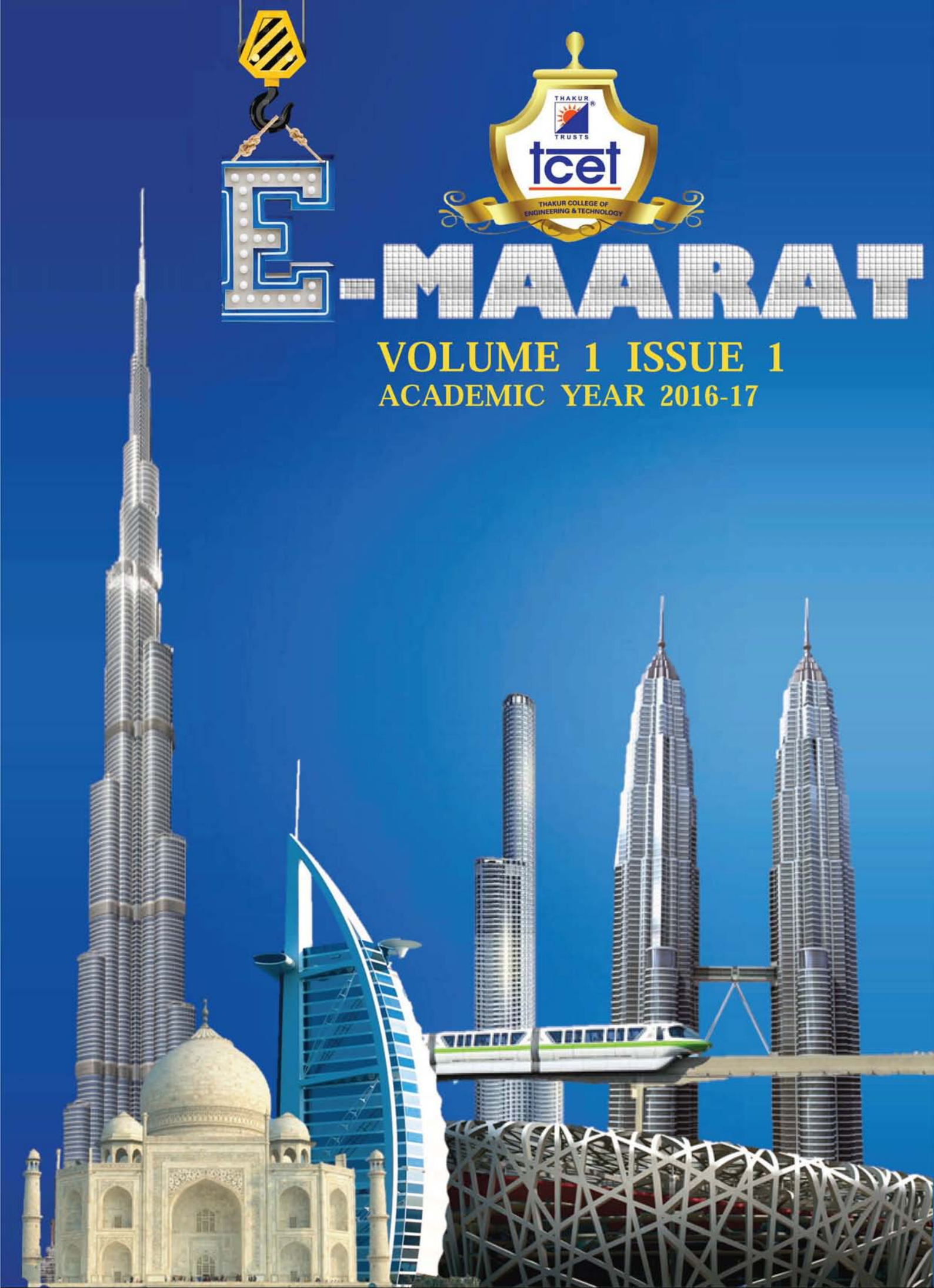




# E-MAAARAT

VOLUME 1 ISSUE 1  
ACADEMIC YEAR 2016-17





# CIVIL ENGINEERING



# THAKUR COLLEGE OF ENGINEERING AND TECHNOLOGY



The Thakur College of Engineering & Technology (TCET) was established in the academic year 2001-02 with a clear objective of providing quality technical education in tune with international standards and contemporary global requirements. The College is recognized by All India Council for Technical Education (AICTE) & Govt. of Maharashtra and is affiliated to the University of Mumbai (UOM). All the courses at the U.G. level, eligible for accreditation in 2011 i.e. Electronics & Telecommunication (EXTC), Information Technology, IT and Computer Engineering (CMPN) were accredited by NBA for three years w.e.f. 16.9.2011. Moreover, these programmes are also given permanent affiliation w.e.f. A.Y. 2015-16 onwards.

The management's commitment to excellence and relevance in technical education is reflected in the marvelous infrastructure that is comparable to the finest institution of its type in the country. The imposing five-storied building, housing state-of-the-art computer laboratories, spacious classrooms, well equipped laboratories, workshops, computer centre with server room, a well-stocked library, wide and well lit clean corridors and a large canteen, conference hall, seminar halls has set new standards in providing facilities of international level.

# **DEPARTMENTAL OBJECTIVES**

## **DEPARTMENTAL VISION**

“To become a department of national relevance in the field of Civil Engineering.”

## **DEPARTMENTAL MISSION**

The department of Civil Engineering is committed to provide undergraduate students with sound knowledge in the field of civil engineering, and build in them leadership and managerial skills along with inculcating the culture of lifelong learning and social sensitivity.

## DEPARTMENTAL MENTOR MESSAGE



**Dr. Sanjay Kumar**  
**Departmental Mentor**  
PhD (Mechanical Engg.)  
M.Tech (Industrial Engg.  
& Management)  
B.E (Production Engg.)

It is great pleasure and I feel proud to be a part of first E-magazine of civil engineering department. It gives insight of youngest department of Thakur College Of Engineering which was established in the year 2014, with the intake of 120 students. In a short span of time, our department is competing with all the established department in academic, co-curricular and extra curricular activities.

In academic front, faculties presented paper in Multicon W-2017. Second year and Third year students were also encouraged to present paper in different domain of civil engineering. There was overwhelming response from the students. Faculties and students are getting platform to involve themselves in research activities.

For overall personality development, apart from academic, co-curricular and extra curricular is the need of hour to involve into projects practically.

Students are encouraged to participate in inter and intra activities. This will help in overall personality development and growth.

Next year students will be in final year. All these activities will help them in placement and higher studies.

With all of them for better future and congratulate for publishing E-MAARAT that will present the face of department in a dignified manner.

## HEAD OF DEPARTMENT

Dr. Seema Jagtap  
In-charge HOD, Assistant  
Professor



### QUALIFICATION:

PhD  
M.Tech Civil  
(Hydraulics Engineering)  
B. E.(Civil Engg. )

**The** primary objective of E-Maarat is to instill the idea of how and why and where civil engineers work. We as a department aim to excell our students in understanding the concepts and provide proper practical exposure.

I am very pleased that we have successfully published the very first edition of our departmental magazine E-Maarat. I applaud all the students for making our department one of its kind and unique by participating in different national and state level civil projects and presentations.

This magazine intends to bring out the creativity and flamboyance of the minds of the students at TCET. Civil engineering is one of the most important, old field of engineering.

The subjects are not merely based on bookish knowledge but require lots of practical and creative approach and we as a department plan to teach our students looking at industry point of view.

I heartily congratulate all the editorial members and faculty members for helping and working together to publish this magazine. Thank you all for your precious time and noteworthy efforts.

We all wish that E-MAARAT stands tall for all the future editions to come

**E-Maarat** – in its very first edition, we have tried to keep it informative, inspiring and fun there was a lot of hard work involved in its making and I believe it is going to turn out to be a huge success.

Infrastructure is all over the place and we are all so lucky to be a part of this stream. It gives me the utmost pleasure to be a part of something that involves our aspiring builders. I am so grateful to the civil engineering department, and faculty colleagues for this amazing opportunity and their relentless support.

Best wishes to all. Hope you all like it.

## FACULTY INCHARGE

Mrs. Rutuja Shinde  
Assistant Professor.



### QUALIFICATION:

M.E.  
(Water Resources &  
Environmental Engineering)  
B.Tech.(Civil)

# MESSAGE FROM EDITORIAL DESK

It gives me an immense pleasure to present you the very first edition of E-Maarat magazine! E-Maarat has been published after a lot of efforts by the whole editorial team. E-Maarat is nothing but the outcome of creativity and seriousness in the technical field showed by both the students of civil department and staff. It is and always will be a platform for the students to showcase their talent whether it be technical, cultural or sports field. Here students get the chance to post articles on their area of interest and also the trending topics in the field of Civil Engineering.

Civil the oldest branch as traced in the history of engineering has a huge potential and a wide scope to work in. E-Maarat focuses not only the trending topics in civil engineering but also the achievements of students and staff which reflect the emerging talents of Civil Department. The magazine not only highlights the students in extra co-curricular activities but also those who have excelled well in university exams. Students have published projects and international papers too which are really informative and can be a boon to the upcoming batches.

E-Maarat also has insights of the work in industry and interviews of reputed industrialists in the field of Civil Engineering. As a new branch at TCET, the Department of Civil has ensured to provide an overall growth and development of the students in all aspects. The only mission of Civil Department is to provide undergraduate students with sound knowledge in the field of civil engineering and build in them leadership and managerial skills along with inculcating the culture of lifelong learning and social sensitivity.

*“Never regret anything in life. If it’s good, it’s wonderful. If it’s bad, it’s an experience.”*

Ajay Dwivedi.  
Chief Editor





# MESSAGE FROM EDITORIAL DESK

*‘As cement binds concrete, Civil binds us’.*

To create awareness amongst the budding civil engineers about modern concrete construction practices and promote the growth of concrete constructions, the department has organized many technical events and non-technical events to boost up enthusiasm level of the students, helping them in bridging the gap between knowledge and practice.

Participation of students in conducted competitions, guest lectures, conferences, technical site visits, opportunities to interact with practicing professionals not only helps students learn about the wonderful concrete industry but also installs within them interest in the field and courage of approaching the oncoming professional life.

The department promotes the growth of concrete constructions and its sub specializations and identifies R &D problems of practical relevance to concrete construction technology.

By hosting more field related and practical workshops and trainings, so as to grow student’s interest in the curriculum which motivates and makes them curious about the subjects and increases participation of the student.

By increasing the practical approach in the curriculum and by making the lectures an interactive makes students attend lectures.

The curriculum today lacks the current industrial knowledge and so to bridge that, the department conducts Student Orientation Program, Student Development Program and bridge courses.

Knowledge of civil engineering subjects are very essential for the an engineer to work on site as it enables him to understand every aspect and helps him to co-ordinate with the workers.

The Subjects taught today lack the current industrial knowledge and so to cope up with this. Field Visits and guest lectures are organized.

These are some views given by students & teachers for improving the current system.

**Jaykumar Lodha**  
**Secretary of Concrete Civil**



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*INDUSTRIAL VENTURE*



**Ravi Nigam**  
 -Founder and Managing Director  
 of Tech-N-ECO

Educational Qualification :-

M.Tech (Structural Engineering)  
 B. Tech (Civil Engineering)

Q1. Tell us about your journey from a B.E graduate to project manager.

Ans: I completed my engineering from Gorakhpur University in 1983, i came to Mumbai and with the reference of my uncle i succeeded to get job in a multinational consultancy firm then known as a Davy Power Gas and now known as (Kvanear Power Gas) taking up big industrial project of many corporate houses.

I was appointed as a site engineer and my first project was at HerdilliaChemicals Ltd, Vashi, later i was transferred to Herdillia, West Bengal to supervise DAP project of Hindustan Lever Ltd. My third project was Energy Conservation at BPCL, Chembur.

In 1986, I left Power Gas and joinedPolychem Ltd. as a project engineer and worked in their Project and maintenance dept. for 10 years. I was in charge of their civil dept. at four different locations and was also part of their project team of one of their new project coming up at Nagothane.

In between, I was selected in PWD, Gorakhpur, UP but didn't continue Govt job as i found it less challenging and totally unprofessional.

In 1996, My company Polychem Ltd. closed down and i was given VRS.

As i was very young and energetic with lot of dream that time without wasting any time I started my Consultancy firm for Building repair in the name of Tech-n-Eco Pvt. Ltd.and in a short period of three years i bagged many project due to sincerity and good past experience and was running a firm with 50 professionals.

I always given importance to my client and career, and for me my career was always my top priority and at initial stage of my career I use to work for 365 days without any break with 14 to15 hours a day. I used lot of innovative way to do business and was always having edge with our competitor. I innovated many new technologies in repair field and was pioneer of many systems which was cost effective and technically strong and the benefit of cost was always shared with client. I have taken copy rights of many of my system from ministry of HRD, New Delhi.

Q2. How would you encourage the students to be more enthusiastic about the industrial knowledge rather than the theoretical aspect?

Ans: I will never encourage the student at this stage for deep industrial knowledge as there is a lot of time, when they will get to know the industrial knowledge as at this stage you yourself don't know, in which industry you are going to settle with. This the time of acquiring max knowledge as our syllabus impart knowledge of almost all field viz. building, irrigation, road , railways, bridges, canals , airways .... Etc. So once you complete your engg and select your career in a particular field, you will automatically get knowledge of that field and that time your theoretical knowledge gained at this stage will help you to communicate easily with the people of other field too of civil engg and will be more successful to handle situation / job at senior position, when you will be expected an all-rounder civil engr.

Q3. What according to you is more trending in civil engineering right now?

Ans: According to me as "Development" is main focus of our Politicians and the same is acknowledged by public too , then there is very high potential of infrastructure project viz. Metro rail, Highways, bridges, dams...etc.

Q4. How would you inspire the upcoming generation to take up civil engineering?

Ans: Civil engineering is directly associated with civilization, and India being a developing nation and as stated above the focus of our all Politician is changed to real development of our country, there is an immense scope of civil engineering, but you must fall in love with it and should see civil engineering. in every aspect of your day today life. You must relate the structure with other structure, develop the curiosity to go into detail of everything where you see even an iota of civil engineering is used, must read magazines of this industry, attend seminars or any other easily available regularly to abreast yourself with current development in this industry, this will give you an edge over your fellow engineer.

Q5. How can institute bridge the gap between industry and institutional knowledge?

Ans: The institute must arrange seminar / lectures in college and do more of site visit, which will clear the perspective of fresh engineers and will help them to choose appropriate field of civil engg of their choice to build their successful career and make them feel proud of their success in future, even the college will also feel proud of their successful students.

Q6. India a land of potential development, how can new techniques help in attaining strong and new infrastructures here?

Ans: There is no end to new idea / innovation, and India as it is rightly said is a developing country, there is immense scope of new technique. You must go for higher study to enhance your knowledge and then keep your mind open to understand the problem being faced by others in this industry and as it is well said every problem has its solution, your mind should start working to solve that problem with your technical knowledge and practical experience gained in your career may be after 5 to 6 years of experience. The new technique found by you will not only give you a job satisfaction but will benefit you financially and will get you social recognition too.

Q7. Anything more for students? As this is completely student-centric?

Ans: Enjoy your college days now as it is not going to come back again but don't forget your aim / dream. You must dream high and pursue it daily and ask yourself what you did for your dream today. You must lay a stone everyday towards your dream as you are now at foundation level, build a strong foundation today and see after 10 years how your dream will take shape and the foundation build today will help you to see your dream come true.



**RAMAKANT V BIRADAR**  
**-Asst. Commissioner MCGM G-North**

Educational Qualification :-

DCE, BE Civil, ME Structures  
 DBM, DHRD, PGDUP  
 PGDUM, LGS, MIE, MISTE

Q. Could you tell us little about your journey from B.E. degree to your present status?

ANS: I got B.E. degree in 1989. Then I worked for 1 year in a construction company. After that I worked as a lecturer in an engineering college for 1 year. Then I joined municipal cooperation of Greater Mumbai as a Jr. Engineer. Subsequently I got posted as an Asst. Engineer. In 2008 I appeared for an exam of MPSC & got 1st rank in Maharashtra. I joined MCGM again as a Asst. Commissioner in Jan 2010. Now I am working as an administrator controlling educational, medical and administrative activities.

Q. What different job aspects can a civil student look at in their core branch?

ANS: One can opt for different aspects like Building planning, Urban planning, Environmental engineering, Infrastructure development etc.

Q. Can you suggest some courses for civil students to bridge the gap between the civil and IT domains?

ANS: In this world of fast development Software development courses like Project planning, RCC design, Estimation and Costing etc. has become most important for an individual.

According to me, Geosynthetic, infrastructure work like highways, metros, monorails etc are trending.

Q. How can an institute make their students industry ready?

ANS: Institutes impart theoretical knowledge to the students. After passing out, students face lot of difficulties to become aware with the practical implication of work. There should be some seminars arranged for students by the professionals of the industry. There must be compulsory internship for at least 6 months before passing out. The project work and thesis should be made from industry point of view.

