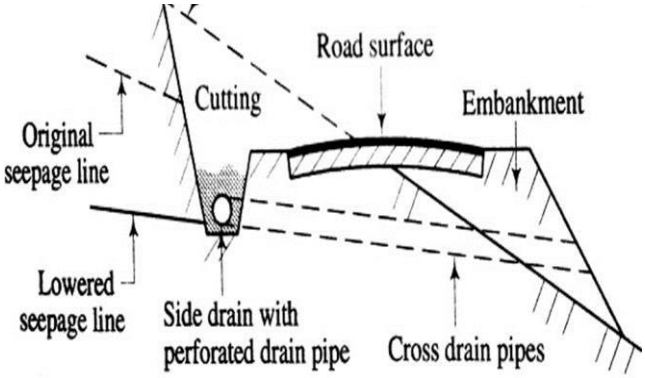
Except for cooling, trees also help to save water. Because of the shade they provide, water will evaporate slowly from low vegetation. Trees need about 15 water gallons a week to

survive, and they release about 200-450 gallons of water per day.

b6. Preventing Water Pollution

Storm_water can be full of phosphorus pollutants and nitrogen. Without trees, storm water flows into oceans and waters without being filtered. Trees break the rainfall and allow water to enter the earth and seep into the soil. Therefore, they prevent storm water from polluting oceans. Except for trees, green infrastructure like green roof can help sooth effects of storm water.





OBJECTIVE:

1. To carry out detailed investigation and survey of proposed scheme.

METHODOLOGY

1. Carrying out detailed topographic survey and soil investigation of the project area.2. Planning of sewer zones considering topography, existing development.3. Estimation of quantity and quality of sewage generated in the project area for each zone based on population, water consumption for domestic waste water.4. Detailed survey of the alignment of proposed sewer network.5. Preliminary design and estimation of the project.6. The survey start from the zone 1 by taking culvert as bench mark then for every 10 meter RL is taken.

SCOPE OF FUTURE WORK

The increasing level of sewage generation is, nowadays a serious problem in the urban areas of world high rates of

Waste management: Waste Management is devoted to the presentation and discussion of information on solid waste generation, characterization, minimization, collection, separation, treatment, and disposal, as well as manuscripts that address waste management policy, education, and economic and environmental assessments. The journal addresses various types of solid wastes including municipal (e.g., residential, institutional, and commercial), agricultural, and special (e.g., construction and demolition, household hazardous, sewage sludge, and non-hazardous industrial) wastes.

4. UNDERGROUND DRAINAGE SYSTEM

INTRODUCTION

An underground drainage system is a solution for collecting excess water and transporting it via underground pipes to a suitable waste water disposal area. Underground drainage is water drainage which is routed underground, rather than along the surface. Drainage is the system or process by which water or other liquids are drained from a place. If the drainage maintenance is not proper, the drainage gets blocked during rainy season, the pure water gets contaminated with drainage water and infection may get spread Most of the cities adopted the underground drainage system and it is the duty of managing station.

2. To carry out detailed engineering planning for proposed underground drainage Scheme, preparing working drawing suitable for execution.

3. To prepare detailed cost estimates for the construction of the underground Drainage scheme.

4. Protecting drinking water sources from contamination by waterborne waste and carrying runoff and surface water away while minimizing hazards to the public.

5. Good sanitation practices with proper management to achieve Optimum public health status and maintain clean environment.

And also carried compass survey by taking fore bearing and back bearing, For every 30 metre manhole is provided in some cases at the junction the man hole is provided less than 30m if required. In zone 1 there are 10 sub road with 2 parallel roads. And in zone 2 there will be a 3 sub roads with 4 parallel roads, for zone 2 bench mark is taken as 7th right side dead end of the zone 1. For all these roads the same procedure is followed. But in the beginning of the sub roads the permanent benchmarks are taken, that may be a culvert, electric polls or compound plinth.

population growth and increasing per capita income have resulted in the generation of enormous waste causing a serious threat to environmental quality and human health.

This is more in case of developing countries where large quantities of sewage water are let haphazardly into the nearby water sources, thereby putting pressures on the scare land water resources and at the same time adversely affecting the health of human beings mostly that of the poor persons who have greater expose to it. Hence there is greater scope to study sewage disposal practice.

5. PARKING SYSTEMS AND ADVANCED TRAFFIC CONTROLS

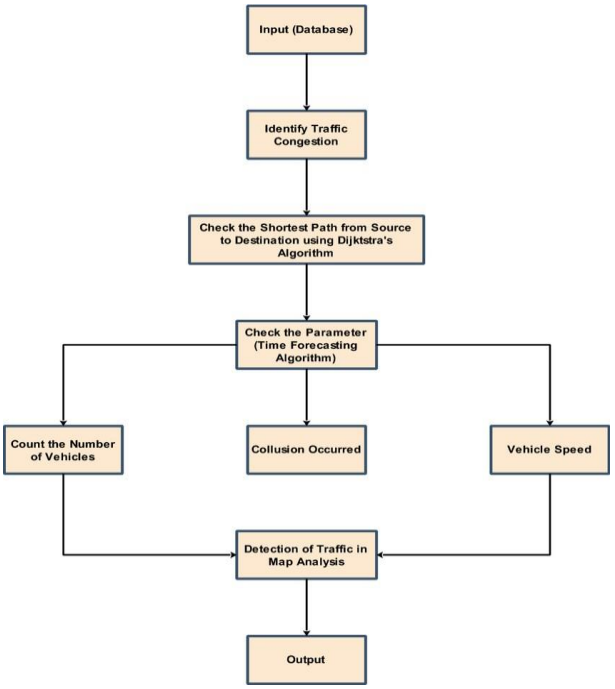
Bangalore is Now Officially the World's Most Traffic Congested City.

