Department of Civil Engineering

DEPARTMENT TECHNICAL ACTIVITIES

HOD MESSAGE

Dr. Naresh Maloth

I am very happy to publish forth issue of departmental Technical magazine for Ay-25-26. This issue is a reflection of the research area of the student and faculty expertise they have achieved. The credit of combining most of article in the form of such goes to the editorial team of students. On behalf of Civil department I am also thankful to executive director Hon. Shri Anil Bagane & I/C Principal Dr. B.B. Sangame , who are keeping us motivated all the time. Last but not least I am also very thankful to my departmental faculty member & supporting staff for doing each & everything. They did to contribute the success of the department.

CONTENT OF MAGAZINE

1) ASSESSMENT OF CARBON EMISSION SOURCES AND SUGGESTIONS FOR REDUCING CO_2 IN SMART CITIES

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Abstract : Rapid urbanization has intensified the need for sustainable solutions in developing smart cities that minimize environmental degradation. Carbon dioxide (CO_2) emissions are among the major contributors to global climate change, arising from transportation, industry, and energy use. This paper presents the key sources of carbon emissions within the urban framework and evaluates strategies to mitigate CO_2 levels. The study utilizes secondary data from the Central Pollution Control Board (CPCB) and NITI Aayog to analyze emissions across energy, industrial, agricultural, and waste sectors. Findings reveal that the energy sector contributes approximately 2.23 billion tonnes of CO_2 annually, followed by agriculture (0.40 billion tonnes), industry (0.23 billion tonnes), and waste (0.07 billion tonnes). The research further explores the potential of renewable energy, electric vehicles, carbon trading, and afforestation as effective carbon reduction measures. Implementation of sustainable energy systems, green mobility, and urban reforestation are recommended as key pathways to achieve low-carbon smart city development.

IndexTerms - Carbon emissions, Smart city, Renewable energy, Sustainable development.

I. INTRODUCTION

Smart cities represent a convergence of technology, infrastructure, and sustainability designed to improve urban living while minimizing environmental impacts. However, with technological advancement comes the challenge of increased energy consumption and CO_2 emissions. Cities account for 80% of global greenhouse gas emissions, with energy and transport being primary sources. This study focuses on assessing carbon emissions in the Indian context, particularly for Kolhapur city, and suggests mitigation strategies through renewable, electric mobility, and carbon offset mechanisms.

II. OBJECTIVE

1.Identify the primary sources of carbon emissions in urban areas.
2. Analyze emission patterns across different sectors.
3. Develop strategies to reduce CO_2 emissions using renewable energy and urban greening.
4. Propose sustainable frameworks like carbon trading and electric mobility for smart cities.

III. METHODOLOGY

The methodology includes secondary data collection from CPCB and NITI Aayog for national emissions, and local data from Kolhapur city for case analysis. A comparative approach was used to analyze CO_2 contributions from sectors: Energy, Agriculture, Industrial Processes, and Waste. Formulas were applied for vehicular CO_2 estimates:

Total CO_2 = (Number of Vehicles) × (Average CO_2 Emission per Vehicle)

Average CO_2 per vehicle (150 g/km) was used to calculate cumulative emissions for Kolhapur.

IV. RESULTS AND ANALYSIS

Table 1. Sector-wise CO_2 Emissions in India

Sector	CO_2 Emissions (Tonnes)
Energy	2,238,408,890
Agriculture	405,983,210
IPPU (Industry)	238,555,840
Waste	75,641,070

Table 2. Kolhapur City Emission Sources (PM and CO_2)

Source	PM_{10} (Kg/day)	CO_2 Contribution (%)
Industries	864.56	61.96
Vehicular Flow	241.02	17.27
Building Construction	77.20	5.53
Domestic	39.91	2.86
Others	172.62	12.38

Table 3. Registered Vehicles and Estimated CO_2 Emissions in Kolhapur

Year	Total Vehicles	Average CO_2 (g/km)	Estimated CO_2 (Ton/km)
2019-20	1,434,332	150	215.15
2020-21	1,521,642	150	228.25
2021-22	1,609,252	150	241.39

Table 4. Estimated CO_2 Emissions Avoided by Renewable Energy in India (FY 2024–25)

Category	Generation (TWh)	CO_2 Avoided (Million Tonnes)	% of Power Sector CO_2 Avoided
RE excl. Hydro	268.5	165.4	11.8%
Large Hydro	149.1	91.8	6.5%
Total	417.5	257.2	18.3%

CO2 Consumption and O2 production by trees:

Trees consume carbon dioxide (CO2) and produce oxygen (O2) through photosynthesis, converting light, water, and CO2 into sugars for growth and releasing O2 as a byproduct during the day.While trees release some CO2 at night through respiration, their net effect over a 24-hour period is a significant consumption of CO2 and a large production of oxygen.The amount of CO2 absorbed and O2 produced varies depending on factors like a tree's species, age, health, and surrounding environment.

Tree Groups and CO_2/O_2 Data:
1. Evergreen Trees (Broadleaf / Tropical)
Examples: Neem, Banyan, Mango, Peepal, Jamun, Mahogany

- CO_2 absorption: 20–35 kg/year
- O_2 production: 14–25 kg/year

Notes: Active year-round; high leaf area; excellent air purifiers.

2. Deciduous Trees
Examples: Teak, Sal, Gulmohar, Amaltas, Arjun

- CO_2 absorption: 15–25 kg/year
- O_2 production: 10–18 kg/year

Notes: Shed leaves seasonally; Teak stores carbon well in wood.

3. Coniferous Trees
Examples: Pine, Deodar, Cypress, Ceda

- CO_2 absorption: 12–20 kg/year
- O_2 production: 8–15 kg/yearNotes: Slower photosynthesis but long-term carbon storage.

4. Fast-Growing Species
Examples: Eucalyptus, Subabul, Poplar, Cassia, Acacia auriculiformis

- CO_2 absorption: 30–50 kg/year
- O_2 production: 22–36 kg/year

Notes: High productivity; short rotation cycles; excellent for reforestation.

5. Fruit-Bearing Trees
Examples: Mango, Guava, Jackfruit, Coconut, Banana, Tamarind

- CO_2 absorption: 20–30 kg/year
- O_2 production: 15–22 kg/year

Notes: Dual benefit — food + environmental; good canopy cover.

6. Wetland / Mangrove Trees
Examples: Rhizophora, Avicennia, Sonneratia, Bruguiera

- CO_2 absorption: 50–80 kg/year
- O_2 production: 35–60 kg/year

Notes: Exceptional carbon sinks; crucial for coastal regions.