Q. How would you encourage the students to be more enthusiastic about the industrial work than the theoretical aspect?

ANS: Students should be provided with practical challenges and environment as in the industry.

Q. What is the scope for civil engineer in near future?

ANS: Civil engineers play vital role for the development of nation. India being a developing nation, there a lot of multinational projects which are yet to come. All small villages are to be developed and we can make a village to a planned city like Chandigarh.

Also there are lot of scope in transport development, high rise construction in urban areas and water supply works .

Q. What is the scope for entrepreneurship for this generation?

ANS: We have scope in running off consultancy works and construction work. One can run a consultancy firm after gaining some sort of experience by working for some firm for some years.

Q. Can you suggest some new projects for students?

- Improvement of transportation by suggesting remedies to highways .
- Construction of bridges to reduce the traffic .
- These on construction of tunnels between Borivali to Mulund through national park.

Q. How would you inspire upcoming generation to take up Civil engineering?

- Vast scope for urbanization .
  - Need for good quality of roads and high rise buildings.
  - Future scope in construction management.
- There is a lot of potentiality and domains for students in Civil engineering field .





Anil Koli

Estate department,  
Junior engineer.  
Mumbai port trust .

**Civil Engineering** is a branch of engineering that encompasses the conception, design, construction, and management of residential and commercial buildings and structures, water supply facilities, and transportation systems for goods and people, as well as control of the environment for the maintenance and improvement of the quality of life. Civil engineering includes planning and design professionals in both the public and private sectors, contractors, builders, educators, and researchers.

I am working with one of the biggest Central Government undertaken firm i.e. 'THE MUMBAI PORT TRUST' for past 22 years and have seen that the civil engineer holds the safety, health, and welfare of the public paramount. Civil engineering projects and systems should conform to governmental regulations and statutes; should be built economically to function properly with a minimum of maintenance and repair while withstanding anticipated usage and weather; and should conserve energy and allow hazard-free construction while providing healthful, safe, and environmentally sound utilization by society.

Civil engineers play a major role in developing workable solutions to construct, renovate, repair, maintain, and upgrade infrastructure. The infrastructure includes roads, mass transit, railroads, bridges, airports, storage buildings, terminals, communication and control towers, water supply and treatment systems, storm water control systems, waste water collection, treatment and disposal systems, as well as living and working areas, recreational buildings, and ancillary structures for civil and civic needs. Without a well-maintained and functioning infrastructure, the urban area cannot stay

**Because** the desired objectives are so broad and encompass an orderly progression of interrelated components and information to arrive at the visually pleasing, environmentally satisfactory, and energy-frugal end point, civil engineering projects are actually systems requiring the skills and inputs of many diverse technical specialties, all of which are subsets of the overall civil engineering profession.

Some of the subsets that civil engineers can specialize in include photogrammetry, surveying, mapping, community and urban planning, and waste management and risk assessment. Various engineering areas that civil engineers can specialize in include geotechnical, construction, structural, environmental, water resources, and transportation engineering.

There are a lot of people who need construction and engineering work done. There are usually a lot of contractors after it, as well. How do you get your firm in there before the others? The trick is to source early and often. Keeping informed as to what development might happen in the future can give you the boost you need.

No-one wants there to be a disaster during a project. It's unprofitable and unsafe. However, it's made all the worse by those without the proper preparation to cope with it. You need to develop a proper continuity plan in the events of disasters, such as mains power failing.

Sometimes, you may see a job that you want to take on, but lack the capacity to do so. Most often this comes down to not having the equipment. Maintain good relationships with those who could provide said equipment. Outsourcing prevents you from spending money on equipment you'll only need for a short time. A job might need use of the large cranes, but you're not going to want to pay for its maintenance afterwards.



**Mukul Goel**  
Founder,  
**MAKE ME BUILDER (MMB).**

#### Education

- B.Tech. in Civil Engineering, IIT Bombay
- M.E. in Project Management, Texas A&M University

## Background

Over the last decade, the construction industry has seen a rapid rise, particularly in the mid-range and premium slabs of urban housing. Land being the prime input to housing development has led to aggressive investments through vast purchasing of land. However, with the current recessionary cycle and currency demonetization, land hoarders have realized that, investment in land with the intention of development, would bear greater fruits rather than holding it for future resale.

## The Opportunity

To realize the full potential of private land holdings and expose them to development, it is imperative that assistance and step by step guidance be available to aspiring developers. The government's policies for easing provisions and delivering homes with basic amenities to millions of first-time home owners has supported this segment of the market. We will focus on lands with potential of creating very large, untapped segment of affordable homes in emerging areas along with basic amenities. Old buildings in high density locations can also benefit from redevelopment.

## Our Goals

At MakeMeBuilder we enable landowners to truly benefit from their land holdings by helping them embark on an entrepreneurial journey. We help them in visualizing, creating, constructing and all necessary operations so they can self-develop and manage projects and create a family business.

## Our Ambition

Make Me Builder aspires to be known as a leading incubator and knowledge center for innovation in construction technology and project management. MakeMeBuilder wants be instrumental in developing sustainable projects in mixed-use housing, education, healthcare, retail, warehousing.

### Services

As part of the incubation program – we ensure that full stack of capabilities are available to an entrepreneur . At the inception we come up with the most suitable project concept in synch with financing opportunities. The project is assessed and cleared up of any legal risks. We deploy the best local and national resources to construct the project while monitoring it for cost, quality and schedule .For sales and marketing we use a combination of Online and On Ground promotion channels.

### What we are looking for?

We wish to reach out to landowners and community leaders in small towns and villages. We want partnering on government projects related to slum rehabilitation, healthcare, education facilities, fostering entrepreneurship and employment.

## OPPORTUNITIES

### Students

Help in business development through social media marketing, research, listing and interaction with landowners, new builders, communities, social organizations, academic institutions, contactors and vendors.

### Startups and Innovators

Partner with us to develop innovative ideas, ventures and projects in a collaborative environment of students, entrepreneurs and industry experts. We invest our time for exchange of equity and for relatively mature organizations, we adopt a performance based consulting

### Professionals

We curate a global network of architects, engineers, lawyers, liaison and regulatory experts, business analysts, planners, financiers and promoters who we attach to your project at a cost the project could afford.

### Social Impact Organizations

Reach out to towns and villages where we want to establish trust with leaders and members of communities. Partnering on government projects related to slum rehabilitation, healthcare, education facilities, fostering entrepreneurship, skill development and employment.

*FACULTY WISDOM*

# APPLICATION OF CALCINED BAUXITE IN PAVEMENT DESIGN FOR ACCIDENT PREVENTION



**Mr. Arpit S. Vyas**  
**Assistant Professor**

**Abstract**—Skidding resistance is an important parameter in the pavement design and selection of material for pavement can play a significant role in improving pavement skid resistance property. NHAI standards recommend the PSV (Polished stone value) of paving material as 55 or more. Though the pavement material basalt satisfies this value in fresh unused state, with increasing exposure to traffic basalt's PSV is found to reduce. Therefore it is important to identify an alternative material that can overcome this limitation of reduced PSV with time and the present research offers some solution in this direction. Objective of the present research is to study the factors influencing skidding of vehicles and evaluate performance of calcined bauxite in comparison with basalt stone as a paving material. Laboratory test results show that calcined bauxite has better material property in terms of hardness and abrasion resistance and decreased porosity. The only limitation being the cost, the paper suggests selective application of this material in specific locations that are identified as black spots rather than completely replacing bauxite.

**Keywords:**Road accidents, Calcined bauxite, Skidding, Skid resistance, Pavement, Polished stone value.

## I. INTRODUCTION

Skidding resistance is an important parameter in the pavement design and selection of material for pavement can play a significant role in improving pavement skid resistance property. Design and construction of pavement with skid resistance material can help reduce accidents. An increase in average speed is directly related to both the likelihood of a crash occurring and to the severity of crash consequences. As per world health organization's road safety report of the year 2010, A 5% increase in average speed leads to an approximately 10% increase in crashes that cause injuries and a 20% increase in fatal crashes. As per NCRB (National crime records bureau), road accidents were the biggest reason behind unnatural deaths in the country they constitute 37.4% of the total cases of un-natural deaths in the country in the year 2012. If we look at the data closely the biggest reason for road accidents after human error is skidding of vehicles when brakes are applied at high speeds (NHAI). As per NHAI the PSV (Polished stone value) of paving material shall be 55 or more. Though the pavement material basalt satisfies this value in fresh unused state, with increasing exposure to traffic basalt's PSV is found to reduce. Therefore it is important to identify an alternative material that can overcome this limitation of reduced PSV with time and the present research offers some solution in this direction.

## II. LITERATURE SURVEY

Research related to pavement surface friction and alternative material has gained momentum in recent years. Few significant research findings are listed here. Researchers in the past have opined that skid resistance of pavement is not only a function of material property but also of service life. In other words those material which are found suitable at the time of pavement laying may loose skid resistance property leading to monitoring and resurfacing on a periodical basis. Piyatrapoomi stated that by using cumulative probability distribution it is found that 85% of road crashes occur on road surfaces having low skid resistance.<sup>1</sup> As per Woodward apart from aggregate properties like size, shape, strength, abrasion and soundness the aggregate must have high levels of skid resistance. Size of surfacing material is an important factor for increasing PTV (Pendulum Test Value).<sup>2</sup> According to P.Kilbey et al. In 2011, 25 per cent of all reported accidents occurred in wet surface conditions & 2 per cent of all reported accidents occurred in icy or snowy surface conditions.<sup>3</sup> Harish H.S et al. stated that skid resistance increases with increase in texture depth and the rolling action of sand particles between pavement surface and tyre during braking may cause a reduction in skid resistance which cannot be easily predicted. From the study it can be observed that value of skid resistance in all the pavement condition will decreases over a period of time.<sup>4</sup> VenkataRao et al. has the opinion that binder content must be limited to a designed optimum level. The dimensions of the aggregate chips and the laying must be such that the aggregates form sufficiently sharp projections. Compromise between providing an adequate micro-roughness and macro roughness may be achieved by choosing a maximum grain size of 12.5mm.<sup>5</sup> According to Sabir H. et al. to achieve desired surface characteristics the aggregate must be Hard i.e Mohr's hardness number shall be higher than 6; Wear on macro scale will cause degradation, rutting, pitting etc.; Wear on micro scale will cause loss of safe skid resistance.<sup>6</sup> Woodward et al. noted that lower polished stone value (PSV) aggregates were able to provide acceptable levels of skid resistance in nominal 6mm size. The paper also suggests that skid resistance of the aggregate may not be a significant factor in the early life of the pavement but on prolong use low skid resistance can lead to accidents.<sup>7</sup> In their book H.Viner et al. mention that texture depth is related to high speed skid resistance in wet conditions, but not to low speed measurements. Accident studies strongly support the need for skid resistance data in addition to texture depth data.<sup>8</sup> H. Viner also suggests that a systematic data base system dedicated for road accidents can predict the possible locations which may get prone to road accidents after a certain operational period. Identification of

Properties	Components	Grade 1	Grade 2	Grade 3
Chemical Analysis (%)	Al <sub>2</sub> O <sub>3</sub>	82.83	86.32	80.19
	SiO <sub>2</sub>	8.12	5.87	9.10
	Fe <sub>2</sub> O <sub>3</sub>	3.47	2.61	5.36
	TiO <sub>2</sub>	3.14	3.92	3.04
	CaO	2.18	0.71	1.61
	MgO	0.01	0.22	0.37
	Na <sub>2</sub> O	0.01	0.01	0.01
	K <sub>2</sub> O	0.12	0.12	0.17
	SO <sub>3</sub>	0.11	0.20	0.13
	LOI	-	-	-

accident prone spots will lead to timely

improvement and chances of occurrence of accidents can be reduced. It is aimed to evaluate the performance of calcined bauxite as a skid resistant material in comparison to basalt aggregate using various characterization tests and also check the economic viability of use of calcined bauxite as a paving material.

### III. RESEARCH METHODOLOGY

Research methodology involves study of physical, chemical and mechanical properties of material and analyzing material's performance on parameters of skid resistance.

Definitions:

**Basalt:** Basalt, a common volcanic rock formed from the rapid cooling of lava is used in construction industry as aggregate for concrete and as paving material for road surface. Its availability in India makes it the most preferred pavement material.

**Calcined Bauxite:** Bauxite, composed mainly of aluminum oxide and aluminum hydroxide mineral is the primary source of aluminum. Calcined bauxite is manufactured by controlled burning of bauxite excavated from the mines; bauxite is heated at an optimized temperature to bring about thermal decomposition, phase transition and removal of volatile fraction. For better understanding of effect of different minerals on skid resistance properties of calcined bauxite we have used three grades (Fig. 1) for initial tests to select the best grade to be tested for PSV test.

Characterization tests:

- Performing following laboratory tests on basalt and calcined bauxite,
  - X-ray fluorescence
  - Apparent Porosity
  - Los angles abrasion value
  - Polished stone value
- Comparing the performance of basalt and calcined bauxite on the basis of tests performed and by the results of physical, chemical and mineralogical property.
- Preparing the cost comparison for construction of new pavement with application of calcined bauxite.

### IV. OBSERVATIONS

The material's ability to provide resistance to polishing and retain its surface texture is indication of its skid resistance. Calcined bauxite is chosen because of its inherent property of hardness and friction resistance and endurance of frictional resistance over a period of time. Endurance is proved by PSV test result. Since it is a new material to be used in construction industry for pavement surfacing, to check the usability of calcined bauxite with respect to commonly used basalt stone following laboratory tests are performed. The results obtained by the tests are discussed in the following section.

X-ray fluorescence (XRF):

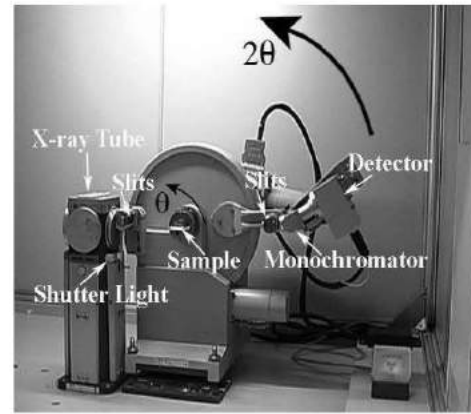


Fig 2: XRF Test apparatus

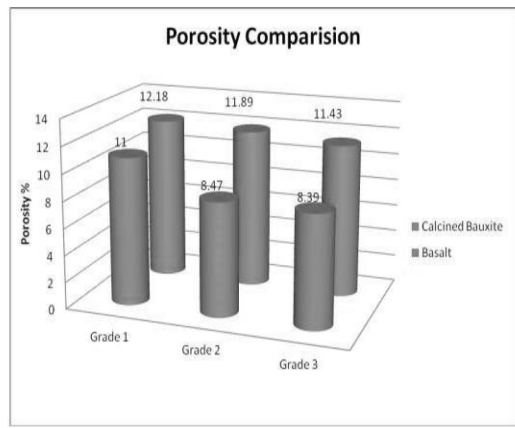
The X-ray diffraction pattern of a pure substance is like a fingerprint of the substance. Fig. 2 shows the XRF test apparatus, in this test the sample is bombarded with X-rays and the rays reflected from the sample are captured by a detector and sent to a computer software which analyses the diffraction of rays to identify each mineral and its percentage presence in the sample. This test gives very precise result as each mineral has a characteristic reflection pattern which is accurately identified by the software. This test is performed to determine chemical composition of basalt and bauxite. The result of XRF test is given in Table 1. Major constituent of basalt is Silica (SiO<sub>2</sub>) and it gains hardness from silica. Basalt also contains other minerals which do not add desirable properties of hardness and strength. Bauxite on the other hand has 80% concentration of alumina (Al<sub>2</sub>O<sub>3</sub>), alumina forms a mineral called corundum having hardness number 9 on moh's hardness scale. This high percentage of corundum in calcined bauxite is found to be the reason behind its hardness and abrasion resistance.

Table 1. Chemical composition

Chemical Components	Basalt	Calcined Bauxite
	%	%
SiO <sub>2</sub>	56.73	9.1
Al <sub>2</sub> O <sub>3</sub>	12.23	80.19
Fe <sub>2</sub> O <sub>3</sub>	10.26	5.36
TiO <sub>2</sub>	2.77	3.04
CaO	7.09	1.61
MgO	3.8	0.37
Na <sub>2</sub> O	1.62	0.01
K <sub>2</sub> O	0.45	0.17
SO <sub>3</sub>	0.06	0.13
LOI	4.94	0

Apparent Porosity: It is the ratio of the volume of open pore space in a specimen to the exterior volume. The result of apparent porosity of basalt and bauxite are shown in Fig.3 basalt is more porous than calcined bauxite it is more susceptible to moisture ingress and degradation due to freeze thaw action and chemical degradation as compared to calcined bauxite.