Bangalore Traffic Bangalore traffic has been officially rated as worst in the world. 'Namma Bengaluru' is now officially the most traffic-congested city in the world. According to the annual report released by the location technology firm TomTom, the city experiences the worst traffic congestion situations. Out of the 416 cities studied for the report, Bengaluru ranked first. The report suggested that an average Bangalorean spends 71 per cent extra travel time stuck in Bangalore traffic. The drivers in the 'Tech City' of India spend an extra 243 hours i.e. around 10 days in traffic during peak hours.

How AI is helping in handling the traffic jams

Now a days, Traffic Jams become a major issue to handle. This has rolled out to be quite challenging because of the constant development in the travel sector, fulled by economic development, and the ever-growing needs to do more with fewer efforts. In fact, the transportation systems are inherently complex which involves a very large amount of components and different parties, each having various opposing objectives.

we are going to see how the implementation of artificial intelligence helps in traffic jam monitoring. In recent times the AI will be the main reason and it Impacts on the successful growth of transportation in various areas.



6. PARKING SYSTEM

One of the most common problems today is a saturation of parking spaces. Vehicles continue to outnumber existing parking spaces, thus clogging roads. Incidences of violence

over occupancy, deformed cars due to a space crunch, and overcharging for parking are some problems that result.

Another problem that arises due to a lack of parking spaces in Indian cities is cruising i.e. vehicles looking for a parking space causing long queues, congestion, and pollution.

SOLUTION TO PARKING PROBLEM

Automated Parking Systems are inherently much safer and more secure because they remove driving and pedestrians from the parking area. No driving means no car damage or possibility of stolen cars. No pedestrians means no need to walk through dim, shadowy parking areas and no opportunity for theft, vandalism or worse.

Typically when free on-street parking isn't available, drivers choose to cruise instead of paying for parking. By under-pricing on-street parking, Indian metros create an economic incentive to cruise. Once occupied, low- cost parking isn't vacated for hours and instances have been recorded of cars being parked for days.

The primary benefits of automated parking systems compared to conventional multi-story cars parks are:

Up to 70% less land area needed

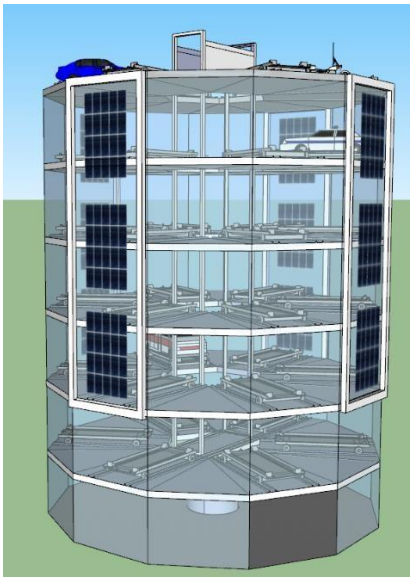
Up to 50% smaller building volume

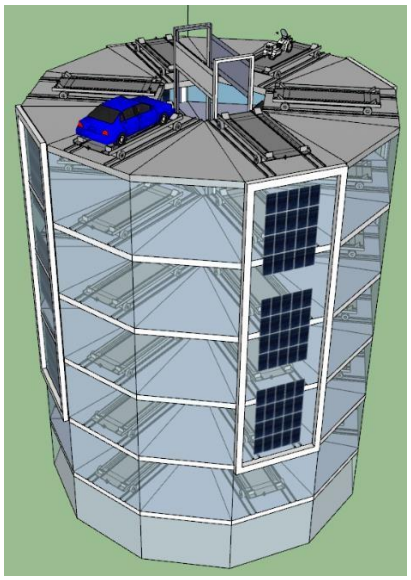
Up to 12% ROI

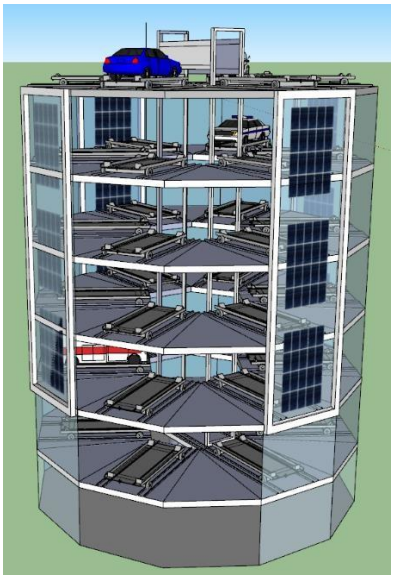
Up to 85% fewer CO2 emissions generated by driving

Tower parking systems

Prototype







This is a prototype designed using the **Tremble Sketchup** software, it works by solar energy converting into electrical energy to hydraulic energy.

PROJECT MODEL

Production of Biogas from Fruit and Vegetable Wastes Mixed with Different Wastes

The present work explores the production of biogas from fruit and vegetable wastes mixed with cow manure in an anaerobic digester. The total solid, volatile solids, moisture content and ash content of the wastes were examined. The materials used as feed were avocado, papaya, mango, tomato, banana peel, and cow manure. Varying volumes of digesters were employed for biogas generation. The combustibility of the gas so generated was tested. The anaerobic digestion of fruit and vegetable wastes mixed with different waste took 55 days to produce biogas (for complete digestion). Anaerobic digestion is very sensitive to change in pH and it is important to maintain pH of 6.7-7.4 for healthy system. The temperature of the digester and the environment also affects the anaerobic digestion process. Upon adjustment of the factors affecting anaerobic digestion, it is felt that co-digestion between FVW and CM produces biogas without need of nutrient or chemical addition to the system. The search for alternative source of energy such as biogas should be intensified so that ecological disasters like environmental pollution, deforestation, desertification and erosion can be arrested.

- In today's fast-growing world, the rate of energy consumption is rising at unexpected rates with each passing day. Ethiopia has also part of this global trend particularly over the last decade. To meet its growing energy requirements, the country has been investing hugely in developing its hydroelectric power generating capacity from water source like Gelgel Gibe dam, Abay River dam, Fincha dam and the like. Besides, the country also relies substantially on the fuel it imports to meet its energy demand.