7. Shrubs and Small Trees
Examples: Bougainvillea, Hibiscus, Cassia fistula, Indian coral tree

- CO_2 absorption: 5–15 kg/year
- O_2 production: 3–11 kg/year

Notes: Smaller biomass but valuable for urban greening.

Data of E-Vehicles:

As of October 2025, India has witnessed a significant surge in electric vehicle (EV) adoption, with total sales reaching approximately 2.17 million units between October 2024 and September 2025.This marks a substantial increase from the previous year, reflecting a growing shift towards sustainable mobility.

EV Sales Breakdown by Category (FY 2024–25)

- Electric Two-Wheelers (E2Ws): Over 50% of total EV sales.
- Electric Three-Wheelers (E3Ws): Approximately 36% of total EV sales.
- Electric Passenger Vehicles (4Ws): Around 11% of total EV sales.

Monthly Sales Trends:

In September 2025, India recorded 181,760 EV sales, slightly down from 186,678 units in August 2025 but up from 159,425 units in September 2024, indicating a 14% year-on-year growth.

Data of E-Vehicles :

In One City, a total of 73,610 electric vehicles were registered in 2023, with December 2023 seeing a record 19.5% EV sales share of all vehicles sold. Sales in the first five months of 2024 totaled 4,016 EVs, though overall sales in the electric vehicle segment have declined.

- Total EV Sales in 2023: 73,610
- Record EV Sales in December 2023: 9,510 EVs, representing 19.5% of all vehicle sales for that month
- Total EV Sales (Jan-May 2024): 4,016

V. DISCUSSION

The analysis shows that India's emissions are energy-dominant, with transport and industries adding substantial local burdens. Kolhapur’s foundry sector, vehicular density, and energy use are significant contributors. Adoption of renewable energy, electric vehicles, and tree plantation can mitigate emissions effectively. Reforestation of 82,600 hectares of unused cultivable land could sequester approximately 1.8 million tonnes of CO_2 annually.

VI. SUGGESTION FOR CO_2 REDUCTION

1. Carbon Trading Systems: Implement carbon markets like 'Vantara' to offset industrial and vehicular emissions.

2. Electric Mobility Expansion: Subsidize EVs, install city-wide charging stations, and promote e-public transport.

3. Urban Green Infrastructure: Develop rooftop gardens, green corridors, and urban forests.

4. Renewable Energy Integration: Mandate solar rooftops in commercial and residential zones.

5. Waste-to-Energy Systems: Encourage methane capture and energy recovery from waste.

6. Public Participation: Launch awareness campaigns for sustainable living and green commuting.

7. Policy Reinforcement: Align municipal plans with India's National Clean Air Programme (NCAP).

VII.CONCLUSION

This study concludes that smart cities must balance technological growth with environmental responsibility. Energy and transportation dominate emission profiles; hence, integrating renewables, promoting EVs, adopting carbon trading, and restoring green spaces can significantly reduce CO_2 emissions. Kolhapur's model demonstrates how localized interventions can scale to national sustainability goals.

VIII. REFERENCES

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2) ECOSHIELD CONCRETE: ADMIXTURE TO RESIST ALGAE

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Abstract. In rainy and shaded areas, normal concrete gets full green algae and moss within a few months. This algae holds water on the surface, creates hair cracks and spoils the look of the structure. In this project we mixed Titanium Dioxide (TiO_2) powder in concrete to stop this problem. We tried 0%, 2%, 4%, 6% and 8% TiO_2 by weight of cement in M20 concrete cubes. After 28 days we checked compressive strength and then kept the broken cubes outside in open air for natural algae growth. Strength was highest at 4% and algae was almost zero at 8%. The best balance came at 6% TiO_2 — we call this the sweet point. So 6% TiO_2 gives good strength + excellent algae resistance. This concrete can be used for boundary walls, footpaths, water tanks etc. with very less maintenance.

Keywords: TiO_2, algae resistant concrete, self-cleaning concrete, compressive strength, sweet point

Introduction

Concrete in open environments in India is constantly battered by intense sun and prolonged rainfall, and this combination often encourages the spread of algae and moss on exposed surfaces. After the monsoon, the lingering dampness on walls, pavements, and facades creates ideal conditions for biological films that stain the surface and slowly contribute to deterioration, driving owners toward frequent cleaning and repair. Conventional responses like brushing, pressure washing, or using chemical biocides tend to give only short term relief, demand considerable labour, and quickly become impractical when applied to large structures or broad architectural fronts.To move beyond these short lived measures, recent work in materials science has turned toward nanotechnology, especially the addition of titanium dioxide particles to cement based mixes.Titanium dioxide acts as a photocatalyst that, under ultraviolet light from sunlight, generates reactive species capable of breaking down organic pollutants and microbial deposits that would otherwise support moss and algae on the concrete surface. In effect, the treated concrete acquires a kind of self cleaning action, where rainwater and wind help remove the degraded residues from the surface.

In this study, the focus is on developing an Ecoshield concrete formulated with a controlled dose of titanium dioxide and then examining its behaviour outside the laboratory Trial panels and elements were exposed to natural weather, including high humidity, temperature swings, and driving rain, so that the performance of the mix could be judged under conditions similar to those of a typical Indian monsoon season.The objective was to determine whether this approach could reliably limit biological growth and reduce maintenance demands over time in real service environmen

[1] Chen, J., & Poon, C. S. explained complete theory of photocatalysis. They proved that anatase TiO_2 when mixed or coated on concrete can degrade organic stains and NOx gases