Figure 3: Porosity of Calcined Bauxite V/s Basalt



Comparison of Porosity and Iron content results:

The comparison is represented in Fig. 4 As iron content in the sample increases the porosity is decreasing, lower porosity will result in a homogeneous mass and stronger material which again favours calcined bauxite.

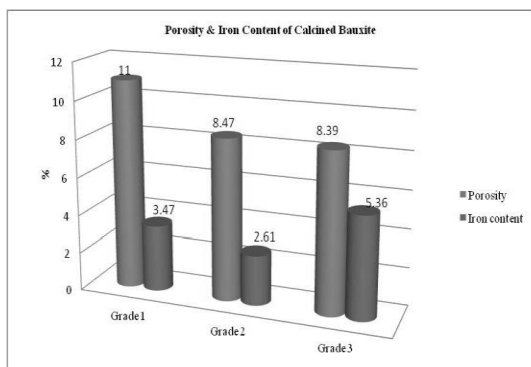


Figure 4: Relation of Iron Content with Porosity

Los angeles abrasion value or aggregate abrasion value (AAV): Los Angeles test is commonly used to evaluate the hardness of aggregates. The test has more acceptability because the resistance to abrasion and impact is determined simultaneously. Aggregate abrasion characteristics are important because the constituent aggregate in pavement must resist crushing, degradation and disintegration in order to produce a high quality pavement surface. AAV test was performed on three grades of calcined bauxite having different Iron content, The relation between Iron content and AAV is shown in Fig.5 It is observed that Grade 3 having highest iron content 5.36% is giving the lowest AAV thereby offering more resistance to abrasion as compared to other two grades.

Figure 5 : Relation of Iron Content with AAV

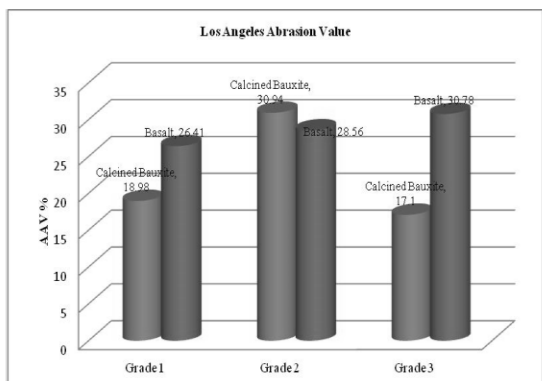


Figure 6 : Comparison of LA Abrasion Value

From Fig.6 it is observed that sample no. 3 of calcined bauxite is giving the lowest AAV (aggregate abrasion value) one can expect this sample to give the best result in PSV test. Accordingly sample no.3 is sent for PSV test as per BS 812.

Sr.	Characteristic parameters	Test method	Result	MORTH limits	Conformity
1	Polished stone value(PSV) of Calcined bauxite	BS 812 part114 – 1989	75	55	Yes

Table 2: PSV Test result

## V. COST-BENEFIT ANALYSIS

The process of applying calcined bauxite on pavement surface is same as that of stone aggregate paving. Hence cost of laying will be same for both, the major difference between the two materials is their cost. Depending on the location currently basalt aggregate costs Rs.7 to 10 per kg whereas calcined bauxite costs Rs.20-25 per kg. Therefore application of calcined bauxite on entire pavement surface will be an economical. However it can be considered for selective stretches of pavement where the chances of skidding are significantly high.

## VI. RESULTS

Sr	Test	Result		Remarks
		Basalt	Calcined bauxite	
1	Apparent porosity	11.43	8.39	Calcined bauxite is more homogenous
2	X ray fluorescence	Major constituent is silica	Major constituent is alumina	High alumina suggests presence of corundum which imparts hardness
3	Aggregate abrasion value (AAV)	30.78	17.1	Low AAV means high resistance to wear and tear
4	Polished stone value	55	75	High PSV means high skid resistance

## VII. CONCLUSION & SUGGESTIONS

The PSV of calcined bauxite is 75 which is very well above the minimum required value of 55 specified by MORTH and 65 for wet road condition as per TRL (Transport research lab). To prevent accidents associated to skidding, a material having higher skid resistance needs to be used. Newly laid basalt pavement surface satisfies the PSV parameters set by MORTH and BS but with prolonged use the PSV keeps decreasing and chances of accidents increases.

Table 3 shows calcined bauxite having better performance potential as pavement material. High PSV material such as calcined bauxite on pavement surface whose PSV value has reduced can help in improving the skid resistance.



Calcined bauxite is costly as compared to normal stone aggregate hence its application on entire road may be un-economical. To eliminate this disadvantage a layer of calcined bauxite can be applied on black spots which are identified by MORTH as places having highest frequency of road accidents. Application on specific black spots will save time and money as only one layer needs to be applied. Single layer treatment will be faster and the road can be open to traffic within few hours.

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# AN EXPERIMENTAL INVESTIGATION OF PHYSICAL AND MARSHAL PROPERTIES OF MODIFIED BITUMEN BINDER



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**Assistant Professor**

**Abstract**—Disposal of waste materials including waste plastic bags has become a serious problem and waste plastics are burnt for apparent disposal which cause environmental pollution. Utilization of waste plastic bags in bituminous mixes has proved that these enhance the properties of mix in addition to solving disposal problems. Plastic waste which is cleaned is cut into a size such that it passes through 2-3mm sieve using shredding machine. The aggregate mix is heated and the plastic is effectively coated over the aggregate. This plastic waste coated aggregate is mixed with hot bitumen and the resulted mix is used for road construction. The use of the innovative technology will not only strengthen the road construction but also increase the road life as well as will help to improve the environment. Plastic roads would be a boon for India's hot and extremely humid climate, where temperatures frequently cross 50°C and torrential rains create havoc, leaving most of the roads with big potholes. In this research work a thorough study has been done on the methodology of using plastic waste in bituminous mixes and the various tests performed on aggregates and bitumen are presented.

## I. INTRODUCTION

Huge quantity of waste plastic are produced every year. Whereas the amount of waste is being recycled is not enough to solve the problem. Disposal of waste materials including waste plastic bags is a serious problem in developing countries, Improper dumping of these non degradable plastic bags causes clogging of drains, reduced soil fertility and create aesthetic problem etc. The aim of this study is to evaluate the performance of waste polymer, LDPE and PET obtained from waste plastic carry bag, and waste tyre rubber to modified bitumen and compared their properties with those of bitumen modified by EVA. Waste utilization is an attractive alternative that not only reduces the cost of bitumen modification but also solve the problem of waste disposal to certain extent. Some of the studies done this field during last decade are summarized here.

India has a road network of over 4,689,842 kilometers in 2013, the second largest road network in the world. It has primarily flexible pavement design which constitutes more than 98% of the total road network. India being a very vast country has widely varying climates, terrains, construction materials and mixed traffic conditions both in terms of loads and volumes. Increased traffic

factors such as heavier loads, higher traffic volume and higher tyre pressure demand higher performance pavements. So to minimize the damage of pavement surface and increase durability of flexible pavement processes and additives that are currently used in bitumen modifications such as styrene butadiene styrene (SBS), styrene-butadiene rubber (SBR), ethylene vinyl acetate (EVA) and crumb rubber modifier (CRM)..

## II. LITERATURE SURVEY

M.Murphy<sup>[1]</sup> and co based on their experimental studies on bitumen modified with recycled polymers reported that, some of the waste polymers showed potential for enhancing the properties of bitumen. Esmail Ahmadinia<sup>[2]</sup> and co concluded that with increase in polyethylene tetra phthalate (PET) content into the mixture, the Marshall Stability first started to increase significantly, but then decrease after 6%. However, the Marshall Flow started with an initial decrease, which was followed by an increase with the introduction of more PET into the mixture. A.I.AL-Hadi<sup>[3]</sup> and cobased on study on the utilization of LDPE in Stone Mastic Asphalt mixtures conclude that Penetration at 25°C will generally decrease as LDPE content increases, which indicates an improved shear resistance in medium to high temperatures. <sup>[4]</sup>The Indian Roads Congress Specifications Special Publication: 53 (2002) indicate that the time period of next renewal may be extended by 50% in case of surfacing with modified bitumen as compared to unmodified bitumen. Science-Tech Entrepreneur (2008) proposed that the durability of the roads laid with shredded plastic waste is much more compared with those which asphalted with the ordinary mix. While a normal highway road lasts 4 to 5 years it is claimed in this paper that plastic-bitumen roads can last up to 10 years. According to this paper rain water will not seep through because of the plastic in the tar. So, this technology will result in lesser road repairs. Verma (2008) studied that plastic increases the melting point of the bitumen and makes the road flexible during winters resulting in its long life. According to author while a normal "highway quality" road lasts four to five years, plastic-bitumen roads can last up to 10 years and it would be a boon for India's hot and extremely humid climate, where temperatures frequently cross 50°C and torrential rains create havoc, leaving most of the roads with big potholes. Sangita et al. <sup>[5]</sup> (2011) suggested a novel approach to improve road quality by utilizing plastic waste in road construction. According to them India spends Rs 35,000 crores a

year on road construction and repairs, including Rs 100,000 crore a year just on maintenance and roads by bitumen modification lasts 2-3 times longer, which will save us Rs 33,000 crore a year in repairs, plus reduced vehicle wear and tear ..

### III. EXPERIMENTAL INVESTIGATION

#### A. Materials

Materials used in this study include 60/70 grade bitumen, aggregates and plastic waste (LDPE).

#### B. Methodology

Methodology can be divided into Four Parts:

Process 1: Plastics waste (bags, cups) made out of PE (poly ethylene), PP (poly propylene) and PS (poly styrene) cut into a size between 2.36mm and 4.75mm using shredding machine.

Process 2(a): The aggregate mix is heated to 170°C and transferred to mixing chamber.

Process 2(b): Similarly the bitumen is to be heated up to a maximum of 160°C to have good binding and to prevent weak bonding (Monitoring the temperature is very important).

Process 3: At the mixing chamber, the shredded plastics waste is to be added. It get coated uniformly over the aggregate within 30 to 60 seconds, giving an oily look.

Process 4: The plastic waste coated aggregate is mixed with hot bitumen and the resulted mix is used for road construction.

The road laying temperature is between 110°C to 120°C, the roller used is 8-ton capacity.

### IV RESULTS AND DISCUSSION

The standard 60/70 grade bitumen was taken and tested for penetration value, in order to confirm the grade of the bitumen. The waste LDPE was collected, washed with water and dried in sunlight for an hour. The dried waste was shredded into small pieces.

A known amount of bitumen was heated to around 160°-170°C, the known amount of shredded waste were added and stirred continuously leading to the formation of a homogenous mixture. It is then cooled in atmosphere air for some time while continuously stirring. Different samples were prepared by mixing different quantity of waste plastic and bitumen on weight basis.

The samples prepared were tested for their hardness, softening point, ductility and specific gravity in order to optimize the product. This bitumen is then used in marshal stability method of testing.

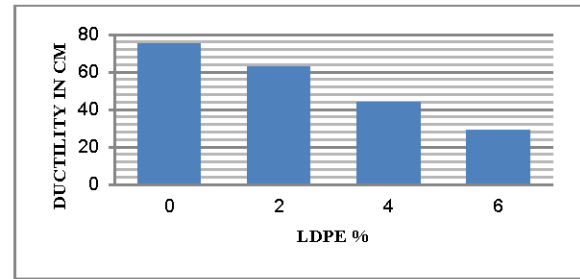


Fig: 2 Effects of weight percent of ldpe on ductility of 60/70 bitumen

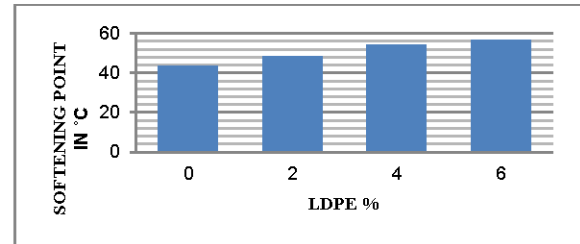


Fig: 3 Effects of weight percent of ldpe on softening point of 60/70 bitumen

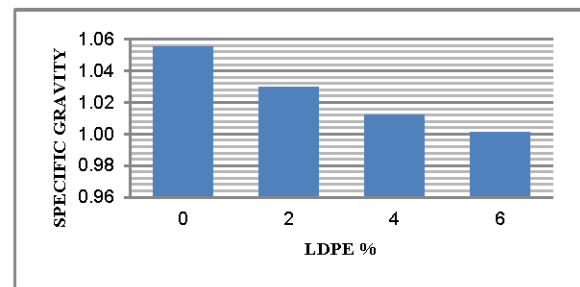


Fig: 4 Effect of % weight of ldpe on specific gravity 60/70 bitumen

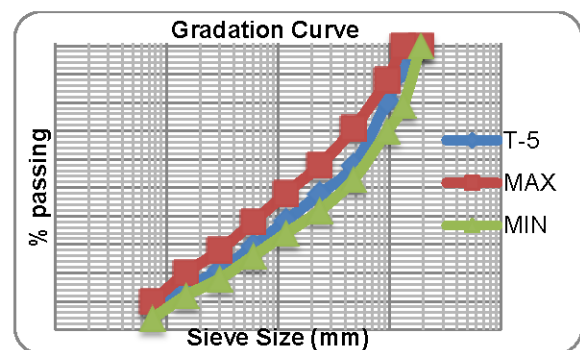


Fig: 5 Gradation curve

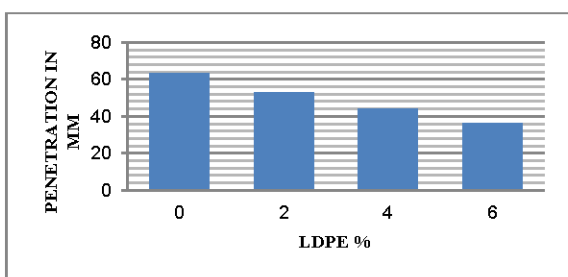


Fig: 1 Effect of weight percent of ldpe on penetration on 60/70 bitumen

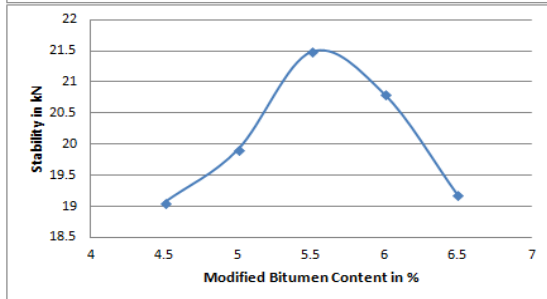
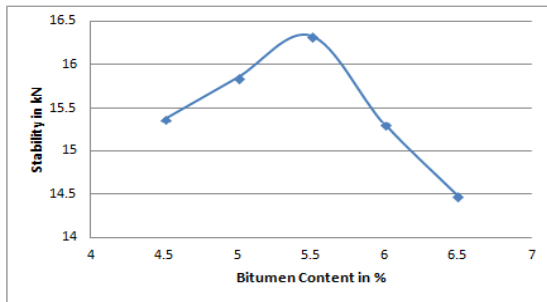


Fig: 5 Bitumen and Modified bitumen content v/s stability

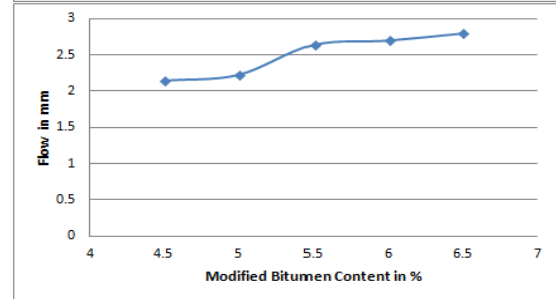
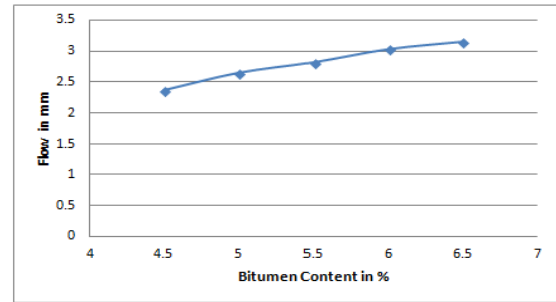


Fig: 7 Bitumen and Modified bitumen content v/s flow

## VI. CONCLUSION

Waste LDPE is utilized for the generation of rubber treated bitumen. This improves the property of bitumen, as well as it is savvy. From the analysis of the results, the following conclusions are drawn.

- 1) With the inclusion of waste LDPE into the virgin the penetration and ductility consistently decrease whereas softening point consistently increase.
- 2) Optimum bitumen content using 4% LDPE is 5.4%
- 3) The bituminous material should have minimum ductility of 25cm hence it is better to use 4 percent LDPE
- 4) Waste LDPE usage helps the enhancing the property of bitumen. And also helps to reduce cost of construction.
- 5) With usage of LDPE helps to prevent environmental pollution
- 6) Mixing of plastic may be carried out locally using local plastic waste and as per local climatic conditions in different proportions. This reduces the transportation charges.