METHODOLOGY

- In this work, various types of fruit and vegetable wastes are used as substrates for biogas production in 25 liter cylindrical plastic anaerobic digesters and gas collection chamber made out of rubber expandable tube with control valves

WASTAGES

Name's of wastes	Weight in kg/grams
► Cow dung	3 kg
► Avocado	5 pieces
► Papaya	1 pieces
► Mango	6 pieces
► Tomato	300garm
► Banana peel	40gram
► Brinjal	80 gram
Green leafes	250gram
potatoes	100gram
Total	**14 kg**

MIXING PROCESS

- Following collection of the biodegradable organic waste, the wastes were prepared for feedstock by chopping manually to a size of 1-4 mm"; "the characteristics of the wastes were determined
- Slurry of approximately 5 Kg of the mixed waste (consisting of 50% each of FVW and cow manure and leftover foods mixed with cow manure) and 50% of leftover food stuffs in another digester, in about 1:5 of tap water was fed into the digester. The FVW and leftover food stuffs portion of the mixed waste fed into the digester consisted of wet weights of waste as indicated in Table 1. The volatile solids of the mixed wastes were calculated.

TOTAL SOLIDS(TS)

Total solids denote organic as well as inorganic matter in the feedstock.TS were measured according to APHA .A 20g of fresh feedstock was weighed (W2) in an empty crucible (W1)

and dried in an oven maintained at 105°C for 24 hour (W3). Per cent TS was calculated by using Equation 1 as shown below.

VOLATILE SOLIDS (VS)

$$\%TS = \frac{W_3 - W_1}{W_2} \times 100 - -$$

Volatile solids represent organic matter of the feedstock (excluding the inorganic salts, ash). This, too, was measured in accordance with APHA [6]. A 3g of oven dried sample was weighed (B) in an empty crucible (A) and heated to 550°C for 1 hour in the muffle furnace to constant weight (C). Per cent VS was calculated by using Equation 2

$$\%VS = \frac{C - A}{B} \times 100 - -$$

CONCLUSION

It is observed from reduction of TS/VS that production of biogas from leftover food waste of students cafeteria mixed with cow manure will give more biogas than Fruit and vegetable wastes mixed with cow manure. The process of biogas production is not merely source of energy, but also used as source of organic fertilizer.

Biogas production process is microbial in nature is affected by temperature, pH, volatile fatty acids, microbial population and ammonia. The control of these factors determines the quality and quantity of biogas produced. Production of biogas from food waste is a major step toward harnessing one of the world's most prevalent, yet least utilized renewable energy resource.

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ISBN: 978-81-956748-3-1

Treatment of Varthur Lake Wastewater Rootzone Technology

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Abstract: ***In this modern era due to rapid increasing of urbanization and human activities, the water bodies are getting polluted due to the increase in flow of domestic waste, sewage waste, industrial waste etc. to these water bodies. To overcome this issue, root zone technology which is a natural way of treating the wastewater through filter beds which consist of coarse aggregate, sand, charcoal and soil. Root zone treatment is one of the most natural and appealing techniques for treating home, industrial, and agricultural pollutants. An experimental set-up is built to construct a wetland. The experimental test setup consisting of a rectangular tub with a test plant bed was utilizedto produce a root zone bed. Inlet and outlet channels were provided for the flow of polluted water. After running out of the root zone bed through the outlets, the treated water was collected in plastic cans. Tubes and plastic water pipes were used to connect the inlet, root zone tub, and outlet. Water samples beforeand after treatment were taken and tested at the lab. Test sampleswere evaluated for selective parameters and the results are analyzed for the time of three days, seven days, fourteen days andare compared with IS standards.***

Keywords: Polluted water, Root zone treatment, Plant bed, Waste water treatment

I. INTRODUCTION

Environment pollution is one of the serious problems that the world is facing in this era. In India, major problems leading to environment pollution are increasing population, industrialization and urbanization. Solving this environment issue should be our top most priority. Central Pollution Control Board (2007) study found that discharge ofindustrial, agricultural and household wastes is the mostimportant cause for pollution of surface and ground water inIndia. Water is an essential component for all forms of life, although the quality of freshwater has been deteriorated due to discharge of the industrial, agricultural and household wastes. The problem is not only that India lacks sufficient treatment capacity but also that the water treatment plants that exists are not operated and are not maintained. Majorityof the government owned waste water treatment plants remain closed most of the time due to improper design or poor maintenance or lack of reliable electricity supply to operate the plants, together with absentee employees and poor management. The wastewater generated in these areas normally percolates in the soil or evaporates. The term root zone emphases the life interactions of bacteria, the roots of the wetland plants, soil, air, the sun, and water. Root zone treatment is an engineered method of purifying wastewater as it passes through the artificially constructed wetland area.The pollutants are removed by various physical, chemical and biogeochemical processes like sedimentation, absorption, and nitrification as well as through uptake by wetland plants. Root zone systems are reported to be most suitable for schools, hospitals, hotels and for smaller communities. Root zone treatment is one of the natural and attractive methods of treating domestic, industrial and agricultural wastes. It is considered as an effective and reliable secondary and tertiary treatment method. Root zone systems are artificially prepared wetlands comprising of clay or plastic lined excavation and emergent vegetation growing on gravel/sand mixtures and is also known as constructed wetland. Root Zone Technology is one of the low-cost methods to treat wastewater. With the help of this system, we can treat the non-Point sources with best results.