under normal UV-A light without reducing compressive strength of concrete. [2] Li, D., Zheng, J., & Guo, Y. The authors investigate the influence of nano-TiO_2 addition on the mechanical properties of cementitious composites. Results reveal that strength and long-term durability increase significantly up to an optimal nano-TiO_2 content, beyond which particle agglomeration occurs, leading to diminished performance. The study identifies the ideal dosage range for maximizing benefits. [3] Murthy,et al. This research examines how nano-TiO_2 affects key engineering properties of concrete. Findings indicate notable improvements in compressive strength, a marked reduction in water permeability, and enhanced overall durability, positioning nano-TiO_2 as a valuable multifunctional additive for high-performance concrete applications. [4] Zijiang, Z., & Zhenhua, D. The paper assesses the self-cleaning capability and photocatalytic activity of cement mortars containing different percentages of TiO_2 under natural and artificial light exposure. The results highlight a clear dosage-dependent response, with moderate TiO_2 contents delivering the best balance between pollutant degradation efficiency and surface cleanliness over extended periods. [5] Guo, M. Z., et al. An experimental investigation reveals that an optimal nano-TiO_2 content refines the internal microstructure of cement paste, increases overall density, and significantly lowers chloride ion penetration depth. These microstructural enhancements translate directly into improved long-term resistance against aggressive environmental agents. [6] Sharma, R., & Patel, P. The researchers report that incorporating up to approximately 4% nano-TiO_2 by weight boosts both mechanical strength and surface whiteness of cement-based materials. The whiter appearance, combined with heightened photocatalytic activity, markedly enhances the self-cleaning effect, making it particularly suitable for architectural applications. [7] Folli, A., et al. This work elucidates the role of TiO_2 particles embedded within cement matrices in removing nitrogen oxides from the atmosphere under real outdoor conditions. The authors detail reaction pathways, long-term efficiency, and durability, confirming sustained photocatalytic performance and contributions to urban air quality improvement.[8] Lucas, S. S, et al. A comprehensive analysis of nano-TiO_2's influence on mortar microstructure shows pore refinement, reduced capillary absorption, and superior resistance to discoloration and biological growth. These changes result in materials that remain visually cleaner and structurally sounder over extended service life. [9] Cassar, L. One of the pioneering studies on photocatalytic cement, this paper presents foundational concepts and early field examples of TiO_2-containing building materials. It quantifies reductions in surface soiling and atmospheric pollutants, demonstrating the real-world viability of self-cleaning facades in urban environments. [10] Hüsken, G. et al. The authors conduct systematic tests on TiO_2-modified precast concrete elements, emphasizing the importance of surface exposure and binder composition. Optimal formulations are identified that maximize both de-pollution capacity and self-cleaning behavior while maintaining mechanical integrity. [11] Pacheco-Torgal, F. et al. This review paper synthesizes existing knowledge on nanomaterials in eco-efficient concrete, with special attention to nano-TiO_2. It highlights consistent evidence of enhanced durability, significant NOx abatement, improved self-cleaning properties, and refined microstructure, reinforcing the role of nano-TiO_2 in sustainable construction.

1 Objectives of the study

The primary objective of this study was to develop a type of concrete that effectively resists the growth of algae through the addition of titanium dioxide (TiO_2) as an admixture, while specifically evaluating its performance when exposed to actual outdoor environmental conditions, with a particular focus on the challenging monsoon season.In addition, we aimed to investigate the effects of varying TiO_2 dosages on key properties such as compressive strength and overall surface characteristics. Furthermore, the research sought to assess the practical applicability of this Ecoshield concrete for construction sites, its safety with respect to environmental impact, and its economic viability considering long-term cost benefits compared to traditional maintenance approaches.

2 Methodology

3.1 Materials Used
The materials included Ordinary Portland Cement (OPC 43 Grade), clean river sand serving as the fine aggregate, 20 mm crushed angular coarse aggregate, potable water, and laboratory-grade anatase titanium dioxide (TiO_2) powder.

3.2 Mix Proportions
We prepared five different M20 grade concrete mixes, incorporating TiO_2 at levels of 0% (as the control mix), 2%, 4%, 6%, and 8% by weight of cement. For each mix proportion, three cubic specimens were cast to ensure reliable testing data.

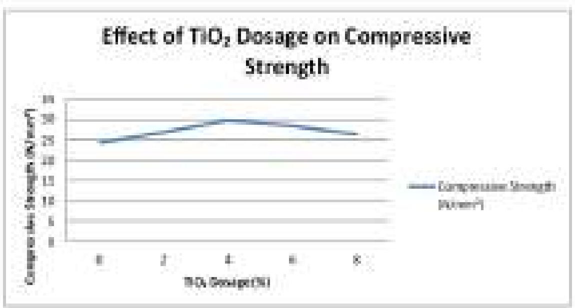
3.3 Mixing Procedure
The process began by blending the dry materials together first. TiO_2 was then added gradually and mixed thoroughly to achieve even distribution. Water was introduced incrementally while using a laboratory mixer, ensuring a uniform mix without any lumps or uneven patches.

3.4 Casting and Curing
Fresh concrete was poured into 150 mm cubic molds and properly compacted using a vibrating table to remove air voids. The cubes were demoulded after 24 hours and subsequently cured by applying a membrane compound, all under rainy atmospheric conditions designed to simulate real field curing during monsoons.

3.5 Exposure to Environmental Conditions
Once curing was complete and initial strength tests conducted, the cubes were placed in open outdoor locations throughout the monsoon season. This allowed for the natural development and observation of algae growth across all faces of the specimens.

3.6 Mechanism of TiO_2
TiO_2 operates primarily as a photocatalyst. When exposed to sunlight, it generates reactive oxygen species that effectively break down organic materials like algae cells. This process prevents biological growth from adhering to the surface and promotes a self-cleaning effect over time.

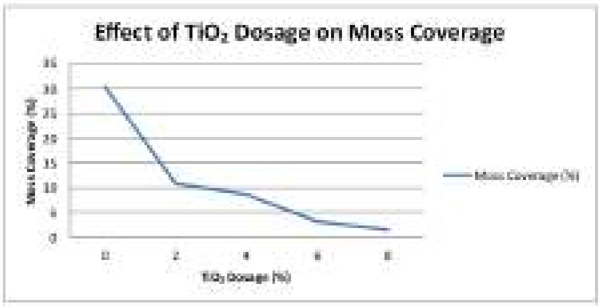
3.7 Compressive Strength Testing (Separate subsection for testing details)
After 28 days of membrane curing, the cubes underwent testing on a 2000 kN universal testing machine. Each specimen was positioned centrally between the loading platens, with load applied at 140 kg/cm²/min until failure. Compressive strength was determined as maximum load divided by the cube's cross-sectional area (150 mm × 150 mm), averaging results from three cubes per mix.



Graph 4.1 - Effect of TiO_2 Dosage on Compressive Strength

3.8 Moss Coverage Assessment via Image Analysis

Post-monsoon, high-resolution photographs of all six faces per cube were taken under uniform lighting. Using Imagesoftware, images were processed by converting to grayscale, applying color thresholding to detect green moss pixels (RGB green channel 0-100), and calculating coverage as (moss pixels / total pixels) × 100%. Measurements were replicated three times per face for precision.



Graph 4.2 – Effect of TiO_2 Dosage on Moss Coverage

Table No. 1 : Cube Summary.

TiO_2 Dosage (%)	No. of Cubes Casted	Purpose
0	3	Reference mix for comparison
2	3	Low dosage level
4	3	Optimum strength expectation
6	3	Optimum algae resistance expectation
8	3	High dosage to verify saturation effect

3 Results and Discussion

4.1 Compressive Strength

The 28-day compressive strength tests yielded the following average values from three cubes per mix:
0% TiO_2 (control): 24.3 N/mm²
2% TiO_2: 26.9 N/mm²
4% TiO_2: 29.6 N/mm² (peak value)
6% TiO_2: 28.4 N/mm²
8% TiO_2: 26.2 N/mm²
Strength improved progressively up to 4% TiO_2, likely due to the filler effect of fine particles enhancing hydration and densifying the matrix. Beyond 4%, a slight reduction was observed, possibly from TiO_2 agglomeration, though all modified mixes outperformed the control.