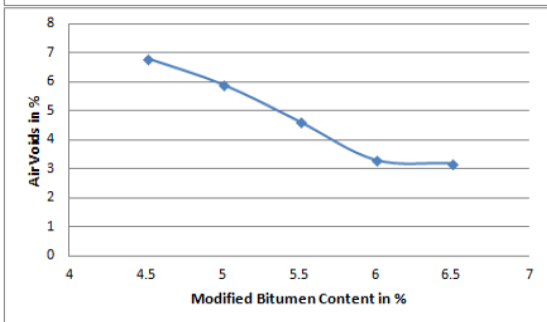
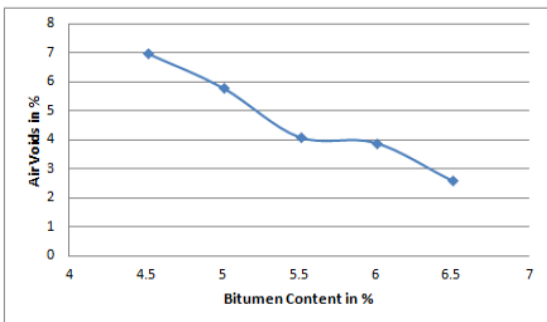


Fig: 5 Bitumen and Modified bitumen content v/s air voids

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# Impact study of Indore BRTs corridor on Mixed Vehicle Traffic along old AB Road



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**Assistant Professor**

**Abstract**—This paper illustrates the analysis conducted on traffic data collected along the Indore BRT mixed vehicle lane. The BRT system in Indore was implemented with full technical specifications and details in May, 2013. The main objective of the project study was to investigate the impact of BRT corridor implementation on mixed vehicle lane. As the BRT corridor was constructed on existing busy route of the city which connects various business and educational hubs and serves the maximum traffic of Indore city. For evaluation various traffic surveys were conducted along the BRT corridor parameters which includes traffic flow, queue length and spot speed study. The study reveals that after the implementation of BRT the carriage way width for MV lane is reduced which impacts directly the traffic flow, queue length and speeds as the free maneuver was affected due to limited carriage way.

**Keywords:** BRT corridor, BRT lane, MV lane, Traffic Flow, Passenger Flow

## II. THE PROBLEM

The Indore BRT system is of about 11.4 km length and includes 21 bus stations. There are two right of way on which the BRTS is running. A central section from Navlakha to LIG Square has a width of 31.5 m whereas on both the sides the total width of the road is 63 m. All the stops are centrally placed having a median aligned BRT lane except one stop at the Palasia Square which is a curb sided station. For 200 m of the length the divided BRT lane is absent around this stop. The dedicated BRT lane is absent. 7 of the stops are located on the narrower lane and 13 stops

are located on broader road. 7 stops are in the mid-section and all the remaining stops are close to major road intersections. The BRT system in Indore was implemented with full technical specifications and details. However, the main drawback of the system was that it was created on an already existing road and the execution work had many difficulties. This included difficulties in traffic management, acquisition of land and other difficulties in other sundry items. The BRT was implemented in May 2013. The traffic woes of mixed lanes on both sides of BRT have increased manifold though a two lane road is provided on both the sides in the narrow portion of BRT. The main reason for the higher traffic flow in the mixed lane is rampant personal motorization in the city of Indore, the road on which the BRTS is built has poor network of adjoining parallel roads and the road is having dense commercial/official land use and is crossing the main arteries that connect the city of Indore to different surrounding places. According to Ministry of Transport and Highways (2012) Indore has 560 vehicles registered per 1000 population which is second highest after the city of Coimbatore with 577 vehicles/1000 persons the highest in India. The share of two wheeler traffic is varying from about 54 to 67 percent and the share of passenger car traffic is varying from 22 to 33 percent along the corridor and the hike in vehicular share is during peak hour is about 40 to 60 percent. This indicates the high traffic intensity on road. Hence the traffic density on this road is quite high during peak hours. Owing to the poor traffic conditions in the Mixed Vehicle (MV) traffic lane, a Public Interest Litigation (PIL) was filed in the Indore Bench of the Hon. High Court of M.P. The PIL was about to scrap the BRT and running the buses in the mixed lane.

## III. THE OBJECTIVES OF STUDY

The objective of the study was to investigate the impact of BRT corridor on mixed vehicle lane as its constructed on existing busy route. In response to public interest litigation (PIL) filed at Indore Bench of the Honorable High Court of the State of Madhya Pradesh. The investigation parameters were traffic flow, queue length and spot speed studies.

#### IV. PROPOSED METHODOLOGY AND DATA COLLECTION

In all kinds of traffic studies, the planning of a sequence of study is quite important aspect. A general traffic engineering problem includes data collection, analysis and interpretation and discussion. Based on the stated objectives the methodology has been proposed and accordingly data was collected. Table 1 presents a classification of different data collected.

**Table 1 Different Data Collected/Surveyed**

Type of Data	Along BRT corridor in MV lane
Traffic Volume @ Midblock	For MV Lane
Spot Speed study	For MV Lane
Queue Length	For MV Lane

Exhaustive analysis carried out under the normal BRT operations on the study corridor.

The traffic volume count survey was conducted at four mid-block sections in MV lane for a period of 6-hours along the corridor. The collected traffic volume data (15-minute interval) was also analyzed hourly and timed peak hour flows presented in the form of both vehicles/hr and PCU /hr. The data collected and analysed. Summary of classified traffic volume at mid- block section is given in table

#### V.RESULTS AND DISCUSSIONS

This research is conducted to know the impact of BRTs corridor as discussed in the previous sections. The key findings of the work are related to effect on MV lane traffic in terms of flow, spot speed and queue length.

1. The mixed vehicle lane have bottleneck from Navlakkha square to LIG square which reduces the number of lanes
2. The traffic flow between the bottleneck section is quite high and more than the capacities of mid-block sections
3. Because of bottleneck the spot speed gets reduced due to restricted maneuver.
4. The queue lengths on the all signals are high along the BRT lane approaches as compare to other approaches because of less number of traffic lanes.

#### VI. CONCLUSIONS

1. The study reveals because of implementation of BRTs the performance of MV lane is affected.
2. The traffic flow along the MV lane in each direction of travel in almost all the mid-block sections reach to its full capacity in the 60 m right of way. In the MV Lane in each direction of travel in almost all the mid -block sections suffer heavy congestion in peak hours in 31.6 m right of way. The study at AiCTSL Office section is indicating that the MV lanes reach its capacity but at CHL Apollo Hospital section the flow is much more than its capacity therefore the congestion to the traffic flow generally occurs in the bottleneck part scenario. At the same time the BRT lane is utilized to a very small fraction of its capacity.
3. The spot speed study also confirms that speed is quite low in the 31.6 m right of the way section as compare to 60m right of way.
4. The queue lengths were high just because of low saturation flow and more normal flow along the corridor approaches..

# NETWORK PLANNING FOR UPGRADATION OF RURAL ROAD



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**Abstract**—The primary objective of the present study is discussing various methods for the deciding the priority of upgradation of rural road namely- (1) utility value (2) network performance index. The next step of the present thesis is to have economic analysis. In this cost analysis, the study suggest the different coats of materials required for the present state of road condition according to the pavement condition index of the road which is decided on the basis of visual observation, riding comfort and driving speed, for the upgradation and maintenance of road surface. Index Terms: Accessibility; Network Performance Index; Utility Value; Priority

## II. METHODOLOGY

Prioritization of rural road for the upgradation is a critical issue. Existing surface of the rural road is not in workable condition in rainy seasons due to un-surfaced path and because of this time required for the reaching to the destination is more. As the upgradation of the road is done and they are connected to the education, market centre, services the poverty levels come down.

## III. PREPARATION OF MASTER PLAN

### A. District Rural Roads Plan (DRRP)

The District Rural Roads Plan is a compendium of the existing and proposed road network system in the District which clearly identifies the proposed roads for connecting the yet Unconnected Habitations to already connected Habitations/ All-weather roads, in an economic and efficient way. The District Rural Roads Plan is prepared at two levels – the Block and the District.

#### Step-I: Preparation of Database

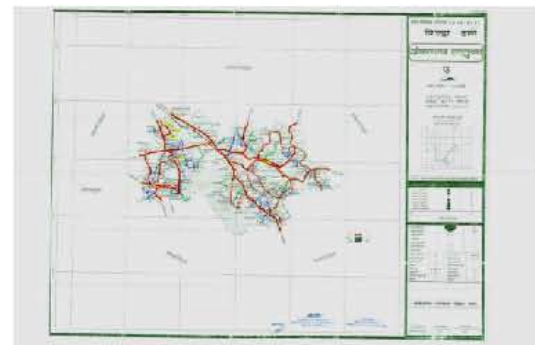
The data related to the habitation, rural road inventory, primary and secondary road data of 13 taluka of Thane District is collected from the P.W.D, Thane. It has been happen that data available through the sources was not accurate or up-to-date. Therefore, these data have been physically verified through field visit.

#### Step-II: Map Preparation

After the database has been prepared from secondary sources and verified through exhaustive field surveys, the task of Map preparation was initiated which is first prepared at the block level and then at District level. After preparing the map we decide the link route, through route and major route link and colouring them with different colours so that they are easy to understand.



**Figure1** Map showing all blocks with major roads of Thane district.



**Figure 2** Map of Ambernath

### B. PREPARATION OF CORE NETWORK

#### Core Network 01:-

The first stage for the preparation of Comprehensive Upgradation Cum Consolidation Priority List (CUCPL) is core network 01. In core network it gives the information about the road number i.e. T.R., L.R., M.R.L., and length of road, starting point and the ending point of road, road no as per 2011, existing surface of the road means the different layers with their thickness, the habitation benefited by the road with their population. This information helps to prepare Comprehensive Upgradation Cum Consolidation Priority List (CUCPL).

#### Core network 02:-

Core Network -2 is similar to Core Network – 1 but it gives some additional information like Net length of road in Km, Average Daily traffic and Pavement condition index of the road considered in core network -1.

#### Core Network 03 (A):-

After tabulation of data in two networks the third network is prepared which contains the name of road, length of the road and Network Performance Index (NPI)

### Network Performance Index (NPI)

The presented model for calculation of NPI is based on the accessibility Index of all the village present in analysis area. The main variables of proposed model are population of origin and distance between the origin node and service center (Eq:3). With the general uses of this model, less populated areas can be neglected and the areas which are very near from the service center will be overvalued.

### Accessibility Index of an Area

The accessibility index gives a model for the accessibility index of an area with respect to the service center. And to evaluate the road network links.

$$A_i = \sum_{j=1}^n (P_j / L_{ij})$$

Where,

$A_i$  = Accessibility index of an origin node

$P_j$  = attraction of the service center, used as population

$L_{ij}$  = shortest path between origin node I to service center j.

### Accessibility Index of an Area with Population

$$A_i = P_i * \sum_{j=1}^n P_j / L_{ij}$$

Normalized model of accessibility index of the population:

$$A_i = (P_i * \sum_{j=1}^n P_j / L_{ij}) / P$$

Where, P is the total population in the analysis area.

$$P = \sum P_i + \sum P_j$$

### Evaluation of Redundancy

A recently published manual of Ministry of Land, Infrastructure, Transport and Tourism Japan (MLIT2011) a gives a simple and practical measure for the evaluation of redundancy as a detour ratio. Detour ratio calculates the lengthiness of the alternative shortest path when one or more links closed in a regular shortest path.

$$DR_{ij} = L_{ija} / L_{ij}$$

Where,

### UPGRADATION WORKS

Upgradation works will be proposed in a district only if no new connectivity remains to be taken up. If there is a new connectivity in District then first new connectivity is done and then upgradation of existing road surface is done.

### Preparation of CUCPL

The work of preparing the CUCPL will be taken up only in those districts which are likely to complete new connectivity. The list will be prepared District-wise for each Priority class on the following proforma

### Core Network 04(A):-

The core network 04 is the most important network. It gives the upgradation list for the each block. For the upgradation of road in Thane District Network Performance Index (NPI) is used. **Core Network 4(B):-**

$L_{ij}$  = shortest path between I and j

$L_{ija}$  = alternative shortest path when one or more links fail in the shortest path

The acceptable limit of a detour ratio for the rural areas of Thane District is assumed as 2, i.e. people will use the alternative path 2 times longer than dry weathered shortest path in rainy season.

### Network Performance Index (NPI)

With the application of redundancy evaluation and sensitivity analysis the final model for the calculation of accessibility index of a village (origin node) will be:  $A_i = [P_i * \sum_{j=1}^n (P_j / (L_{ij} * \delta_{ij}))] / P$

Where,  $i, j = 1, 2$

$= \infty$ , if  $DR_{ij} > 2$   $L_{ij} = CRD$ , if  $L_{ija} \leq CRD$

$= L_{ija}$ , if  $L_{ija} > CRD$

$P_i = CPR$ , if  $P_i \leq CRP$

$= P_i$ , if  $P_i > CRP$

Where,

$P_i$  = population of origin node

$P_j$  = population of final node

$L_{ij}$  = distance between the node

P = total population at that node

CPR = maximum population on that road

A network performance Index (NPI) is calculated based on accessibility index of all village presents in an analysis area. In our definition, a total accessibility index of all villages (origin node) is termed as a network performance index of that network.

$$NPI = \sum A_i$$

In present NPI model is used for deciding the Priority of upgradation of rural road in blocks of Thane District. Table 05 shows the NPI of sample Core Network selected in CN-2. Similar exercise is carried out for entire Ambemath block.

### Core Network 03(B):-

Core Network 3 (b) is similar to Core Network 3 (A) but it gives the utility value of each candidate road along with the weightage of habitation on candidate road. Table no. 06 shows the utility value of sample core network selected in CN -I and CN-2

Core Network -4(B) is similar to Core Network 4(A) but it gives the upgradation list for candidate road based on the utility value of road. The roads are arranged according to descending order of utility value of road.

### CONCLUSION

In the world, 1.1 billion extremely poor people live in rural areas. In India alone, more than 80% of rural road network sections are yet not be connected by All-weathered roads (MORD 2007). To upgrade those road network from "dry weathered" to "all weathered" practitioners needs a priority list of the dry weathered links. Existing prioritization processes are mostly based on the population and social economic characteristics, but this method is not feasible.

In this thesis, utility value and Network Performance Index, this network evaluation methodology was employed to prioritize "dry weathered road" network



links for the selection of upgrading project. A Network Performance Index (NPI) was derived in order to quantify the impact of upgrading of particular link in a network considering accessibility of a village. Index was obtained after assumption of improving the dry

weathered links based on accessibility and network closure vulnerability approach. And the Utility value of the road is based prepared District rural road plan at block level as well as District level. Second stage we prioritized the rural road based on the utility value of the road and network performance index. After getting the priority list by using these two methods, we are in position to identify that the priority for the upgradation of road by using network performance index and the utility value of the road. Finally priority list of all 13 blocks is prepared for the selection of upgradation of rural roads.

utility value 46.85 therefore is consider for first priority.

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on the weightage of the road and the length of the road. The weightage of road is calculated by considering the facilities under the road. In the same way, network performance Index (NPI), gives the priority list, examples are follows, Proposed methodology prioritized the dry weathered road network links in two stages. First stage

*STUDENTS PAPERS*

# A Survey on Cost Comparison of Sustainable Plastic Road with Regular Bitumen Road

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**ABSTRACT:** The population growth, industrialization, consumerism and scientific development have led to the uncontrollable accumulation of waste. Proper waste disposal is of great importance in both pastoral and metropolitan areas. This study discussed the suitability of plastic waste materials for pavement construction. The waste is mixed in different proportions to the soil sample and their influences on geotechnical properties were studied. The results of the tests indicated that plastic alone is not suitable for pavement subgrade. When quarry dust was added along with soil plastic mix, it maintains the CBR value within the required range.

## I. INTRODUCTION

The rate of production of waste has increased tremendously in almost all parts of the world in the past few decades. The quantities of these waste that are accumulating, are causing serious disposal problems. The conservative methods of disposal are found to be inadequate. Due to population growth, industrialization, consumerism and technological development there has been a tremendous increase in the rate of production of waste. Every year, 7.2 million tons of hazardous waste is produced and its disposal is becoming a major issue and about one km<sup>2</sup> of additional landfill area is needed every year. Indian government spends about Rs 1600 crore for treatment & disposal of these wastes. In addition to this, industries release about 150 million tons of high volume low hazard waste every year, which is mostly dumped on open low lying land areas. In this situation, the conventional waste disposal methods are found to be derisory. Through this project, a small attempt has been made at deducing a new technique of waste disposal. This paper aims at proposing a new method of disposal of plastic, quarry dust, and tyre waste by using them in the sub-grade soil of pavement. The Main objective of this study are safe and prolific

disposal of wastes - plastic, quarry dust, and tyre, the study of index properties and CBR values of variable mixes of soil and waste and suitability of soil-waste mix in sub grade.