II. LITERATURE REVIEW

In a study by Brix (1987), root zone treatment plants are very nearly up to conventional secondary treatment standard (removal efficiency: 51 to 95%), nutrient nitrogen and phosphorous results vary (total N removal: 10 to 88%; Total P removal: 11 to 94%). Baskar *et al*. (2009) found that TSS, BOD and TN particularly show large variations. Thus, the root zone treatment can be utilized independently or as an addition to conventional treatment for complete treatment of waste water. In the study by Gopalan (2009), the waste water discharged in a campus setting was analyzed to determine its characteristics. Unlike in a municipal area, the waste water from campus shows variation in concentration according to student strength. TSS, BOD and TN particularly show large variations. The root zone method (constructed wetland) was employed on a lab scale to treat the waste water. The results were compared with the conventional treatment. A recent study conducted by Raval and Desai (2015) shows that during Root Zone treatment improved a lot which was indicated by reduction in BOD, COD, nitrate & phosphate value and increase in DO value. Abinaya (2015) the overall experimental resultsdemonstrated the viability of applying sub- surface horizontal flow constructed wetland unit to treat Grey water.Thus, the Modified root zone treatment can be utilized independently. Kannan (2017) BOD and COD particularly shows a large temporal variation. The root zone treatment can be utilized independently for a small-scale unit or as an additional unit to conventional treatment system for complete treatment of waste water by using the plant Azolla. Mane *et al.* (2017) Phytoremediation with the appropriate assortment of locally adaptive plant is an assured, more trustworthy and sustainable technology for better treatment of sewage in local environment. It is concluded that canna indica is suitable aquatic plant forsewage treatment. Jajoo *et al.* (2018) The model had higher values for BOD, COD, TS, TDS and TSS values and it was found that initially the pH turned out to be more alkaline. The removal efficiency for the 1st trial had good values as compared to the 2nd trial. Rani *et al.* (2018) the wastewater can reduce the physio chemical parameters in to a desirable

limit; hence the efficient us e of the treated water can be done. Gunvant, et al. (2019) COD of sewage waste was 220 mg/l and that of treated effluent is 26 mg/l there is 88% reduction in COD btw raw sewage and treated effluent.Likewise, BOD was 125 mg/l and that of treated effluent is 15 mg/l and is found to be 87% reduction for Colocasia esculenta. Hydraulic loading rate of root zone technology plant is worked out to be 67.35 litre/m^2/day. Same way COD of sewage waste was 190 mg/l and that of treated effluent is 28 mg/l, there is 80% of reduction in COD between raw sewage and treated effluent. Likewise, BOD was 135 mg/l and that of treated effluent is 120mg/l for canna Indica. cost required for treatment is Rs 3.5/m3 which is very less compared to cost in conventional methodology. Thorat (2019) BOD, COD, TDS, TSS, TN, Phosphate decreases and increase in pH by colacassia root zoon Hence, the overall study strongly recommends the use of CWs for treatment of domestic waste water for pathogenic bacteria, besides pollutants. Nanaware et al. (2019) During supplying waste it was observed that sewage is very good for plants as during the sewage treatment process, plants are seen to be grown very well. There was considerable decrease in turbidity of water in outlet when compared to the turbidity of inlet water. The Dissolved Oxygen (DO) was seen to be increased. Therefore, from the result we came to the conclusion that this method is effective for reducing turbidity, increasing DO, and bringingpH near to that of neutral water. Mahadik and Shelar (2020) High level of bacterial and viral removal Decreased biological oxygen demand and reduction of suspended solids.

III. METHODOLOGY

The lake ecosystem is an integral part of Bangalore, although unplanned urbanization and industrialization have led to the contamination of these water bodies. Varthur Lake, which has an area of 180.40 hectares (445.8 acres) is the second largest lake in Bangalore city and also one of the most polluted lakes in Bangalore. Figure 1 shows the overview of the methodology.

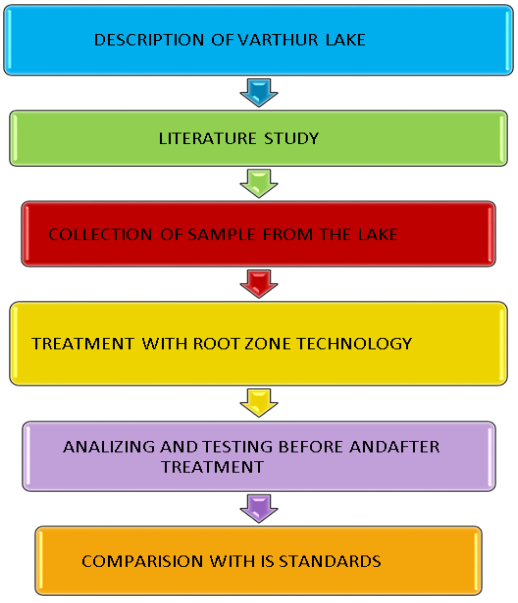

Figure 1. Overview of Methodology

Its ecosystem is under continuous degradation because of sewage water from Bangalore entering the lake from Bellandur Lake, further upstream. This is a man-made lake, built by the Gangakings over thousands of years ago for agriculture and domestic uses but now the lake is receiving 40% of the sewage water from Bangalore for over 50 years resulting in eutrophication. Sample of polluted water was collected from Varthur lake, Bangalore and the treatment process was carried out. Samples were analysed for the following parameter. Parameters tested are biological oxygen demand (BOD), PH, Dissolved oxygen (DO), Chlorides, Turbidity, Color, Temperature and Total dissolved solids. Root zone technology which is a natural way of treating the wastewater through filter beds which consist of coarse aggregate, sand, charcoal and soil is used to treat the polluted water. Root zone treatment is one of the most natural and appealing techniques for treating home, industrial, and agricultural pollutants. Test samples wereevaluated for the selected parameters and the results are analyzed for the time of three days, seven days, fourteen days and are compared with IS standards.

IV. TREATMENT OF WASTEWATER BY ROOT ZONE TECHNOLOGY

Root zone technology is effective technology called Decentralized Wastewater Systems (DEWATS). It was developed in 1970s in Germany and has been successfully implanted in different countries mainly in Europe and America. The root zone wastewater treatment system makes use of biological and physical-treatment processes toremove pollutants from wastewater. The term root zone encompasses the life interactions of various species of bacteria, the root of the wetland plants, soil, air, sun and of course, water. It consists planted filter-beds containing gravel, charcoal, sand and soil. The RZWT system is one of the of natural way of treating domestic, industrial effluents and agricultural waste. It is an engineered method of purifying wastewater as it passes through artificially constructed wetland area.