4.2 Algae Resistance (Moss Coverage)

Sample Images

Fig. 1. Sample Image Processing

Processed images

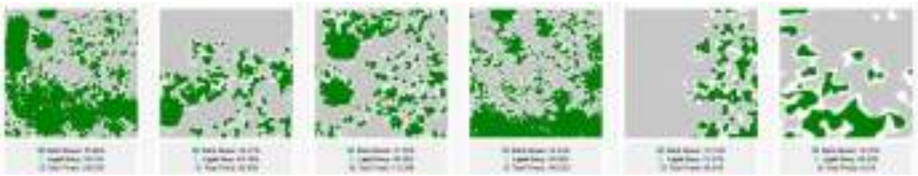


Fig. 2. Processed Image (0% TiO_2) = Avg. 30.35 % Moss Coverage

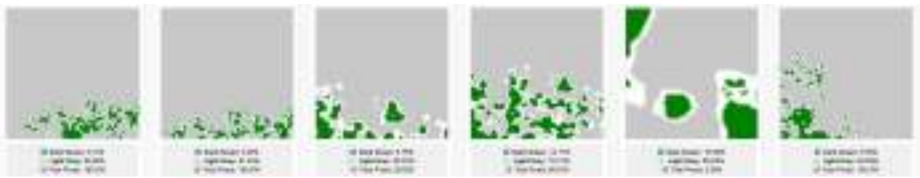


Fig. 3. Processed Image (2% TiO_2) = Avg. 10.86 % Moss Coverage

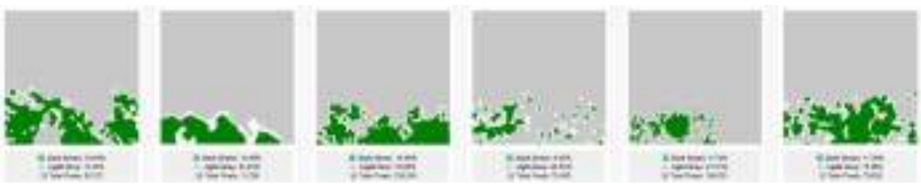


Fig. 4. Processed Image (4% TiO_2) = Avg. 8.61 % Moss Coverage

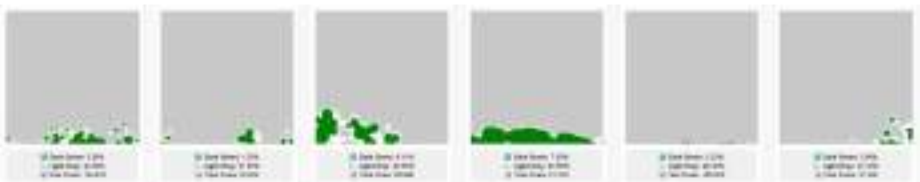


Fig. 5. Processed Image (6% TiO_2) = Avg. 3.21 % Moss Coverage

Fig. 6. Processed Image (8% TiO_2) = Avg. 1.57 % Moss Coverage

4.3 Surface Behaviour

Surfaces treated with higher TiO_2 dosages maintained remarkable cleanliness even after extended rain and high humidity exposure. Minimal staining or moss adhesion was evident, as the photocatalytic process rapidly degraded organic deposits and prevented their accumulation.

4.4 Discussion

These findings confirm TiO_2 enhances both mechanical strength and algal resistance. Strength peaks at 4%, while resistance improves up to 8%. Normalizing the data produced a “sweet score” metric, with the highest value at 6% TiO_2—offering the best overall balance. Real-world monsoon testing provided insights unattainable in labs alone. Key factors include proper mixing for dispersion and adequate sunlight exposure.

Table No. 2 – Compressive Strength (28 days)

Tio2 Dosage (%)	Avg. Compressive test in **N/m**	Remark
0	24.3	Base Strength without Tio2
2	26.9	Strength increased due to micro filler effect
4	29.6	Peak strength achieved
6	28.4	Slight reduction still higher than control
8	26.2	Decreased due to Tio2 agglomiration

Strength increased nicely up to 4% TiO_2 and reached maximum 29.6 N/mm^2. This happened because tiny TiO_2 particles filled the small holes and made hydration better. After 4%, strength came down a little because TiO_2 particles started making lumps and bonding became uneven. Still, even at 8% the strength is higher than normal concrete (control). So 4% is best for strength.

Table No. 3 – Moss Analysis

Tio2 Dosage (%)	Avg. Moss Coverage	Remark
0	30.35	Maximum algae growth observed
2	10.86	Noticeable reduction in growth
4	8.61	Significant improvement, strong resistance
6	3.21	Very high resistance, minimal algae presence

8	1.57	Highest resistance, negligible moss growth

Moss coverage reduced from 30.35% (normal concrete) to only 1.57% at 8% TiO_2. More TiO_2 means more particles on surface, so sunlight kills algae faster. At 6% moss is only 3.21% which is almost zero. This proves TiO_2 really works as self-cleaning agent in real monsoon weather.

4.5 Determination of Optimum Dosage

Normalized Strength *(S_n) = Actual strength ÷ Maximum strength (29.6)*
Normalized Moss Resistance (M_n) = 1 – (Actual moss % ÷ Highest moss %)

Sweet Score = (S_n + M_n) ÷ 2

Table No. 4 – Sweet point analysis

TiO_2 (%)	Actual Strength (N/mm^2)	S_n	Actual Moss (%)	M_n	Sweet Score
0	24.3	0.82	30.35	00	0.41
2	26.9	0.91	10.86	0.64	0.78
4	29.6	1.00	8.61	0.72	0.86
6	28.4	0.96	3.21	0.89	0.93
8	26.2	0.89	1.57	0.95	0.92

4.6 Interpretation of Sweet Point Results

From the sweet score table we can see that strength is highest at 4% but algae resistance keeps improving till 8%. At 4% the sweet score is 0.86 — good strength but still some algae visible. At 8% algae is almost gone (0.95 moss resistance) but strength dropped a little (0.89).

When take average of both, 6% gives the highest sweet score 0.93. This means at 6% lose only 1.2 N/mm^2 strength from the maximum but gain huge algae resistance (moss only 3.21%).