## II. RELATED WORK

Growth and Quality of infrastructure is one of the most important developing indication of any nation. Infrastructure includes various sectors i.e Roads, Bridges, Dams, Tunnels, etc, Among all these different sectors, construction of roads takes up the major part of all the infrastructure work in any nation, being it the most basic yet the most useful mode of transport among all the others.

As the construction of roads plays such an important role in the development of any nation it is equally important to assure that it doesn't affect any other developing aspect of it.

The second most important point of concern after infrastructure for any country has to be its environment viz. to make it a better place to live in for any living habitat.

We this research work we are trying to find a balance between these two factors which governs the progress of the nation or any place and also reducing the overall cost of any road project. In the direction of finding this balance we've tried to alter some of the materials and their quantities which are being used in the construction of regular roads. We've tried to replace some amount of bitumen with the processed waste plastic and waste rubber tyres and have carried out complete cost analysis of the same

## III. DEFINITION

A substance that contains one or more organic polymers of large molecular weight, solid in its finished state and at some state while manufacturing or processing into finished articles, can be shaped by its flow.

#### IV. TYPES OF PLASTICS

1. Thermosets
2. Elastomers.
3. Thermoplastics.

#### V. WHY USE OF PLASTIC?

Polymers have a number of essential properties, which exploited alone or together make a significant and expanding contribution to construction needs.

1. Durable & corrosion resistant.
2. Good insulation for cold, heat & sound saving energy and dipping noise pollution.
3. It is economical and has a longer life.
4. Maintenance free.
5. Hygienic.
6. Ease of processing/ installation.
7. Lightweight.

#### VI. BASIC PROCESS

1. Segregation
2. Cleaning process
3. Shredding process
4. Collection process

#### VII. CO-PROCESSING OF PLASTIC WASTE MANAGEMENT

##### A. PLASTIC WASTE MANAGEMENT

- 1) Conventional Technology
  - Recycling
  - Incineration
  - Land-filling
- 2) New Technology
  - Plasma Pyrolysis Technology
  - Liquid Fuel
  - Polymer Blended Bitumen Roads
  - Co-processing in Cement Kiln

##### B. PROCESS

1. Wet
2. Dry

##### i. Wet Process

1. Waste plastics by direct mixing with hot bitumen at 160°C.

2. The Mechanical agitator is needed.
3. The Addition of stabilizers and proper cooling.
4. Since the wet process requires a lot of investment and bigger plants.
5. Not commonly used.

##### ii. Dry Process

Mixing the appropriate quantity of dry shredded waste plastic with hot aggregate prior to production of bituminous mixes at hot mix plant by varying percentage of plastic by weight of the mix.

- (i) Various types of waste plastic are collected, analyzed as per their type and sent for storage.
- (ii) These segregated wastes are then cleaned and dried to remove impurities from them. Then cut into a size of 1.18-4.36 mm using shredding machine, (PVC waste should be eliminated)
- (iii) The aggregate mix is heated to 165°C (as per the HRS specification) and transferred to mixing chamber. Similarly, the bitumen is to be heated up to a maximum of 160°C (HRS Specification) to have good binding and to prevent weak bonding. (Monitoring the temperature is very important).
- (iv) At the mixing chamber, the shredded plastics waste is to be added to the hot aggregate. It gets coated homogeneously over the aggregate within 30 to 45 seconds, giving a look of oily coated aggregate.
- (v) The plastics waste coated aggregate is mixed with hot bitumen at the temperature range between 150°C-165°C. The resulted mix of temperature range 130°C-140°C is used for road construction. The road laying temperature is between 110°C-120°C. Using the roller of 8 ton (min.) capacity.

#### VIII. COST ESTIMATION

The Cost of Waste Plastics: **Rs.7 / Kg.**

The Cost of Processing: **Rs.5 / Kg.**

The Total cost of Waste Plastics: **Rs.12 / Kg.**<sup>[5]</sup>

- Optimum percentage of plastic in the blend as per the test results is around **8%** (% Wt. of bitumen)
- Generally roads in India are constructed in basic width of **3.0 m, 3.75 m. and 4.0 m.**
- Consider 1 Km length road of width 3.75 m. it uses bitumen approx. 21300 Kg. **For new work** and 11925

## For Up-gradation

The Cost of Bitumen: **Rs.8400 / Drum (200 Kg.)**<sup>[6]</sup>

The Cost of Bitumen: **Rs.42 / Kg.**

**1. Cost of New Road / Km** including BBM, Carpet, and Seal Coat: Rs. 18,95,000/-10

→ Bitumen required for work (approx.): **21,300 Kg. / Km**

→ Cost of bitumen in new work: **Rs.8,95,000 / Km.**

→ Waste plastic, co-processed with bitumen for PMB (8% by Wt.): **Rs.1,704 / Kg.**

→ Cost of waste plastic used: **Rs.20,450 / Kg.**

→ Cost of Bitumen saved (1704Kg. equivalent to plastic used): **Rs.71550**

→ Total savings per Km.: **Rs. 51,100**

→ Cost of Road (Up gradation)/km including Carpet and Seal Coat: **Rs. 10, 80,000**<sup>[7]</sup>

→ Bitumen Required for work (approx.): **11925 Kg. / KM.**

→ Cost of bitumen in repairs (Up gradation) per Km.: **Rs. 5,01,000/-**

→ Waste plastic, co processed with bitumen for PMB (8% by Wt.): **954 Kg.**

→ Cost of waste plastic used: **Rs. 11450**

→ Cost of Bitumen saved (954Kg. equivalent to plastic used): **Rs.40,050**

→ Total savings per Km.: **Rs.28,600**

→ Optimum amount of waste plastic used in dry process: **10%** (by Wt. of aggregates)

→ Amount of waste plastic used in the road (10% by Wt.): **4687.5 Kg.**

**2. Total Amount of waste plastic** used in road construction using both the processes together (i.e. Combination of wet process & dry process): 1704 + 4687.5 = **6391.5 Kg**

**3. Total Cost of waste plastic** used in road using mix process: **Rs.76,700**

**4. Extra cost** for construction of road (Cost of waste plastic used in road construction – Total savings using modified bitumen): 76,700 – 51,100 = **Rs.25,600 / Km**

**Table 1: Showing compressive & Bending strength**

% of plastic coating over aggregates	Compressive Strength (Mpa)	Bending strength (Mpa)
10	250	325
20	270	335
30	290	350
40	320	390

According to the findings as the percentage of Plastic Coating over Aggregate increases the corresponding Compressive and Bending Strength increases.

## IX. ADVANTAGES

1. The Strength of the road increased.
2. Better resistance to water & water stagnation.
3. No stripping & have no potholes.
4. Increased binding & better bonding of the mix.
5. Better reliability property.
6. Maintenance cost of the road is almost zero.
7. No effect of radiation like UV rays.

## X. DISADVANTAGES

- 1) Cleaning process -Toxic present in the co-mingled plastic waste start leaching.
- 2) During the road laying process- the presence of chlorine will definitely release lethal gas.

## **XI. COMPARISON**

- 1) The durability of the roads laid out with shredded plastic waste is much more compared with roads with asphalt with the ordinary mix.
- 2) While a normal 'highway quality' road lasts four to five years it is claimed that plastic-bitumen roads can last up to 10 years.
- 3) Rainwater will not leach through because of the plastic in the tar.
- 4) The cost of plastic road construction may be slightly higher compared to the conventional method.
- 5) The maintenance cost is low as compared to conventional method.
- 6) Its initial cost is slightly more as compared to conventional method.

# Engineering Economics and Life Cycle Cost Analysis of Green Building

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**Abstract:** *Green Building promotes the efficiency of buildings with regards to the use of water, renewable energy and materials while reducing the structure's impact on individual's health and the environment through its better design, construction, operation, maintenance system. Hence Green Building is all about the complete building life cycle Life-cycle cost analysis (LCCA) is an evaluating mechanism to evaluate the total financial/resource requirements for total ownership of a building for a pre-determined service period of the building. LCCA is highly helpful for project options that accomplishes the same task demands, having different initial/ construction costs and operational costs, needs to be examined in order to execute the option that optimizes financial requirements. Green building related expenses can be classified as 1) Non-Recurring Cost: Initial Costs, Residual Values, Finance Charges and 2) Recurring cost: Operation, Maintenance, and Repair Costs, Replacement Costs, Non-Monetary Costs. This article mainly emphasizes on the Maintenance and Repair cost analysis of green building materials; giving plausible trends for next 25 years for various essentials using DISTRICT SCHEDULE RATE (DSR), WHOLESALERE PRICE INDEX (WPI) and CONSUMER PRICE INDEX (CPI). These trends are only applicable for the whole of Mumbai city and suburban district.*

## 1. Green Building

A building which can function using an optimum amount of energy, consume less water, conserve natural resources, generate less waste and create spaces for healthy and comfortable living, as compared to conventional buildings, is a green building.

Green building design is a sensible and climate compliant approach to building design. Different factors, like geographical location, existing climatic conditions, use of locally available and low embodied energy materials and design consideration significant to the type of usage of the building are normally taken into consideration. Such an approach ensures minimum damage to the environment, while constructing and using the building.

### 1.1 Advantages of Green Building over Conventional Building

Reduced operating costs by increasing productivity and using less energy and water, Improved public and occupant health due to improved indoor air quality, Reduced environmental impacts by, for example, reducing storm water runoff and the heating effect.

Conventional methods of building use tremendous quantities of material, many of them non-renewable and toxic, and pay little attention to the impact the building has on the environment. Green buildings not only reduce these impacts but are also healthier and consume less energy saving money in the long run.

Using green building materials and products promotes conservation of dwindling nonrenewable resources internationally. In addition, integrating green building materials into building projects can help reduce the environmental impacts associated with the extraction, transport, processing, fabrication, installation, reuse, recycling, and disposal of these building industry source materials.

## 2. Life Cycle Cost Analysis (LCCA)

LCCA is "an economic estimation considering all agreed projected significant and relevant cost flows over a period of analysis expressed in financial value. The projected costs are those needed to achieve defined levels of performance, including reliability, safety and availability".

Broadly, life cycle costs are those associated directly with constructing and functioning of the building; while whole life costs include other costs such as land, income from the building and support costs related with the activity within the building.

### 2.1 Importance of LCCA

LCCA brings all costs of each substitute to a common point in time to attain a fair judgment. LCCA can readily make out the option with the lowest total cost based on present value of all preliminary and future costs. The most reasonable option in the long term is not always the option with the lowest capital or initial costs. When whole-life cost of an asset or alternative must be considered, an LCCA should be performed to determine the most cost-effective route.

## 3. Maintenance and Repair

Building revamp and maintenance mainly consists of conserving proper state of a building, its functions and utilities in routine use the types of building maintenance are:

- Day to day repairs service facilities
- Annual repairs
- Unpredictable repairs
- Additions and alterations
- Preventive maintenance

## 4. Research Methodology

The maintenance and repair costs are found for various elements that are subjected to maintenance and repairs. The costs of these elements are gathered from the DISTRICT

SCHEDULE OF RATES OF MUMBAI AND SUBURBAN AREA over the last 15 years i.e. from year 2001. Since DISTRICT SCHEDULE OF RATES OF MUMBAI AND SUBURBAN AREA is used, these trends are only applicable to Mumbai district. These rates are considered as the basis for the projected cost over the next 25 years i.e. till year 2040. Basic rates for cistern fittings and labor wages have been collected from the WHOLESALE PRICE INDEX and CONSUMER PRICE INDEX respectively corresponding forecast is developed. Forecasts are developed with the help of trend lines characterized by specific curve equations thereby giving projected rates.

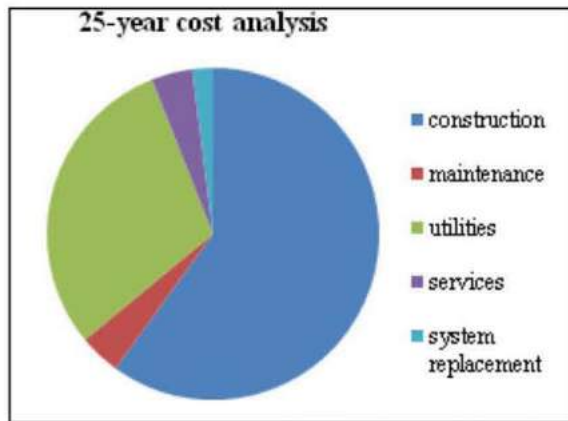


Chart 1: 30-Year Analysis

Since the maintenance and repair cost is 3rd highest for a super structure thus this article mainly emphasizes on it.

## 5. Elements Considered for Maintenance

Next 25 years of cost projections for following maintenance elements have been determined:

- 1) Internal Plastering
- 2) External Plastering
- 3) Zero Voc Internal Painting
- 4) Cistern Fittings
- 5) Dado Tiling
- 6) Flooring
- 7) Water Proofing
- 8) Green Glass
- 9) AAC Blockwork

The main reason behind selecting these elements lies in the fact that these maintenance and repair parameters are the most common and most widely subjected in reference to maintenance and repair works.

### 5.1 Internal Plastering

DESCRIPTION: The analysis considers internal plastering being undertaken in single coat, having 12 mm thickness. The plaster is prepared in fly ash cement to water ratio 1:5. Cost of neeru finish has been neglected in this analysis. The cost of scaffolding required and curing provided has been considered

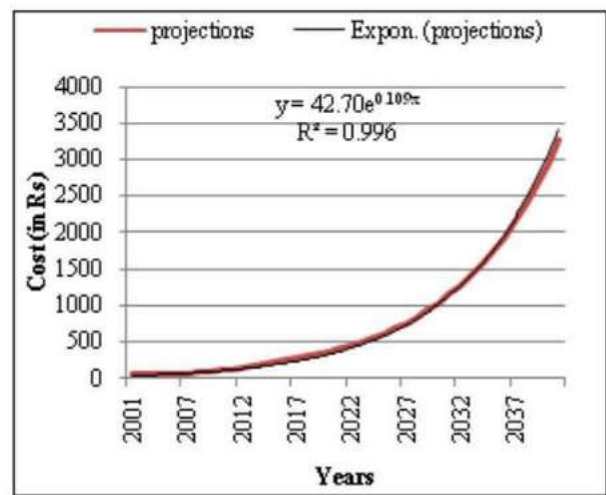


Chart 2: Cost Projections for Internal Plastering

Table 1: Cost Projections for Internal Plastering

Years	Projected COST(Rs/Sqm)	Years	Projected COST(Rs/Sqm)
2016	263.5237	2029	1030.573
2017	292.6699	2030	1144.556
2018	325.0397	2031	1271.146
2019	360.9897	2032	1411.737
2020	400.9158	2033	1567.878
2021	445.2579	2034	1741.288
2022	494.5042	2035	1933.878
2023	549.1973	2036	2147.768
2024	609.9395	2037	2385.315
2025	677.3999	2038	2649.135
2026	752.3216	2039	2942.135
2027	835.5297	2040	3267.54
2028	927.9408		

### 5.2 External Plastering

DESCRIPTION: Rough cast cement plaster is considered for external plastering. The plastering is provided in two coats to concrete, stone or brick masonry. The analysis also includes preparing the base and watering the surface. The base coat is 12 to 15 mm thick, prepared in cement to water ratio of 1:4. The analysis also considers water proofing of the surface using water proofing compound at the rate of 1 kg per 50 kg of fly ash cement. Rough cast treatment provided is 12 mm thick and in proportion 1:1.5:3 (cement: sand : coarse aggregate). The cost of scaffolding required and curing provided for 14 days has been considered.