A. PROCEDURE OF ROOT ZONE TECHNOLOGY

Construction Wetland: consider the length of reactor as 60cm length, breadth 54cm and height 48cm, a root zone treatment bed with wetland plants can be constructed. At lower level consider 80mm thick with aggregate 20mm down size. Figure 2 shows the arrangement of reactor.

Figure 2. Arrangement of reactor

Second layer from bottom 70mm thick with charcoal and third layer from bottom 70mm with sand and the top layer 120mm with black cotton soil. Inlet and Outlet flow rates will be adjusted by using bucket. Figure 3 shows the plant arrangement. Planting Arrangement: Reeds is planted as seedlings or planted clumps. During the

first growth period a sufficient supply of nutrients is required. To prevent entry of soil into under-drain pipe and washing out of soil a graded filter is provided at the lower portion of the reactor. The filter consists of crushed stone of graduation 20 mm at bottom. Figure 4 and 5 show the inlet pipe and outlet pipe, respectively.

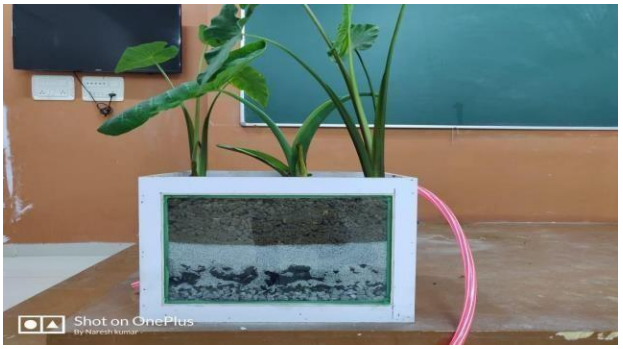

Figure 3. Plant arrangement.

Figure 4: Inlet pipe

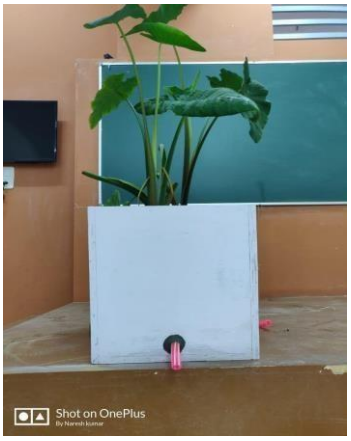

Figure 5: Outlet pipe

We have taken sample Varthur Lake (fishing pond in Karnataka). This lake was polluted due to it runs through the city and slum areas, this lake has become filthy. Asample has been taken from the sample bottling. All samples, excluding those gathered for bacteriological, oil- based, or solvent analysis, should be collected in one liter ortwo 12-litrefresh PVC bottles. At low flow rates, to take the sample deeply, a hand-pump extending with the tube shouldbe used. Then, a depth sample tumbler (250 ml, 500 ml, or 1000 ml) with screw-in extension rods should be used.

Figure 6: Collecting the waste water sample

Parameters tested: Test samples were evaluated for selectiveparameters such as Chlorides, pH, Turbidity, BOD, colour,and DO, with a normal procedure in both circles (controlbed and plant bed). Both beds of CWs had their soils evaluated before and after treatment. Finally, the efficiency of the test plant's pollutant reduction and treatment was determined.

B. MECHANISMS IN THE ROOT ZONE

- The experimental protocols used in this study were comparable to those previously defined. Colocasia is well-known adaptable marshland plant in India that have been used to remediate wastewater. In the Angular Horizontal Subsurface Flow procedure, the created wetland was transplanted into the intended wetland system.
- Each experimental set-up had two sets of buckets of varying sizes and dimensions. The wastewater was collected in vertical buckets as a holding tank (inlet).
- Fill the bottom of the built-up structure with 80 mm thick coarse aggregate. The second layer of the reactor was then filled with 70 mm thick charcoal and third layer of the reactor was filled 70mmsand. At the top, there is black cotton soil up to 120 mm deep.
- Plants on the bed were acclimatized for one week at a time using appropriate dilutions.
- In each set, an experimental test setup consisting of a rectangular tub with a test plant bed was utilized to produce a root zone bed with a length of 60cm, breath of 54cm and height of 48cm having suitable outlet. For uniform distribution of waste, the perpendicular pipe was put overhead the pot in an upturned "T"figure and connected creek of every set holding tank in with the rubber pipe. The plastic tube was 40 cm long and flow is manually adjusted.
- Plastic cans were used for the collection of treated water after flowing out from the root zone bed through the outlets. Inlet root zone tub and outlet were connected to each other with taps by tubes and plastic water pipes. Treated water samples were collected and analyzed in laboratory.

V. RESULTS AND DISCUSSION

TABLE 1: pH OF THE COLACASIA PLANT

Sl. No.	Details	Colacasia Plant
1	Prior to the treatment	10.5
2	After one day	10.5
2	After Three Days	9.9
3	After Six Days	9
4	After12 Days	8.3

TABLE 2: THE CHLORIDES VALUE OF THE COLOCASIA PLANT

Sl. No.	Details	Colocasia Plant
1	Prior to the treatment	175.69 mg/l
2	After one day	174 mg/l
3	After Three Days	265 mg/l
4	After Six Days	311.67 mg/l
5	After 12 Days	456.78 mg/l

TABLE 3: THE DO VALUE OF THE COLACASIA PLANT

Sl. No.	Details	Colacasia Plant
1	Prior to the treatment	26mg/l
2	After one day	24.5mg/l
3	After Three Days	20.6mg/l
4	After Six Days	17.5mg/l
5	After 12 Days	12.69mg/l