So 6% TiO_2 is the perfect balance strength is still very high (28.4 N/mm^2) and surface stays almost completely clean even after full monsoon exposure. This is why recommend 6% TiO_2 as the optimum dosage for Ecoshield Concrete in real construction.

4.7 Overview

Checked how TiO_2 changes concrete strength and algae growth in real monsoon weather.Strength went up nicely till 4% because tiny TiO_2 particles filled the small holes inside concrete and made hydration faster. After 4% strength came down a little because particles started making lumps and bonding became weak. Still, even at 8% strength is higher than normal concrete.

Algae side is totally different. More TiO_2 means more particles on the surface, so when sunlight falls, it kills algae faster. Moss dropped from 30% to just 1.5% at 8%. At 6% it is only 3%almost clean.

Sweet point table shows that 4% is best only for strength but algae is still there. 8% is best for algae but lose some strength. When take average of both, 6% gives the highest score (0.93). So lose only 1.2 N/mm^2 strength but gain huge algae resistance.This matches what Chen and Poon (2009) and Guo et al. (2014) said small amount of TiO_2 gives good results. Our outdoor test proves it works in real Indian rainy season also.So 6% TiO_2 is the perfect amount for Ecoshield Concrete strong enough for load and clean enough for good look for many years.

4 Material Characterization

Due to limited budget, we couldn't carry out advanced analyses like SEM (scanning electron microscopy) or XRD (X-ray diffraction). The specimens exposed outdoors during the monsoon picked up surface moss, which made them unsuitable for proper microstructural examination anyway. That said, the TiO_2's effectiveness was obvious through basic visual inspections—things like much lower algae coverage and noticeably cleaner surfaces on the treated cubes. These simple observations backed up the quantitative results from strength and coverage tests.

5 Durability and Environmental Impact

TiO_2 is chemically stable, non-toxic, and poses no risks to the environment. When used in concrete, it doesn't cause any ecological issues or leach harmful substances. The self-cleaning feature also means less frequent maintenance is needed, which helps concrete structures last longer overall and reduces the environmental footprint from repeated cleaning chemicals or labor.

6 Cost Analysis

Incorporating TiO_2 does raise the initial material cost a little mainly because it's more expensive than standard cement additives. However, this is offset by big savings down the road from much lower cleaning and repair bills. Fewer pressure washes, no harsh chemicals, and less frequent maintenance make Ecoshield concrete a smart, economical pick for long-term projects.

7 Limitations

We faced budget constraints that prevented advanced tests like SEM and XRD for microstructure analysis. Also, the outdoor specimens got covered in moss during monsoon exposure, making them unfit for those detailed studies. As a result, our conclusions rely mostly on visual surface observations and basic measurements rather than in-depth material characterization.

8 Future Scope

Looking ahead, future studies could include detailed microstructural analysis with SEM and XRD on cleaner samples. Long-term performance testing in various climates would be valuable too, along with fine-tuning the optimal TiO_2 dosage. Combining controlled lab experiments with extended field trials could provide even stronger, more comprehensive results for real-world applications.

Conclusions

This study demonstrates that Ecoshield concrete with TiO_2 addition effectively reduces algae growth on surfaces while providing self-cleaning properties and maintaining acceptable mechanical strength. The optimal dosage of 6% TiO_2 strikes the best balance between strength gains and algae resistance. Overall, the material proves sustainable, environmentally safe, and cost-effective over time showing strong potential for use in humid, monsoon-heavy regions.

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3) PERFORMANCE EVALUATION OF RECYCLED CONCRETE USING HUMAN HAIR AS FIBER REINFORCEMENT

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Abstract. Waste has the most impact on the environment in developed India. Byusing the waste material in concrete,alargenumberofresearchersareinvestigatingnovelapproachesandideasforinnovationinthefield of concrete technology. The purpose of this studyis to recycle aggregate (RA) from construction demolition sites by using human hair waste from salons to substitute natural aggregate (NA). Fiber reinforced concrete and partially mixed recycled material with varying percentages of 0%, 25%, 50%, 75%, and 100% by total weight ofconcretein Kg/m^3arethemain applications for M20(1:1.5:3) grade concrete. Check the concrete's performance in this regard by conducting a compressive test on 10 cubes. Thus, add 2 cm of human hair (fiber)indifferentpercentages(0.5,1%,1.5%,and2%), cast40 cubes, andteston CTM. Theentire50 cubes are cast, with 25 cubes curing for 7 days and the remaining cubes staying for 28 days. The experimental findingsdemonstrate that concrete containing human hair and recycled aggregate (CDW) has both strength. Withastrengthofalmost100%NA,theresultsshowthat50%RAand5%NAareappropriateforsustainable construction. It is alsonotedthat adding human hair as fiberreinforcement boosts the concrete's compressive strength by 0.85% and 1.57%, respectively, with 0.5% and 1% of the concrete's total weight.

Keywords:Humanhair,recycleaggregate,compressivestrength,sustainabledevelopment.

1 Introduction

The infrastructural development of global nations are mostly influenced by the construction industry. the construction industryis a significant contributor tothe environmental burden caused byvarious streams of solid and fluid-based wastes. One of the most common solid wastes generated during the Construction, Demolition, and Renovation Wastes (CDRW). Recycled concrete aggregate (RCA), commonly referred to as recycled concrete, is an economical and environmentally friendly substitute for conventional concrete. For achieving sustainability, Fibers are added to concrete to improve its flexural strength and ductility, control and decrease cracking, and increase overall toughness and durability. Steel, glass, natural, and synthetic fibers are among the fibers usedin concrete.naturalfiberderivedfromagriculturalwasteproductssuchassugarcaneash,bambooash, whet ash, and coconut shell ash.