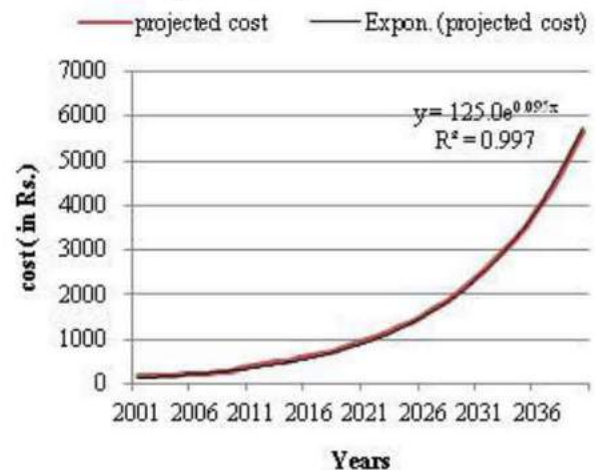


Chart 3: Cost Projections For External Plastering



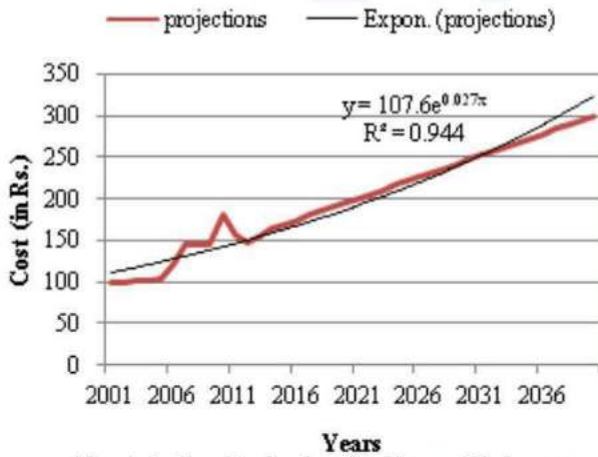
**Table 2: Cost Projections for External Plastering**

Years	Projected COST(Rs/Sqm)	Years	Projected Cost(Rs/Sqm)
2016	263.5237	2029	1030.573
2017	292.6699	2030	1144.556
2018	325.0397	2031	1271.146
2019	360.9897	2032	1411.737
2020	400.9158	2033	1567.878
2021	445.2579	2034	1741.288
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2024	609.9395	2037	2385.315
2025	677.3999	2038	2649.135
2026	752.3216	2039	2942.135
2027	835.5297	2040	3267.54
2028	927.9408		

**5.3 Cistern Fittings with Labor Wages**

**5.3.1 Cistern Fittings**

DESCRIPTION: Under cistern fittings only considerations regarding the regular taps that are used are made. Taps ranging from kitchen taps to toilet and bathroom taps and basin taps are considered here. The costs considered are average cost of taps in household. The base costs are gathered from the WHOLESALE PRICE INDEX.



**Chart 4: Cost Projection for Cistern Fittings**

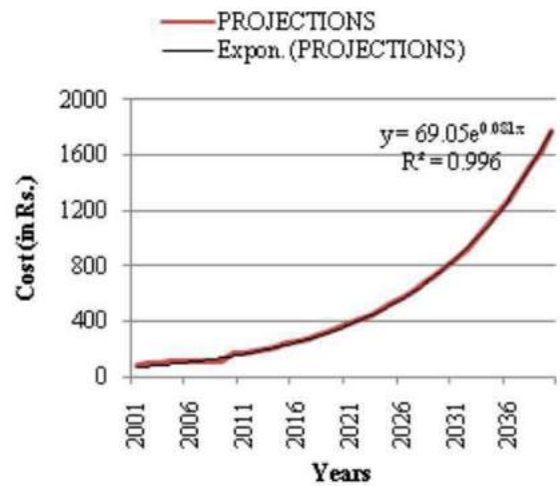
**Table 3: Cost Projection for Cistern Fittings**

Years	Projected Cost	Years	Projected Cost
2016	175.0323	2029	242.0623
2017	180.1885	2030	247.2185
2018	185.3446	2031	252.3746
2019	190.5008	2032	257.5308
2020	195.6569	2033	262.6869
2021	200.8131	2034	267.8431
2022	205.9692	2035	272.9992
2023	211.1254	2036	278.1554
2024	216.2815	2037	283.3115
2025	221.4377	2038	288.4677
2026	226.5938	2039	293.6238
2027	231.75		
2028	236.9062		

**5.3.2 Labour Requirement for Fittings**

Description: Skilled labour is considered for the fitting of taps since time requirement for the fixation of tap is nominal, generally unskilled labour wages are considered here. Since

the base wages of the unskilled labour is collected from the Consumer Price Index references.



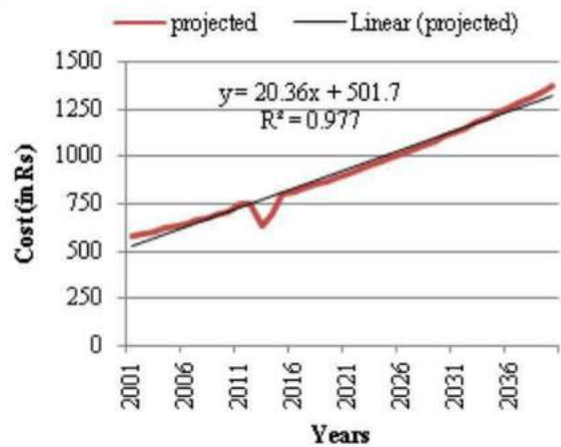
**Chart 5: Cost Projection for Labour Wages**

**Table 4: Cost Projection for Labour wages**

YEARS	PROJECTED COST(Rs/Hr)	YEARS	PROJECTED COST(Rs/Hr)
2016	252.9275	2029	727.1442
2017	274.331	2030	788.6773
2018	297.5457	2031	855.4176
2019	322.7249	2032	927.8056
2020	350.0349	2033	1006.319
2021	379.6559	2034	1091.477
2022	411.7835	2035	1183.841
2023	446.6298	2036	1284.021
2024	484.425	2037	1392.679
2025	525.4185	2038	1510.532
2026	569.8809	2039	1638.357
2027	618.106	2040	1777
2028	670.412		

**5.4 Dado Tiling**

Description: The analysis consists of providing and fixing plain ceramic tiles of size 300 mm X 200 mm. The plaster used is cement mortar ratio of 1:4. The forecast includes filling of joints with neat cement flurry or cement paste. The cost also includes curing and cleaning after dado tiling is done.



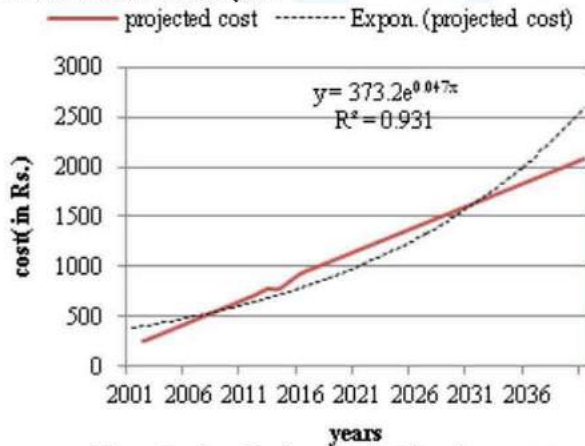
**Chart 6: Cost Projection for Dado Tiling**

**Table 5: Cost Projection for Dado Tilings**

YEARS	PROJECTED COST(Rs/Sqm)	YEARS	PROJECTED COST(Rs/Sqm)
2016	813.9379	2029	1079.762
2017	831.8262	2030	1103.492
2018	850.1075	2031	1127.744
2019	868.7907	2032	1152.529
2020	887.8844	2033	1177.859
2021	907.3978	2034	1203.745
2022	927.34	2035	1230.2
2023	947.7205	2036	1257.237
2024	968.5489	2037	1284.867
2025	989.8351	2038	1313.105
2026	1011.589	2039	1341.964
2027	1033.821	2040	1371.457
2028	1056.542		

**5.5 Flooring**

*Description:* The analysis consists of providing and laying of marble mosaic that is 10 mm thick. This flooring is made of marble chips of white or any other colour. These chips are preferably of 6 mm size. Coloured cement is more suitable for flooring. It also includes an under layer of cement concrete 1:2:4. Providing aluminium strips for panels, leveling, compacting, curing, polishing, rubbing and cleaning are considered in the analysis.



**Chart 7: Cost Projection for Flooring**

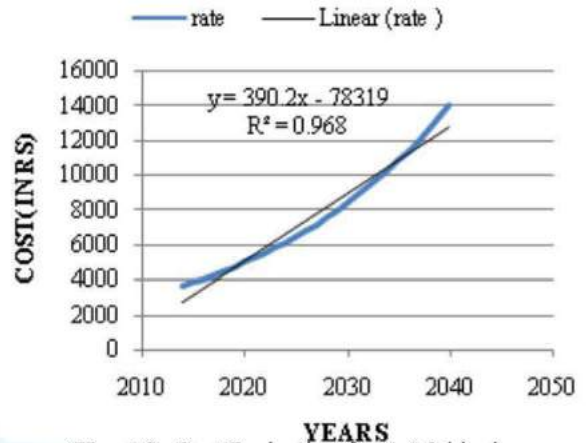
**Table 6: Cost Projection for Flooring**

YEARS	PROJECTED COST(Rs/Sqm)	YEARS	PROJECTED COST(Rs/Sqm)
2016	989.7752	2029	1584.853
2017	1035.55	2030	1630.628
2018	1081.326	2031	1676.403
2019	1127.101	2032	1722.178
2020	1172.876	2033	1767.954
2021	1218.651	2034	1813.729
2022	1264.426	2035	1859.504
2023	1310.202	2036	1905.279
2024	1355.977	2037	1951.054
2025	1401.752	2038	1996.83
2026	1447.527	2039	2042.605
2027	1493.302	2040	2088.38
2028	1539.078		

**5.6 AAC Blocks**

The analysis consists of providing autoclaved aerated concrete block masonry conforming to IS 2185(Part-3) of

size 200\*240\*650 mm in cement mortar 1:4 in superstructure including bailing out water manually, striking joints on unexposed faces, racking out joints on exposed faces and watering etc, complete



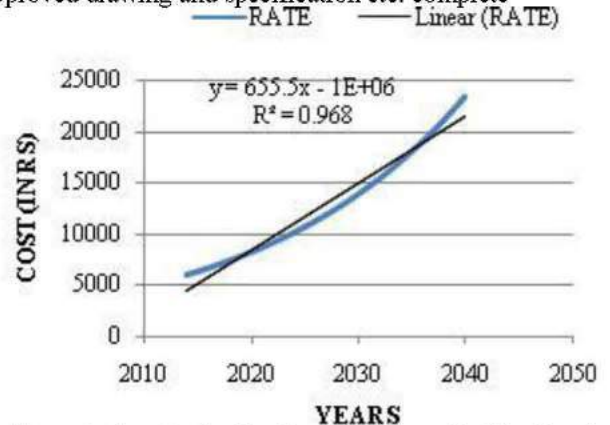
**Chart 8: Cost Projection for AAC blocks**

**Table 7: Cost Projection for AAC blocks**

Years	Projected Cost	Years	Projected Cost
2014	3635.767	2028	7528.894
2015	3829.809	2029	7930.714
2016	4034.208	2030	8353.978
2017	4249.515	2031	8799.833
2018	4476.31	2032	9269.483
2019	4715.215	2033	9764.198
2020	4966.867	2034	10285.32
2021	5231.951	2035	10834.25
2022	5511.182	2036	11412.47
2023	5805.315	2037	12021.56
2024	6115.147	2038	12663.16
2025	6441.514	2039	13338.99
2026	6785.3	2040	14050.9
2027	7147.433		

**5.7 Aluminium Double Glazed Window Glass**

Providing and fixing in position extruded modular aluminium fixed double glazed low e -value, low U-value (solarban) glass panel window having frame made out of extruded tubular section mechanically assembled at corners with glazing, beading of angle 25mmx25mm x 1.6 mm thick including plain sheet glass 5.5 mm thick with rubber gasket and wooden encasement wherever necessary etc. as per approved drawing and specification etc. complete



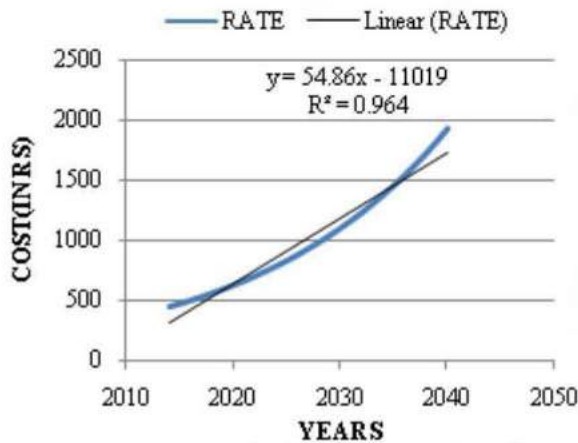
**Chart 9: Cost Projection for Aluminium double glazed window glass**

**Table 8: Cost projection for Aluminium Double glazed window glass**

Years	Projected Cost	Years	Projected Cost
2014	5992.475	2028	12506.87
2015	6315.833	2029	13181.75
2016	6656.64	2030	13893.04
2017	7015.838	2031	14642.72
2018	7394.418	2032	15432.86
2019	7793.427	2033	16265.63
2020	8213.966	2034	17143.33
2021	8657.198	2035	18068.4
2022	9124.347	2036	19043.38
2023	9616.704	2037	20070.98
2024	10135.63	2038	21154.03
2025	10682.56	2039	22295.51
2026	11258.99	2040	23498.6
2027	11866.54		

**5.8 Zero Voc Paint**

DESCRIPTION: Applying of zero VOC, odour less, solvent free, non toxic paint having anti-bacterial and anti-fungal property and complying with all the GREEN product standard with coverage of up to 12 m2 /litre of surface area of required shade to the building and workshop’s plastered surface has been considered including scaffolding, surface preparation and cleaning.



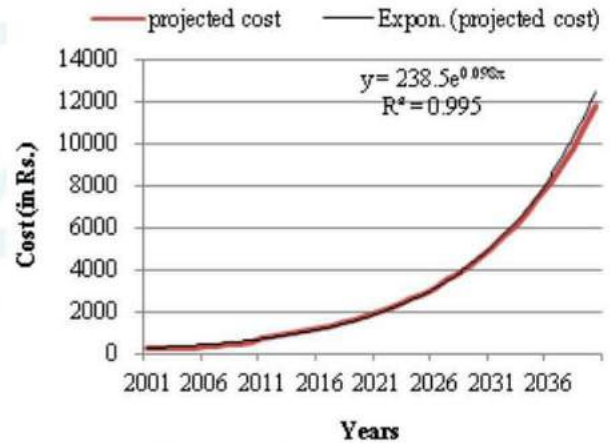
**Chart 10: Cost Projection for Zero VOC paint**

**Table 9: Cost projection For Zero VOC paint**

Years	Projected Cost	Years	Projected Cost
2014	5992.475	2028	12506.87
2015	6315.833	2029	13181.75
2016	6656.64	2030	13893.04
2017	7015.838	2031	14642.72
2018	7394.418	2032	15432.86
2019	7793.42	2033	16265.63
2020	8213.966	2034	17143.33
2021	8657.198	2035	18068.4
2022	9124.347	2036	19043.38
2023	9616.704	2037	20070.98
2024	10135.63	2038	21154.03
2025	10682.56	2039	22295.51
2026	11258.99	2040	23498.6
2027	11866.54		

**5.9 Waterproofing**

Providing and laying waterproofing treatment of 112mm average thickness consisting of 12 m thick layer in cement mortar 1:3 with water proofing compound and jute fiber at the rate of 1 kg, each per bag of cement as base, constructing and laying brick bat coba in cement mortar 1:5 with waterproofing compound at the rate of 1 kg per bag of cement and having average thickness of 80 mm and finishing with 20mm thick cement plaster layer in cement mortar 1;3 with waterproofing compound at the rate of 1kg per cement bag, including all lead, lifts and laid to proper slope to drain off water entirely preparing bell mouth including watta, beveled or chamfered portion at the junction of parapet and work up to height 300 mm or as directed and including finishing the top layer of water proofing treatment with false marking of 30 cm x 30 cm, curing



**Chart 11: Cost Projection for waterproofing**

**Table 10: Cost projection for waterproofing**

Years	Projected Cost	Years	Projected Cost
2014	697.6	2028	1056.542
2015	796.4344	2029	1079.762
2016	813.9379	2030	1103.492
2017	831.8262	2031	1127.744
2018	850.1075	2032	1152.529
2019	868.7907	2033	1177.859
2020	887.8844	2034	1203.745
2021	907.3978	2035	1230.2
2022	927.34	2036	1257.237
2023	947.7205	2037	1284.867
2024	968.5489	2038	1313.105
2025	989.8351	2039	1341.964
2026	1011.589	2040	1371.457
2027	1033.821		

**6. Conclusion**

Thus based on the cost projections and trends of different activities/ process it can be conferred that the maintenance and repair costs of green building are bound to increase with time. Some tend to increase linearly while some tend to increase exponentially. These graphs will help the financial controllers and economy managers to predict the cost of specific repair maintenance work in the future years. These predictions will assist to plan and manage the finances according requirement.

## **“Solving Travelling Issues in Mumbai – Elevated Rail Corridor”**

Chirag Jain

Saket Bhagat

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### **Abstract:**

This paper investigates about studying the innovative concept of “Elevated Rail Corridor” proposed by the Western Railway in the overcrowded city of Mumbai.

### **Introduction:**

Mumbai has one of the most crowded and overloaded suburban systems in the world. The System is operated by Western and Central Railway and is spread over 319 route km operating more than 2,300 train services daily.

The existing Corridor is about 60 km long from Churchgate to Virar with 28 stations. Non air-conditioned local trains (EMU) run for about 20 hours a day. The trains are over-crowded much beyond their rated carrying capacity with headway of around four minutes and are intensively utilized. The City is expanding towards Virar and beyond resulting in high annual growth

rate in passenger movement between Virar and Borivali as compared to southern sections.