TABLE 4: THE TURBIDITY VALUE OF THE COLACASIA PLANT

Sl. No.	Details	Colacasia Plant
1	Prior to the treatment	23 NTU
2	After one day	22 NTU
3	After Three Days	18 NTU
4	After Six Days	12 NTU
5	After 12 Days	9.6 NTU

TABLE 5: THE BOD VALUE OF THE COLACASIA PLANT

Sl. No.	Details	Colacasia Plant
1	Prior to the treatment	460mg/l
2	After one day	449.89mg/l
3	After Three Days	402.20mg/l
4	After Six Days	356.11mg/l
5	After 12 Days	296.54mg/l

TABLE 6: SHOWS THE TOTAL HARDNESS VALUE OF THE COLACASIA PLANT

Sl. No.	Details	Colacasia Plant
1	Prior to the treatment	710mg/l
2	After one day	706mg/l
3	After Three Days	667.89mg/l
4	After Six Days	608mg/l
5	After 12 Days	563.78mg/l

VI. CONCLUSION

Domestic, agricultural, and industrial waste, as well as urban and highway runoff, are all treated using construction wetlands in developing countries. The most prevalent method is the rootzone system, which is utilized for household trash. From the project above, it can be said that the technique of RZT can decrease the impurity level exposed beneath.

- Before treatment, the pH level was 10.5. After treatment, the pH level was 8 .3.
- After 1 day, 3 days, 6 days, and 12 days, the Chloride level in the Colacasia rootzone increased by 1%, 8%, 28% and 46% respectively.
- After 1 day, 3 days, 6 days, and 12 days, the DO level in the Colacasia rootzone decreased by8%, 23%, 33% and 52% respectively.
- After 1 day, 3 days, 6 days, and 12 days, the Turbidity level in the Colacasia rootzone decreased by 5%, 22%, 48%and 58% respectively.
- After 1 day, 3 days, 6 days, and 12days, the BOD level in the Colacasia rootzone decreased by3%, 13%, 23% and 35%, respectively.
- After 1 day, 3 days, 6 days, and 12 days, the Total hardness level in the Colacasia rootzone decreased by 1%, 6%, 15% and 21%, respectively.
- The colour water before treatment was brownish-gray and the colour of water after the treatmentwas colourless.
- Overall, the study says that CWs should be used to clean household wastewater of pathogenic bacteria and other pollutants.

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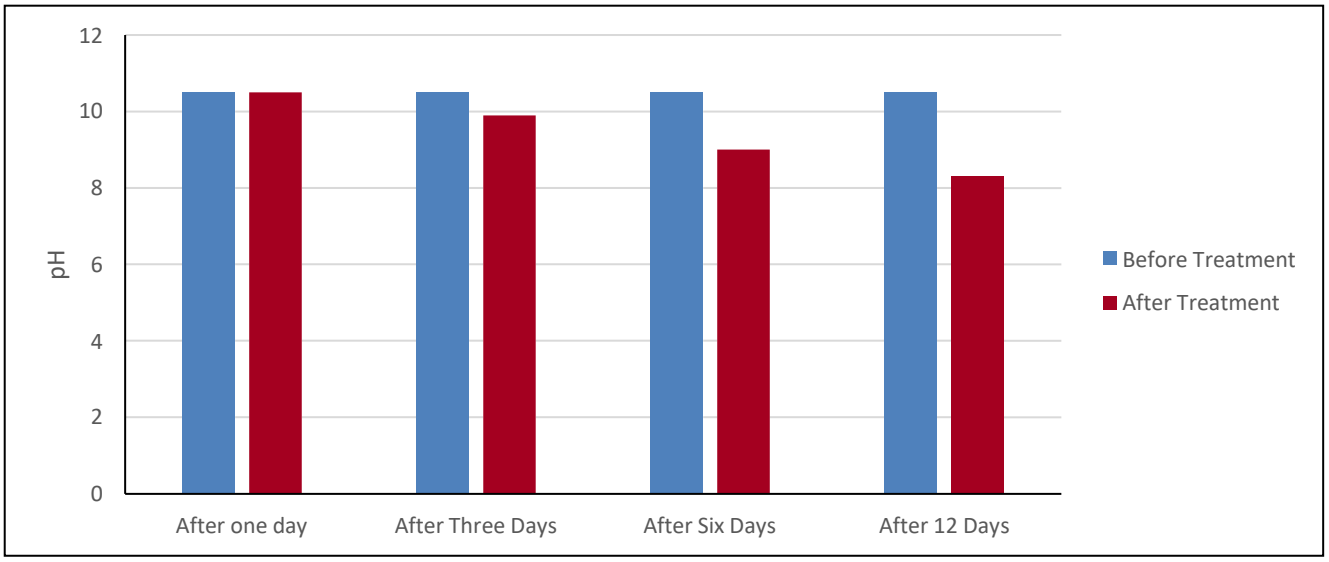