LiteraturesReviews

Humanhaircontainsbetween45%and51%carbonbymasssinceitisanaturalfiber.Humanhairisaconstruction material it's have long history in Egypt Mudbricks have traditionally been made by combining horsehair and mortar[1].NowdayshairfiberreinforcedconcreteofM20gradewith0%,0.5%,1%,1.5%,and2%hair addition by weight of cement are gives good results [2]. also concrete cubes and cylinders of M30 grade [3] and M-40 grade used for plain cement concrete [4]. Anther use Hair Fiber concrete Solid 3D shapes, chambers, and light emissions sizes were examined with varying rates of human hair fiber expansion, and the outcomes were com-paredtothoseofmid-rangegradeplainconcretecement.thisconcreteissuitableforsustainableconstruction [5]. Achieving sustainability addition of RCA affects the concrete's strength, this study's 28-day cube compressive strengthshowsthat100%substitutionofnaturalaggregatescan saveupto16%incosts. Additionally, usingPSC rather than OPC can save costs by up to 29% [6]. performance of concrete made with recycled aggregate (RA) utilizingdurabilityindexesasindicators.Atages3,7,28,and56days,durabilityindices,includingwater,oxygen permeability, and chlorideconductivity, were measured for three distinct concrete mixes that contained 0%, 50%,and100%RA.Thematching OPI statisticshowed a37.6%increase [7]. Theimplicationsof basicchanges in all aggregate qualities on concreting work are extensively examined. In a similar manner, recycled aggregate concrete's characteristicsarealso established[8]. Concretewith 0%, 20%, 50%,and100%RA was produced by substituting portions of the natural aggregate in the RA series. The results indicate that the properties of RA are significantlyinfluenced bythekindofcementandthedesignoftheconcretemix[9].Anumber ofobstacleshave been identified after a thorough analysis and evaluation of the worldwide released data on recycled aggregate standardsofdifferentnations[10].theoverallenvironmentaleffectsarecontingentonthetransportationdistances andmodesoftransportation ofbothrecycled andnaturalaggregates. Calculated for theparticular case study, the limit natural aggregate transport distances at which the environmental impacts of RA can be comparable to or even less than those of NA [11]. Since there are situations in which their cost is less than that of items created from traditional building materials, the selling price is not a barrier to the market's use of RCA. [12].

2 Methodology

MaterialCollections

Aggregate–

Concrete is mixture of various materials like cement, aggregate& sand. collect a construction demolition waste (recycle aggregate) from demolitionsite, it’s replace only Natural aggregate.size of Recycle Aggregate (RA) aretypicallyretainedona4.75mmsieve.NaturalAggregate(NA)Aggregatesaretypicallyretainedon a 4.75mm sieve. Shapeandtextureshould be angular andrough,Theymust be freefrom adherent coatings, clay lumps, and organic matter. Dust or silt can weaken the bondbetween aggregate and cement paste.

Sand–

Sandisagranularmaterialwithpropertiesincludingitsparticlesize(typically\(0.063\)mmto\(2.0\)mm),shape, and distribution, which affect its density and permeability. Sand must be free from adherent coatings, organic impurities, clay lumps, and shale. Should be low (typically < 2-3%) to avoid absorbing water needed for hydration.

Cement

OPC or PPCisgenerallyrecommended. Goodfinenessisrequiredfor earlyhydration, promotingfaster strength gain. Must pass soundness tests to prevent volume changes after setting.

HumanHair

humanhairiscollectedfromgent’ssalon.Selecthairwhichhavelessthan2cmlength,morethan2cmlengthof Hair is recycle. Selected should have black colour, dryand clean.

MixingorCasting

PreparationofconcretewithRA&withoutfiber(humanhair)–

Generally M20 (1:1.5:3) grade of concrete is used for fiber reinforced concrete. before selecting a material cast theconcretecubeswithstandarddimensions(15cmx15cmx15cm),cast10cubesinthat5cubesfor7dayscuring & 5cubes for 28days curing. Partiallyreplace Natural Aggregate(NA)toRecycle Aggregate (RA) with deferent proportion as follows. Table no.1show detail specification of this step.

I. 100%NaturalAggregate(NA)ofweightconcreteinKg/m^3
PrepareM20gradeofconcretemixtureofsand,cement&Aggregatewith0.45watercementratio.Take28days &7daycuringfor twocube,after 0%moisturecondition testthecubeinCTM.

II. 100%RecycledAggregate(RA)ofweightconcreteinKg/m^3
PrepareM20gradeofconcretemixtureofsand,cement&Aggregatewith0.45watercementratio. Buttotally replace the aggregate to CD waste (recycle Aggregate).

III. 75%RA&25%NAofweightconcretein Kg/m^3
PrepareM20gradeofconcretemixtureofsand,cement&Aggregatewith0.45watercementratio.But75% replacetheaggregatetoCDwaste(recycle Aggregate) bytotal weight ofaggregate.

IV. 50%RA&50%NAofweightconcretein Kg/m^3
PrepareM20gradeofconcretemixtureofsand,cement&Aggregatewith0.45watercementratio.But50% replacetheaggregatetoCDwaste(recycle Aggregate)bytotal weight ofaggregate.

V. 25%RA&75%NAofweightconcretein Kg/m^3
PrepareM20gradeofconcretemixtureofsand,cement&Aggregatewith0.45watercementratio.But25% replacetheaggregatetoCDwaste(recycle Aggregate)bytotal weight ofaggregate.

4) USE OF RICE HUSK ASH AND WATER HYACINTH FIBERS FOR BRICK MANUFACTURING

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*Abstract :*The current study present an enhanced mix proportions for eco-friendly brick developing approach that used Rice Husk Ash (RHA) and Water Hyacinth Fibers (WHF) as partial replacement of soil. The main goal of this work is to reduce environmental waste and make eco-friendly bricks for light weight structure. In this study, bricks are produced by replacing soil with 10%, 20%, and 30% proportions of RHA and WHF separately, and their performance is evaluated by compressive strength and water absorption test. The study shows that bricks containing 10% replacement of either RHA or WHF shows best results, and also bricks showed lower water absorption and optimum compressive strength making them useful in light waste structure. This modified method shows how agricultural and aquatic waste materials can be successfully used in sustainable brick manufacturing.

I. INTRODUCTION

The construction industry today is expanding rapidly, and with that building material like bricks in high demand. However the manufacturing of bricks cause lot of pollution. At the same time, agriculture produce lots of waste, which is usually burned or decomposed.

This project is developing an approach by producing bricks that are both cost-effective and environmental-ly friendly by using Rice Husk Ash (RHA) an agricultural waste and water Hyacinth Fibers (WHF) a rapidly growing plant in water. By using this waste material, we can make bricks environment friendly and cut down the manufacturing cost and make it more economical. The purpose of this study is to see how bricks are react when they replaced with RHA and WHF in different proportion. The study focuses on key properties like compressive strength and water absorption.

I.I.Rice Husk Ash (RHA)

When rice husk is processed to separate the grains from husk, about 20% of the total weight of the rice is turned into husk waste. Rice husk is a byproduct of rice. Rice husk ash (RHA), a byproduct composed of amorphous silica (SiO_2), is produced when husk is burned under controlled temperature(between 600ºC to 700ºC)

In brick manufacturing, RHA is frequently used as soil replacement. RHA is used for thermal insulation, reduce the weight of bricks, and to improve compressive strength. Bricks become lighter and cheaper option as a result. Maintaining a proper ratio is important since using extra RHA can increase water absorption and decrease binding. By recycling waste from agriculture into a useful building material, use of RHA not only improves the mechanical properties of bricks but also helps in waste management.