Lateral expansion by way of laying additional tracks by the side of existing tracks is not feasible due to non-availability of required land strip for most length of the Corridor.

Therefore, the idea exploiting the airspace above the existing railway came into existence and hence the concept of ‘Elevated Rail Corridor’ was envisioned. This innovative concept of ‘Elevated Rail Corridor’ (elevated railway) tackles the connectivity issues faced by the population living in the suburbs. The basic concept behind providing this Elevated Rail Corridor is to use the air space above the existing Western Railway in the Space-starved City of Mumbai. The main purpose of this corridor is to distribute the population traveling on the existing railway system.

An artist's impression of the stations on the elevated corridor



**Present Scenario: Problems faced by the Mumbai Railway Commuters (Western).**

- Overcrowding (Population explosion).
- Delayed trains.
- Obsolete trains.
- Impossible to add more trains.
- Lack of safety.
- Improper drainage facilities and other services.

**Solution to the current problems until now by Western Railway**

- Introduction of new rail coaches 'Bombardier'.
- To avoid trespassing: More than 52 per cent of people killed in railway accidents in 2013 were run over by

trains while trying to cross the tracks.

- Increasing the 12 coaches to 15 coaches train.

**Case Study: Elevated Rail Corridor**

The 63 km long railway corridor project connecting Oval Maidan in Churchgate to Virar was announced in May 2008 with 24 stations across the stretch. Out of these, 13 stations were proposed to be elevated, 3 on ground level and 8 underground. Western Railways had proposed to make available around 76 acres of railway land to the developer of the project, for commercial exploitation. The railway corridor was to be developed through Public Private Partnership (PPP) on Design, Build,

Finance, Operate and Transfer (DBFOT) basis.

The Churchgate-Virar Elevated rail project was one of the large infrastructure projects selected by the PMO's office in July 2013 for allocation of implementation deadline.

Request for Qualification (RFQ) for the Rs.225 billion project was issued on 7 August 2013. The applicants were asked to submit their applications by 20 September 2013. Selection of the applicants was scheduled for 4 October 2013 and the name of the successful bidder was to be announced on 31 December 2013. The concession agreement for the project was expected to be signed before the end of 2013-14. Ministry of Railways (MOR) was concerned about the capacity constraint on the Corridor and is keen to take suitable measures to augment the system capacity as well as to provide improved services to the commuters.

- Lateral expansion by way of laying additional tracks by the side of existing tracks is not feasible due to non-availability of required land strip for most length of the Corridor.

The breakup of stretch is as given below:

MOR has therefore, envisioned a two track elevated Corridor with a capacity of 90,000 PHPDT along Churchgate-Virar section. It is expected that introduction of air-conditioned EMU services will help in addressing the twin issues of capacity constraint as well as non-availability of high quality travelling comfort to the commuting public.

#### **Proposed Corridor –**

Oval Maidan - Virar Elevated Corridor will have a length of 62.268 Km on Oval Maidan - Virar stretch of Mumbai passing through Churchgate, Charni road, Mumbai Central, Mahalaxmi, Lower Parel, Elphinston Road, Dadar, Matunga Road, Mahim Junction, Bandra, SantaCruz, Andheri, Jogeshwari, Goregaon, Malad, Kandivali, Borivali, Dahisar, Bhayandar, Naigaon, Vasai Road and Nalasopara.

26 stations are proposed on the corridor from Oval Maidan to Virar. Out of which 5 stations would be underground, 19 elevated and 2 at grade.

Particular	Oval Maidan - Mahalaxmi	Mahalaxmi - Borivali	Borivali - Virar	Total
Length (In Km)	8.04	27.41	27.818	<b>63.268</b>
Underground (In Km)	8.04 (12.70%)	-	-	<b>8.04(12.70%)</b>
Elevated (In Km)	-	25.213 (39.85%)	17.807 (27.67%)	<b>42.72 (67.52%)</b>
At Grade (In Km)	-	2.20 (3.48%)	10.311(16.30%)	<b>12.511(19.78%)</b>
Stations (in Nos)	5 Nos. (All U/G)	14 Nos. (All Elevated)	7 Nos. (5 Elevated and 2 At Grade)	26 Nos.

Broad features of the alignment are-

1. Oval Maidan-Mahalaxmi -The underground alignment for this section is considered feasible as:

- Acquisition is private land/properties is minimum
- Road traffic diversions will be limited
- Will serve Nariman point/Mantralaya
- Oval Maidan station will get integrated with Hutatma Chowk station on Colaba- Bandra
- Metro
- Operational facilities will be provided, at Oval Maidan
- Aesthetics of Heritage Building will not be affected.

2. Mahalaxmi - Borivali- the alignment is mainly elevated except for a length of 2.2 km north of Santa Cruz to north of Ville Parle Station, where due to the height restrictions imposed by Airport Authority of India, the alignment is brought to surface.

3. Borivali - Virar - While proposing the alignment for this section, provision for two future lines has been kept. Feasibility of keeping alignment at grade has been seen, wherever land is available within railway right of way, or feasible for acquisition.

Revenues

The revenues are expected from the mix of fare box and no-fare box

1. Fare box revenue- From the demand analysis, it has been estimated that about 1.7 million

passengers would use the corridor in year 2019-20.

2. The concessionaire will enjoy the freedom of setting tariff.
2. Other sources of revenue- Other sources of revenue could be commercial development and advertisement on the station building. Also it is possible to raise revenue through leasing of parking rights at stations, advertisement on trains and tickets, advertisement within stations and parking lots, advertisement on viaducts, coloums and other metro structures, co-branding rights to corporate, film shootings and special events in premises.
  - Available land parcels with Railways are limited.
  - Limited scope of air space exploitation on running system.
  - Project viability to be improved by
    - Use of appropriate FSI on available plots.
    - Flexible land use.

### **Modified proposal of the Elevated Rail Corridor (Andheri-Virar)**

Since the Western Railway's proposal was not viable to the reasons stated before, we

came up with a modified proposal of the rail corridor irrespective of the design considerations.

The salient features of the proposals are:

- 1) Route: Andheri-Virar Full elevated, acquiring space around and above the existing railway lines.
- 2) Length: 38 kilometers rail length.
- 3) Stations: Andheri, Jogeshwari, Goregaon, Malad, Kandivali, Borivali, Dahisar, Mira Road, Bhayandar, Naigaon, Vasai Road, NalaSopara, Virar.
- 4) Cost: 10,918 Crores (If the construction work begins in 2016).
- 5) Type of Vehicle: A/C locals (being introduced on March 31<sup>st</sup> 2016)
- 6) Safety Measures: Platform screen doors (PSDs) and platform edge doors (PEDs) at train or subway stations screen the platform from the train. They are a relatively new addition to many metro systems around the world, some having been retrofitted to established systems. They are widely used in newer Asian and European metro systems.
- 7) Revenue Collection: Fast food joints (providing a floor between the existing railway and new elevated railway stations.



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# SMART SOLUTIONS FOR CITIES

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*Abstract -- This paper investigates on analyzing the methods and techniques of constructing new modern buildings by utilizing ultra-low energy. This study involves types of solutions which can be implemented by a well organized way. It emphasizes mainly on climate change & various other efforts to reduce construction hazards. One of the main tasks of the construction industry is to increase the strength and reliability of structures while reducing construction costs & ill-effects caused by it. In this techniques the energy use of constructing structures is being reduced to a very far extent. The paper enlightens on topics such as passive house, porous concrete & a well organized drainage*

*system(SUDS) . Hence, there is feasibility to adopt these advanced construction techniques.*

## 1. Introduction

This project shows the ways / solution for lowering the usage of electricity, minimizing the construction hazard, minimizing the CO<sub>2</sub> emission. Seeing to the present situation of the rising issue of Climate change we have put spotlight on revolutionary solution and cease the use of crummy method. Better standard for living. Better drainage system for a well-planned town. Plan for an ideal building and town plans. Due to the aftermath of these crumbling methods it becomes obligatory for us to use the smart and advanced ways so that the human will live in ease. Healing up the environment has been of utmost significant in these days that are why we must look into this matter. So this project is been more or less associated with environment friendly situation because

nature is our best source and nothing is bigger than nature.

Drainage system which employs new roads (Porous Road) for systematic storage of rain water and storm water for lowering the water's waste, pollution etc. and utilizing that water for other chore work. This will also reduce the effect of flood in the region. New structure or method of construction (Passive Building) for easy way of construction, with new and better materials, for lowering the cost of electricity consumption and using the natural source on behalf of artificial source.

## 2.Review of literature

### Passive house:

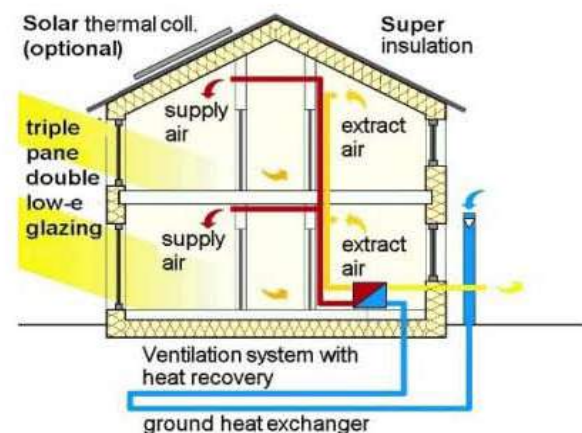
A building standard that is truly energy efficient, comfortable, affordable and ecological at the same time. Passive House is not a brand name, but a construction concept that can be applied by anyone and that has stood the test of practice. Yet, a Passive House is more than just a low-energy building.

Passive Houses allow for heating and cooling related energy savings of up to 90% compared with typical building stock and

over 75% compared with average new builds.

In terms of heating oil, Passive Houses use less than 1.5 liters per square meter of living space per year – far less than typical low-energy buildings. Similar energy savings have been demonstrated in warm climates where buildings require more energy for cooling than for heating. Passive Houses are also praised for their high level of comfort. They use energy sources inside the building such as the body heat from the residents or solar heat entering the building – making heating a lot easier.

### Design of passive house:-



### Components of passive house:-

1. Passive solar design and landscape
2. Super insulation
3. Advanced window technology
4. Air tightness
5. Ventilation

6. **Space heating**

7. **Lighting and electrical appliances**

**Space heating:-**

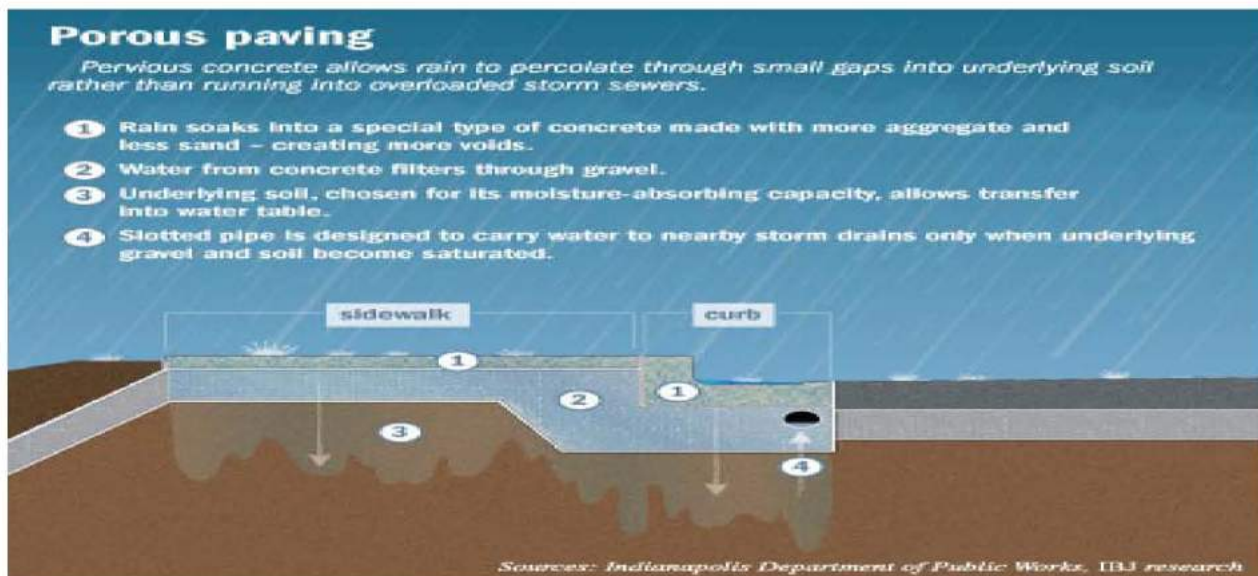
				Criteria <sup>1</sup>	Alternative Criteria <sup>2</sup>
<b>Heating</b>					
heating demand	[kWh/(m <sup>2</sup> a)]	≤		30	
<b>Cooling</b>					
cooling + dehumidification demand	[kWh/(m <sup>2</sup> a)]	≤		Passive House requirement <sup>3</sup> + 15	
<b>Airtightness</b>					
pressurization test result n <sub>50</sub>	[1/h]	≤		1.0	
<b>Renewable Primary Energy (PER)<sup>4,5</sup></b>					
PER demand	[kWh/(m <sup>2</sup> a)]	≤		75	Exceeding the criteria up to +15 kWh/(m <sup>2</sup> a) is permitted... ...with compensation of the above deviation by additional generation
renewable energy generation (with reference to ground area)	[kWh/(m <sup>2</sup> a)]	≥		-	

**2. Porous Concrete:**

Porous concrete are special type of concrete which allows water to percolate through it so that the water can be used in other different purposes. It has been increasingly in demand because they offer site planners and public works officials the opportunity to manage storm water in an environmentally friendly way. Impervious surfaces such as roofs and pavements create runoff, so that dirt and debris are washed into streams and waterways. At the same time, water has often been regarded as the “enemy” of concrete. Great efforts are taken to assure that water does not enter the

roadway material, especially in areas with numerous freeze/thaw cycles. Ironically enough, porous concrete offers the opportunity to address both of these problems in many parking lot and paved area applications. With the proper design and installation, porous concrete parking areas can provide cost-effective, attractive parking lots with a life span of twenty years or more, and at the same time, provide storm water management systems that promote infiltration, improve water quality, and eliminate the need for a detention basin.

## Drainage system



A sustainable drainage system (SUDS) is designed to reduce the potential impact of new and existing developments with respect to surface water drainage discharges. The term sustainable urban drainage system is not the accepted name, the 'Urban' reference having been removed so as to accommodate rural sustainable water management practices.

SUDS use the following techniques:

- Source control
- Permeable paving such as pervious concrete
- Storm water detention
- Storm water infiltration
- Evapo-transportation (e.g. from a green roof)

### 3. Conclusion

The above mentioned techniques offers a great technical & ecological advantages in comparison to other forms of construction. The first priority before construction of any structures should be environment so keeping this mind this paper emphasizes mostly on reducing environmental hazards of conventional techniques.



Project : **POWER TRACKS.**

Chetan Koli TE CIVIL B .

Power tracks project is built in 2 phases as Moving Platform and Electrical dynamo

PHASE 1 :- Power Tracks project is basically a moving or raising platform which will raise by the force created by axle of train when it will get struck to hydraulic pistons connected parallel to railway tracks .

When the train approaches station , before the station parallel to railway tracks hydraulic lifters



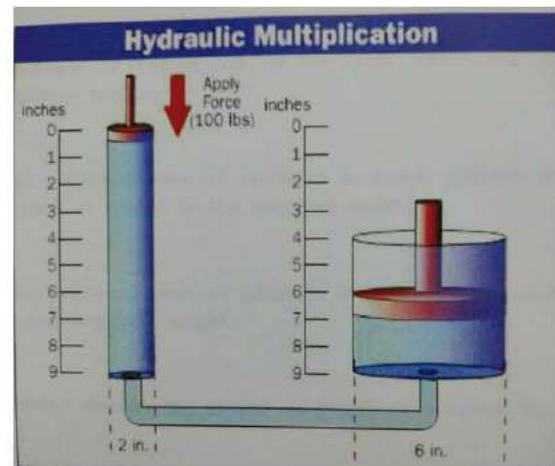
are placed .It works on principle of hydraulic piston .

Example : 500 trains travel everyday from Churchgate to Virar due to raising platform technology the time gap is reduced from 3 minutes to 1.50 minutes and number of trains travelling can be doubled to around 1000 trains everyday from Churchgate to Virar.

PHASE 2 :- Electric Dynamo works on the principle that when the train comes towards

railway station axle of wheels of train struck pistons placed at regular intervals . To this pistons electricity generating dynamos are fixed up , when train comes and strucks pistons springs connected to piston gets momentum and electricity is generated.

The average electricity generated will be around 80-90 volts per piston when all axles of 1 train struck with around 40 km/hr .



Due to the action of piston the compressed air is introduced and pumping of water at stations can be done . As number of trains are increased the water pumping is increased as calculated value is 4800 litres of water can be pumped on per day basis.

Manual Braking of the train is not needed as the train will automatically come to a halt by the pistons providing resistance to speed if train enters station with a design speed .