Figure 7: pH of the Colocasia plant

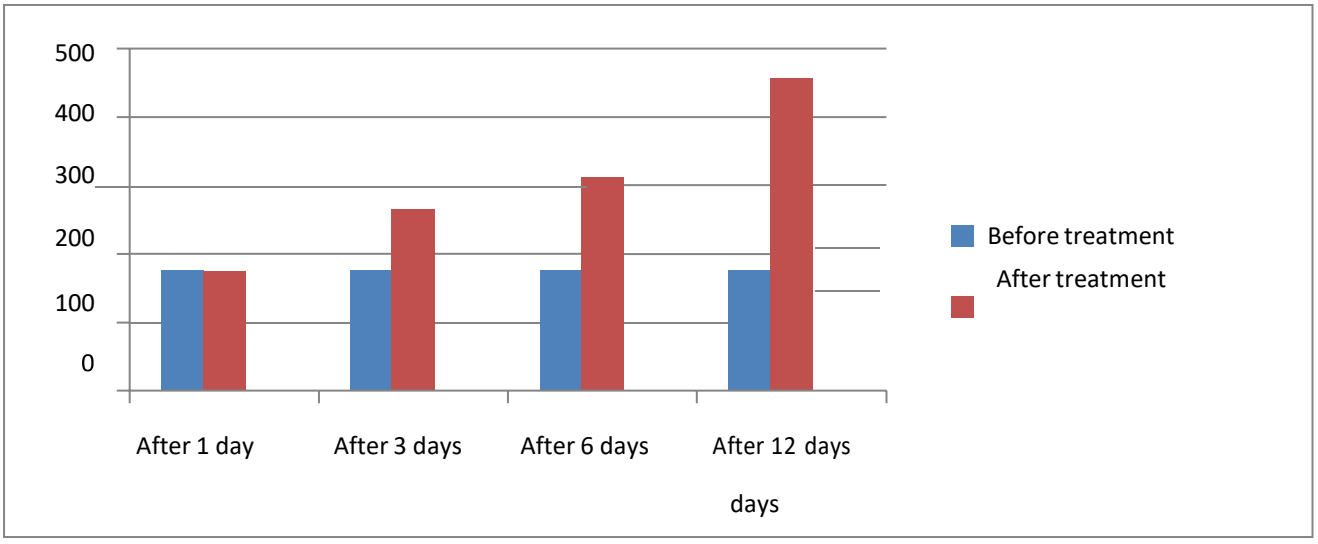

Figure 8: Chloride value of the Colocasia plant.

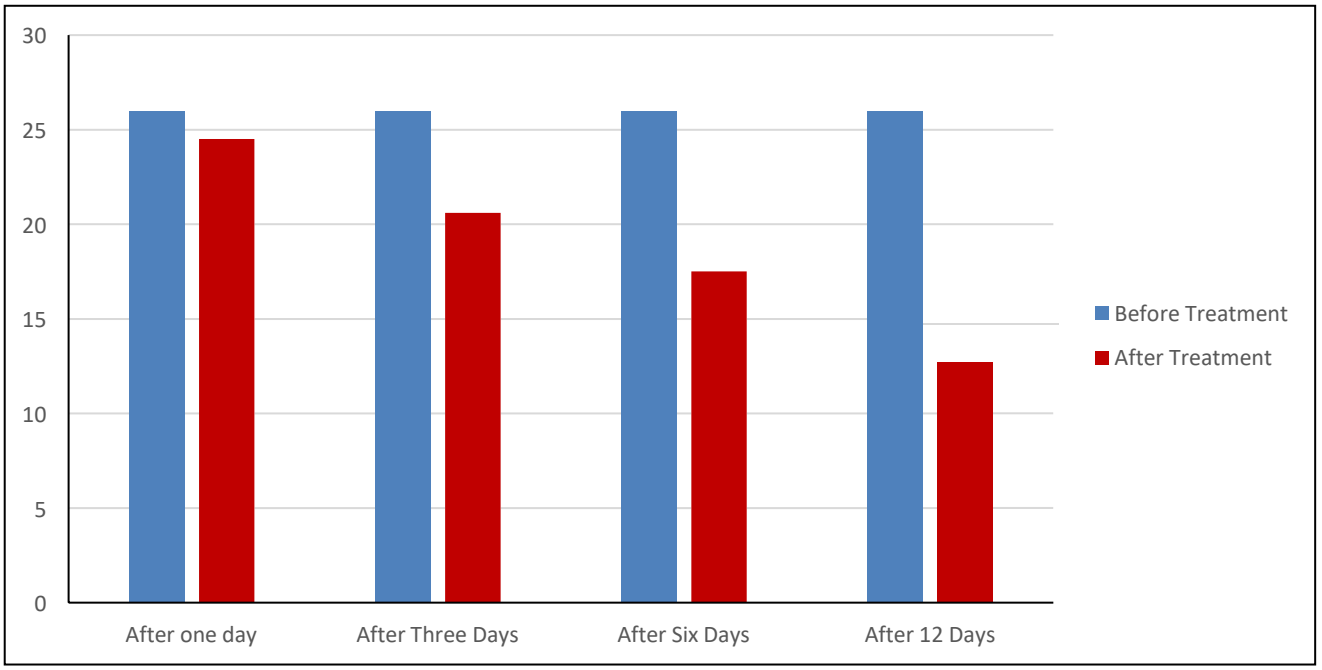

Figure 9: DO value of the Colocasia plant.

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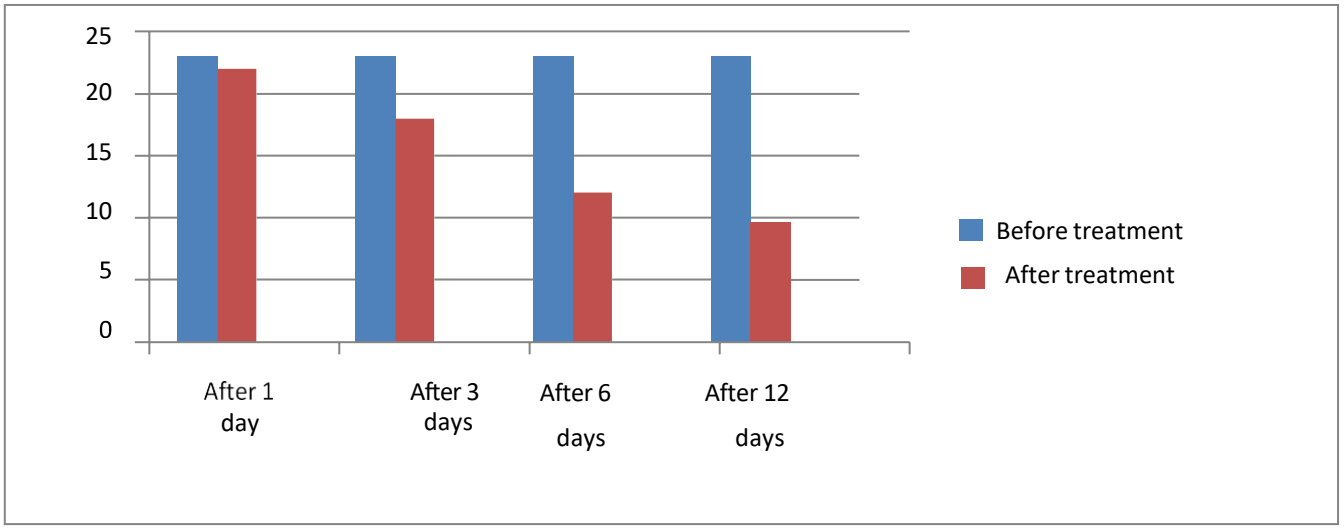