I.II.Water Hyacinth Fibers (WAF)

Water hyacinth (Eichhornia crassipes) is a fast-growing aquatic weed commonly found in ponds, lacks, and rivers. Though it poses serious environmental problems by chocking waterways, it contain fibrous stem rich in cellulose, hemicellulose, and lignin, making it suitable for use an a natural reinforcement material.

When processed and mixing with soil or clay, WAF can improve the crack resistance of bricks. The fibers act as a micro-reinforcement, holding the particles together and minimizing shrinkage cracks during drying and curing. Moreover, they make bricks lighter in weight, provide better thermal insulation, and contribute to eco-friendly construction by reducing dependence on non-renewable materials.

II. NEED OF THE STUDY.

1.Future research may examine the use of different ratios of rice husk ash (RHA) and water hyacinth fibers(WHF) for bricks manufacturing.

2.To get a more information about bricks performance different test can be conducted, like thermal conductivity, efflorescence, and durability over time under different weathering conditions.

III. RESEARCH METHODOLOGY

III.I Materials Used

1. Soil: Locally available clayey soil was used as the primary binding material. The soil was sieved through a 4.75 mm sieve to remove impurities such as stones, roots, and debris.

2. Rice Husk Ash (RHA): Rice husk ash was obtained by controlled burning of rice husk at a temperature range of 600°C–700°C to ensure the presence of amorphous silica. The ash was sieved to achieve uniform particle size.
3. Water Hyacinth Fibers (WHF): Extracted from dried stems of the water hyacinth plant, cut into 1–2 cm pieces.
4. Sawdust and Bagasse: Used to make the bricks lighter and improve insulation.

III.II Mix Proportion

Bricks were made in the following proportions:

1. For RHA: Soil + Sawdust + Bagasse + 10%, 20%, and 30% RHA
2. For WHF: Soil + Sawdust + Bagasse + 10%, 20%, and 30% WHF

III.III Preparation of Bricks

1. Mixing: All dry materials were mixed thoroughly in a pan mixer to achieve uniform distribution. Water was gradually added (approximately 20–25% by weight) to obtain a homogeneous and workable mix.
2. Molding: The prepared mix was placed into standard brick molds of size 190 mm × 90 mm × 90 mm. Manual compaction was applied to remove air voids and ensure proper shape.
3. Drying: Bricks were shade-dried for 24 hours and then sun-dried for 5–7 days.
4. Firing: To increase their durability and hardness, dried bricks were burned in a kiln at 700ºC to 900ºC.
5. Cooling: Before testing, fired bricks are kept for natural cooling.

III.IV Tests Conducted

1.Compressive Strength Test: The force is applied on brick until failure is done on compressive testing machine (CTM)

$$Compressive\ Strenght = \frac{Maximum\ Load(N)}{Area\ of\ Brick(mm^2)}$$

2.Water Absorption Test: First oven dried bricks weight is taken(W_1) then bricks are kept in water for 24 hours and weighted again(W_2)

$$Water\ Absorption = \frac{W_2 - W_1}{W_1} \times 100$$

IV. RESULTS AND DISCUSSION

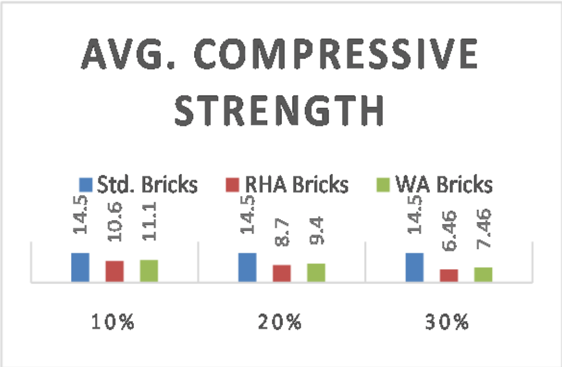
4.1 Results of test

Table 4.1: Results of avg. compressive strength and avg. water absorption test

Brick Type	% Addition	Avg.Compressive Strength	Avg.Water Absorption (%)
Standard Brick	0	14.5	19.02
RHA Brick	10	10.6	13.82
RHA Brick	20	8.70	15.90
RHA Brick	30	6.46	19.60
WA Brick	10	11.1	13.2
WA Brick	20	9.40	15.58
WA Brick	30	7.46	18.70

Bricks made with rice husk ash (RHA) and water hyacinth fibers(WHF) have little lower compressive strength than regular bricks. But in this study , the changed bricks have multiple benefits, like decreased weight, cheaper production cost, less water absorption and environmental friendly. They are suitable for condition where very high strength is not required because their compressive strength is in between 10 to 11 N/mm^2. Also, these bricks showed less water absorption than regular bricks, improving their water resistance. The use of commonly available waste materials in the replacement of soil is primarily responsibly for lower cost.

Overall, the modified bricks are still very good fit for light weight structure, non- load bearing structure like compounds walls, pavement blocks, tiles and landscaping purpose. Also, using them promotes sustainable building practices, waste reduction and cost savings.



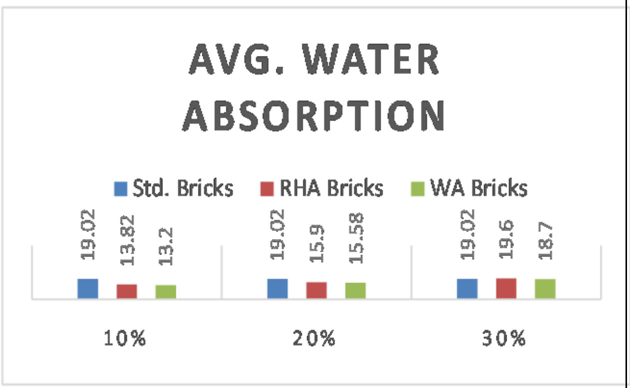


Fig. No. 4.1: Comparison between Avg. Compressive Strength

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5) STUDYOF DEWATERING AND STABILIZATION IN SLUDGE TREATMENT CONSTRUCTED WET LAND

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Abstract : The study focuses on dewatering and stabilization of sludge using constructed wetland system. To improve filtration and aeration, a model was built using PVC barrels filled with layers of coarse and fine aggregates. When the caster plant was first tested, it was unable to survive in sludge. Colocasia esculenta, which shown good growth and adaptability, was adopted later. By promoting natural treatment through plant uptake and microbial activity, the built wetland effectively decreased sludge moisture and improve stabilization. The method showed a low cost environmentally friendly sludge management option that would promote sustainability and reduce its impact on environment.

IV. INTRODUCTION

In order to protect both human and the environment, waste water treatment is an important process. Sludge develops in huge amount as a by product of waste water treatment. This sludge needs further treatment before it can be safely disposed or reused since it includes both organic and inorganic particles and it contains a high moisture level. Sludge can cause odour issues, pollutes groundwater, and spread harmful bacteria when it is stored or disposed poorly.