# Comparative Study of Rice Husk Ash, Metakaolin & Standard Concrete

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**Abstract—** This paper summarizes the comparison between properties of Rice Husk Ash (RHA) and Metakaolin when used as partial replacement for Ordinary Portland Cement (OPC) in concrete. OPC was replaced with these mineral admixtures at 5%, 10% and 15% by weight. 0% replacement served as the control. Compressive Strength test was carried out on hardened 150mm concrete cubes after at 1, 3, 7, 28, 45 & 56 days curing in water. Compression strength test confirms its suitability as a partial replacement mineral admixture.

## I. INTRODUCTION

In present era the development of a nation is symbolized by presence of its infrastructure, there is a huge demand for sustainable development of infrastructure in developing as well as in developed countries. Concrete being the most versatile and used construction material on earth facing the scarcities of its prime constituent i.e. cement. Use of cement as a binding material not only imposes limitation on compressive strength of concrete but also leads to excessive heat of hydration, increases potential chloride attacks, adds to cost, reduces durability of concrete and structure as a whole.

Use of Mineral admixtures has been practiced recently in order to overcome these effects. In this paper we summarize two such admixtures namely RHA and Metakaolin.

Rice milling generates a byproduct known as husk. This surrounds the paddy grain. During milling of paddy about 78% of weight is received as rice, broken rice and bran. Rest 22% of the weight of paddy is received as husk. RHA is produced by burning rice husk between 600 and 700°C temperatures for 2 hours. It contains 90-95% SiO<sub>2</sub>, 1-3% K<sub>2</sub>O and < 5% unburnt carbon. Rice Husk Ash (RHA) has been reported to be a good pozzolan by numerous researchers. During mass concrete, as compared to OPC concrete, RHA is very effective in reducing the temperature of mass concrete.

Table 1: Physical and Chemical properties of RHA

PROPERTIES	SPECIFICATION
Appearance	Grey Black
Bulk Density ( gm/cc)	0.58
Moisture at 105°C	1.87%
Loss On Ignition	< 6.0%
Residue on 350μ mesh	< 0.5%
SiO <sub>2</sub> +Al <sub>2</sub> O <sub>3</sub> +Fe <sub>2</sub> O <sub>3</sub>	min. 90%

Metakaolin is a semi-natural product which is obtained by calcinations of kaolin clay at a temperature between 500°C to 800°C. Metakaolin is produced under controlled conditions to refine its color, remove inert impurities and produce particle size to high degree of purity and pozzolanic reactivity. Incorporating Metakaolin in concrete add to various properties of concrete. In fresh state of concrete, it eliminates or minimizes the bleeding, reduces segregation. The resistance to chloride ion penetration, fire and water permeability also becomes better. Due to improved microscopic structure concrete becomes durable.

Table 2: Physical and Chemical properties of Metakaolin

PROPERTIES	SPECIFICATION
Appearance	Off White to Buff
Bulk Density ( gm/cc)	0.35-0.50
Moisture at 105°C	< 0.5%
Loss On Ignition	< 2.0%
Residue on 350μ mesh	< 0.5%
SiO <sub>2</sub> +Al <sub>2</sub> O <sub>3</sub> +Fe <sub>2</sub> O <sub>3</sub>	min. 90%

## II. MATERIALS AND METHODS

### • Materials

1. Cement- Ambuja OPC 53 grade of cement was used.
2. Flyash- Ashtech (India) Flyash was used.
3. Metakolin- 20 micron
4. RHA- RHA was obtained from Orissa, India.
5. Coarse Aggregate (10mm & 20mm)-Turbe (Quarry), Navi-Mumbai, India.
6. Fine Aggregate (crushed sand -VSI) - Turbe (Quarry), Navi-Mumbai, India.
7. Water-Bore well water used. The water used was clean and free from any visible impurities. With conformation to IS 456-2000 requirements.
8. Admixture- Super plasticizer Sikament 5204NS (to increase workability)

## III. METHODOLOGY

- *Mix Design*

Department of Environment (DOE) Method is used to design the M40 concrete.

Four trials as 0%, 5%, 10% and 15% replacement of metakaolin and RHA with binder are designed. The design mix includes 130Kg of fly ash as a constant ingredient in all the mixes.

The proportions for trial mixes are presented in the tables below.

**Table 3: Mix Design for M40 (Standard Concrete)**

M40	1 CUM (kg)	0.05 CUM (kg)
Cement	400	20
Flyash	130	6.5
C/Sand	453.72	22.69
C.A 1	504.86	25.24
C.A 2	757.28	37.86
Water	180	9
Admixture	5.3	0.265

**Table 4: 5% Replacement of OPC with RHA/ Metakaolin**

M40	1 CUM (kg)	0.05 CUM (kg)
Cement	393.5	19.675
Flyash	130	6.5
RHA/Metakaolin	6.5	0.325
C/Sand	644	32.2
C.A 1	440	22
C.A 2	640	32
Water	182.4	9.12
Admixture	5.3	0.265

**Table 5: 10% Replacement of OPC with RHA/ Metakaolin**

M40	1 CUM (kg)	0.05 CUM (kg)
Cement	387	19.35
Flyash	130	6.5
RHA/Metakaolin	13	0.650
C/Sand	644	32.2
C.A 1	440	22
C.A 2	640	32
Water	182.4	9.12
Admixture	5.3	0.265

**Table 6: 15% Replacement of OPC with RHA/ Metakaolin**

M40	1 CUM (kg)	0.05 CUM (kg)
Cement	380.5	19.025
Flyash	130	6.5
RHA/Metakaolin	19.5	0.975
C/Sand	644	32.2
C.A 1	440	22
C.A 2	640	32
Water	182.4	9.12
Admixture	5.3	0.265

- *Test Cubes*

Specimen cubes of size 150mm X 150mm X 150mm were casted for compression test under controlled environment.

- *Testing of samples*

The cubes prepared for testing were cured properly and tested as per compression test procedures in digital Compression testing machine of 3000 KN capacity. Tests are carried out at the age of 1, 3, 7, 28, 45 and 56 days of test cubes. The test results are reported in table for control, RHA & Metakaolin concrete respectively. Table tables below gives the test results at respective days.

#### IV. RESULTS AND DISCUSSIONS

**Table 7: Compressive Strength at 5% replacement in MPa**

No of Days	Standard	With RHA	With Metakaolin
1	8.56	8.1	13.65
3	19.45	18.56	23.45
7	30.65	28.23	35.85
28	43.86	52.36	51.59
45	53.44	61.52	59.42
56	56.78	64.65	61.32

**Table 8: Comp ressive Strength at 10% replacement in MPa**

No of Days	Standard	With RHA	With Metakaolin
1	8.56	10.23	16.63
3	19.45	26.32	31.56
7	30.65	34.33	41.87
28	43.86	51.56	56.40
45	53.44	59.32	61.65
56	56.78	68.23	65.54

**Table 9: Comp ressive Strength at 15% replacement in MPa**

No of Days	Standard	With RHA	With Metakaolin
1	8.56	9.65	18.25
3	19.45	21.41	29.85
7	30.65	26.34	36.50
28	43.86	49.64	56.45
45	53.44	56.53	58.25
56	56.78	64.12	60.15

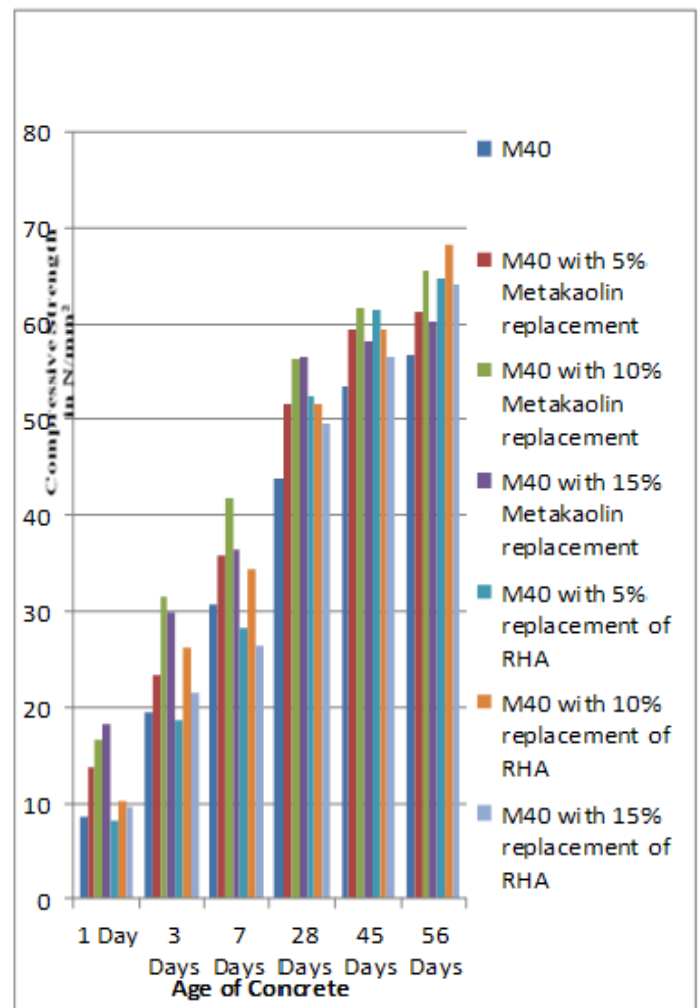


Fig 1: Effect of age on compressive strength of concrete w.r.t different replacement of RHA & Metakaolin by the weight of cement.



## V. CONCLUSION

At all the cement replacement levels of Rice husk ash, the rate

of development of compressive strength up to 28 days is slower as compared with that of concrete in which RHA content is zero, while the rate of development of strength gradually increases after 28 days up to 56 days in case of RHA mixed concrete.

The compressive strength of concrete having 10% replacement was found to be more than the other levels of replacements. (I.e. 0%, 5%, & 15%).

For the desired workability and strength, the water content required in case of RHA mixed concrete was more than in normal concrete. This is because RHA is finer than cement & the fact is that RHA particles being finer it has more surface area and hence water required is comparatively more.

Metakaolin replacement accelerates the rate of gain of strength in concrete and is predominant at early age. Metakaolin replacement shows an increase in 28 day strength between 13 to 30 percent with comparison to without replacement mix.

Mixes with 10% and above metakaolin replacements were reported for reduction in workability and makes concrete sticky. Mix with 10% replacement of Metakolin resulted maximum increase in compressive strength.

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***RISING TALENTS***

# SE IN SPORTS

NAME	SPORTS EVENT
AJIT YADAV	INTER CRICKET
AKASH YADAV	INTER CRICKET
ADITYA SINGH	INTER CRICKET
YOGESH SHARMA	INTRA CRICKET
AATISH SINGH	INTRA CRICKET
ASHISH CHOUDHARY	INTRA CRICKET
SAURABH POKHARKAR	INTRA CRICKET
SALMAN ALI	INTRA CRICKET
SHASHANK PONGERKAR	INTRA CRICKET
SUNIL LODHI	INTRA CRICKET
KULDEEP DEVAL	INTRA CRICKET
SURESH MISHRA	INTRA CRICKET
SHASHANK PONGERKAR	INTRA FOOTBALL
DISHA MANA	VOLLEYBALL STATE LEVEL CHAMPION
RAHUL GUPTA	NFA GOA FOOTBALL WINNER
SHUBHAM RATHOD	WUSHU MARTIAL ARTS
SHUBHAM RATHOD	VOLLEYBALL ZONAL
ROHIT PARKAR	FOOTBALL ZONAL
ROHIT PARKAR	400 M RUNNER UP
ROHIT PARKAR	RELAY WINNER
SHUBHAM DHAWADE	KABBADI MATCH

# SE IN CULTURAL EVENTS

NAME	EVENT
PRABLEEN KAUR BHOMRA	INTRA DANCE
KRUPALI SHAH	INTRA DANCE
RAHUL SAVARATAKAR	INTRA DANCE
SURBHI SAWANT	INTRA DANCE
VINAYA SAWANT	INTRA DANCE
PRABLEEN KAUR BHOMRA	VOCALS ( COLLEGE BAND )
SHUBHAM WAGH	GUITAR ( COLLEGE BAND )

# TE IN SPORTS

NAME	SPORTS EVENT
ADINATH GITTE	BASKETBALL
ADINATH GITTE	VOLLEYBALL
PRATHAMESH DESHPANDE	FOOTBALL
PARTH DAGLI	FOOTBALL
RUSHABH MARU	FOOTBALL
KARAN PATEL	FOOTBALL
ROHAN KAKATI	ATHLETICS
KRUNAL PANCHAL	FOOTBALL
SAGAR SINGH	FOOTBALL
OMER KHAN	FOOTBALL
ABDUL	FOOTBALL
MANAV DAVE	FOOTBALL
KEVAL SHAH	FOOTBALL
AMIT DHAKA	FOOTBALL
AYUSH BHARADWAJ	FOOTBALL
SAMADHAN BANGHAR	CRICKET
PARTH DAGLI	CRICKET
RAJ GHOSH	BASKETBALL
CHETAN KOHLI	BASKETBALL
VISHAL MANJREKAR	BASKETBALL
SANJAY THAKUR	BASKETBALL
ANAND SINGH	BASKETBALL
SURESH MISHRA	CRICKET
SONU MISHRA	CRICKET
NITESH MISHRA	CRICKET
BELAL KHAN	CRICKET

# TE IN CULTURAL EVENTS

<b>NAME</b>	<b>EVENT</b>
<b>ASHWINI SINGH</b>	<b>DANCE</b>
<b>MONICA KORLEPARA</b>	<b>DANCE</b>
<b>MONICA KORLEPARA</b>	<b>FASHION</b>
<b>NIDHI SHAH</b>	<b>FASHION</b>
<b>NIDHI SHAH</b>	<b>DANCE</b>
<b>SHIVANI TAMBE</b>	<b>DANCE</b>
<b>RAJAT MISHRA</b>	<b>DANCE</b>
<b>DEEKSHA PATEL</b>	<b>DANCE</b>

# TE IN TECH/ART

NAME	EVENT
JAYKUMAR LODHA	BRIDGE DESIGNING
CHETAN KOLI	BRIDGE DESIGNING
MIHIR VOHRA	BRIDGE DESIGNING
SUPREET SAYAGAVI	TECH DEBATE & TECH PAPER PRESENTATION
MOHIT KAREZIA	TECH DEBATE & TECH PAPER PRESENTATION
AJAY DWIVEDI	TECH PAPER PRESENTATION & JOURNAL
JAIDEEP PRABHU	TECH PAPER PRESENTATION & JOURNAL
MANIK MATTOO	TECH PAPER PRESENTATION & JOURNAL
SACHIN GUPTA	JOURNAL
ANKUR MANJARE	TECH PAPER PRESENTATION
MONICA KORLEPARA	JOURNAL
SHIVANI TAMBE	JOURNAL
HARSH MEHTA	TECH PAPER PRESENTATION & JOURNAL
TEJ PATEL	BOAT MAKING
MEET RAWAL	BOAT MAKING
DHAVAL AMLANI	QUIZ
HISTESH MISTRY	TECH PAPER PRESENTATION & JOURNAL
AJAY DWIVEDI	NPTTEL
PRATHAMESH DESHPANDE	SKETCH ARTIST
MONICA KORLEPARA	SKETCH ARTIST
ROHAN KAKATI	SKETCH ARTIST
ADINATH GITTE	SKETCH ARTIST
PRAJKTA PUNWATKAR	SKETCH ARTIST

# TOPPERS

THIRD YEAR



MEET RAWAL CIVIL A  
9.96 SGPI  
UNIVERSITY TOPPER



TEJ PATEL CIVIL A  
9.84 SGPI



SAUREEN NAIK CIVIL A  
9.84 SGPI



MIHIR VORA CIVIL B  
9.5 SGPI



CHETAN KOLI CIVIL B  
9.36 SGPI



AKASH YADAV CIVIL B  
8.8 SGPI



# TOPPERS

SECOND YEAR



RISHABH GUPTA CIVIL A  
8.78 SGPI

MILAN GADA CIVIL A  
8.74 SGPI



ARPIT SETHI CIVIL B  
8.59 SGPI



SHIVA ANUSURU CIVIL B  
8.59 SGPI



ABHISHEK GURAV CIVIL A  
8.48 SGPI



DIVYA THAKUR CIVIL B  
8.48





## **EDITORIAL TEAM**

**DEVANG MARATHA**

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**AJAY DWIVEDI**

**VICKY GUPTA**

**SUPREET SAYAGAVI**

**DEEKSHA PATEL**

**DHAVAL AMLANI**

**(DESIGNER)**

**(EDITOR)**

**(EDITOR)**

**(INHOUSE)**

**(INHOUSE)**

**(EDITORIAL HEAD)**

**(CHIEF EDITOR)**

**(TECHNICAL)**

**(DESIGNER HEAD)**

**(TECHNICAL)**

**(DESIGNER)**