Figure 10: Turbidity value of the Colocasia plant

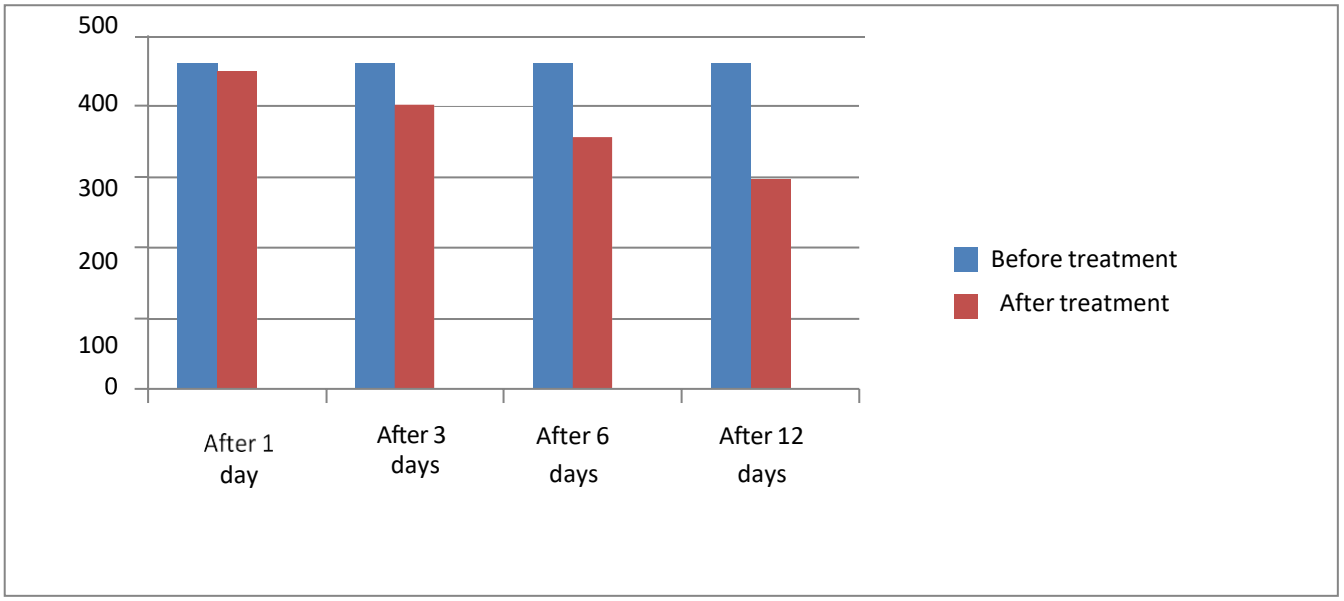

Figure 11: BOD value of the Colocasia plant

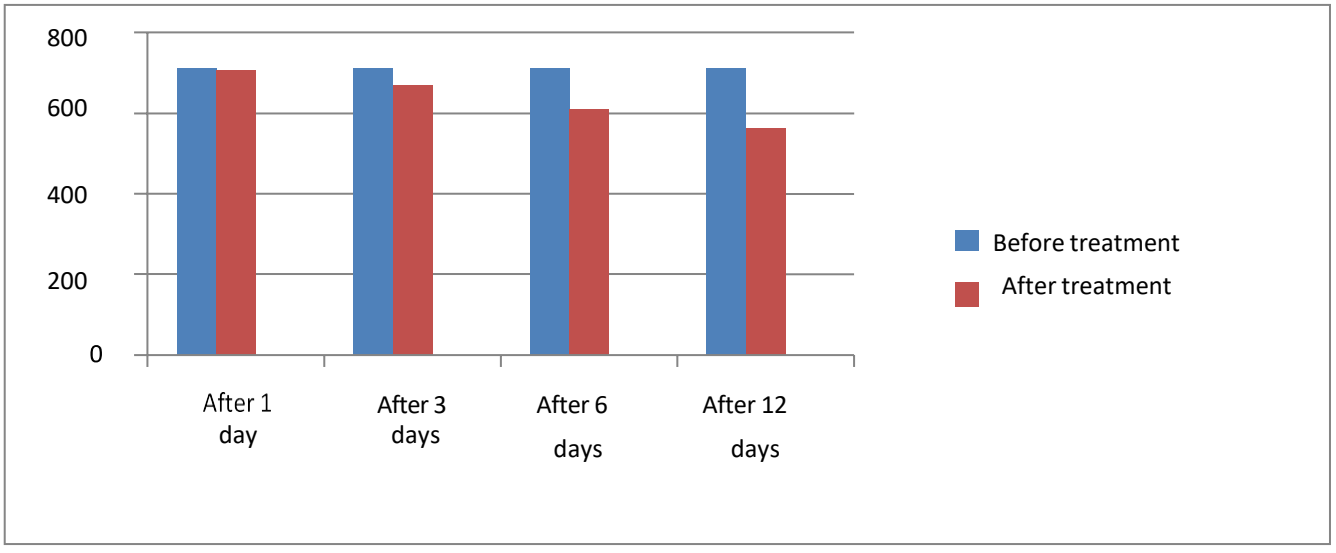

Figure 12: Total hardness value of the Colocasia Plant.