Traditional sludge treatment method includes centrifuges, filter presses, and drying beds have number of problems. They are less suitable for small treatment plants because of their high energy requirement, continuous maintenance needs, and high cost of operation. As a result, there is a increasing demand for affordable and environmentally friendly sludge management.

Using constructed wetlands, which are designed systems that replicate the natural wetland process, is a good example. Sludge dewatering and stabilization being by the combined action of plants, soil, and bacteria in constructed wetlands. The bacteria helps in the decomposition of organic matter, the roots provide aeration, and the plants helps in evapo-transpiration.

In this study, sludge treatment constructed wetland was created using PVC barrels that were filled with coarse aggregates for aeration and drainage. The caster plant was initially chosen, but it was unable to survive in the sludge. Colocasia esculenta, which showed better growth and adaptability in sludge.

V. OBJECTIVE

1. To design and develop pilot scale sludge treatment constructed wetland model.
2. To study the performance of caster as wetland plant in sludge dewatering and stabilization.
3. To study growth of wetland plant i.e. Colocasia esculenta in STCW.

VI. RESEARCH METHODOLOGY

III.I Collation of materials

Before the setup is done all the materials are needed to collected. To get removal of pollutants, coarse aggregate of 30mm, 20mm, and 6mm were collected, cleaned, and dried. To design pilot scale units two PVC barrels were chosen. To keep the medias oxygen supply constant, holes aeration pipes were made. In order to ensure that the sludge used in the study represented typical municipal sludge, it was collected from local sewage treatment plant.

III.II Preparation of the Constructed Wetland Units.

A 1meter tall cylindrical PVC container used to create a small manmade wetland. To collect drained water for later observation, a tap was fitted at the bottom. To promote airflow and root oxygenation, two vertically placed aeration pipes with holes were placed inside the barrel.

Three separate layers made inside the barrel:

- First layer: 15 cm of 30 mm coarse aggregate for drainage
- Second layer: 10 cm of 20 mm aggregate for filtration
- Third layer: 15 cm of 6 mm fine aggregate for rooting and support

Each layer was compacted lightly to avoid settlement.

III.III Plant Selection and Establishment

The study began with caster plant. However, due to its poor survival in sludge, it was replaced by Colocasia esculenta, a plant known for its tolerance to wet and nutrient-rich environments.

The plants were placed in the top layer and watered regularly for around 20 days to help them develope strong roots. During this period, no sludge was added.

III.IV Loading of Sludge

After plant development, raw sludge collected from the STP was added to the wetland system in controlled quantities to avoid overloading. The sludge was poured slowly over the media surface to allow uniform distribution. The loading was done in batches to study the response of the plant and the filtration media. Water draining from the tap at the bottom was collected to observe changes in colour, odour, and consistency.

III.V Regular Monitoring and Maintenance

The system was monitored daily to observe:

1. Plant growth and survival
2. Moisture reduction in sludge
3. Condition of drained liquid
4. Any signs of clogging or media settlement

Photographs were taken time to time, to track the development of Colocasia esculenta and sludge behaviour. The moisture content of the sludge were regularly checked to determine the progress of dewatering.

III.VI Analysis of Sludge Before and After Treatment

Raw sludge and treated sludge samples were collected for comparison. The following parameters were examined:

1. Moisture content
2. Texture and colour
3. Odour reduction
4. Presence of stabilized organic matter

These observations helped understand how effectively the constructed wetland system removed water and supported natural stabilization.

III.VII Evaluation of System Performance

The performance of the constructed wetland was judged based on:

1. Reduction in sludge volume
2. Improvement in sludge quality
3. Plant health and growth rate
4. Rate of water drainage through the media

The overall efficiency was determined by comparing initial and final sludge characteristics along with plant response.

Table No. 3.1 : Characteristics of raw sludge

CONTENT	1	2	3	4	5	6
Nitrogen	7.8	7.3	7.6	7.5	7.9	7.2
Phosphorus	10.2	9.7	9.3	9.8	10.1	8.9

Potassium	0.8	0.8	0.7	0.8	0.9	0.8
pH	7.94	6.84	7.27	7.8	7.7	7.8
BOD	60	62	58	64	62	61

Table No. 3.2: Characteristics of processed sludge

CONTENT	PERCENTAGE
Nitrogen	40.73
Phosphorus	12.65
Potassium	-
pH	7.2
BOD	54

IV. RESULTS AND DISCUSSION

The wetland system is built for reduce excess water from sludge and improve stabilization. The Colocasia esculenta plant showed good growth and adaptability, improving aeration and natural filtration. Sludge quantity reduced and quality is improved in layered aggregate for proper drainage. All this things considered, the system turned out to be an easy, affordable and sustainable for sludge management.

Constructed wetlands are an efficient and sustainable way to stabilize the sludge. The pilot scale model showed how effectively Colocasia esculenta adapted to sludge and helped in the stabilization of organic materials. The overall effectiveness of treatment was improved by layered aggregate in drainage and aeration. Small scale waste water treatment can helpful in affordability, and sustainability when compared to traditional methods.

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6) Preparation ofconcrete with RA&NA withfiber(humanhair)-

casttheconcretecubeswithstandarddimensions(15cmx15cm x15cm),cast40cubesinthat20cubesfor7days curing&20cubesfor 28dayscuring.Partiallyadd0.5,1,1.5&2%offiber (humanhair)withdeferentproportion as follows. Table 2,3,4 & 5 show detail specification of this step.

- 100%NaturalAggregate(NA)ofweightconcreteinKg/m^3+0.5,1,1.5&2%offiber PreparefivecubeofM20gradeofconcretemixtureofsand,cement&Aggregatewith0.45watercement ratio. In fivecubeonebyonemix0.5%,1%,1.5&2%humanhairbytotal weight ofconcrete.Take 28 days &7daycuringforten cube,after0%moistureconditiontestthecubeinCTM.

- 100%RecycledAggregate(RA)ofweightconcreteinKg/m^3+0.5,1,1.5&2%offiber Prepare4cubeM20gradeofconcretemixtureofsand,cement&Aggregatewith0.45watercementratio. Buttotallyreplacetheaggregatetoi CDwaste(recycleAggregate).In five cube onebyonemix0.5%,1 %,1.5&2%humanhairbytotalweightofconcrete.Take28days&7daycuringfortencube,after0% moisture condition test the cube in CTM.
- 75%RA&25%NAofweightconcreteinKg/m^3+0.5,1,1.5&2%offiber Prepare4cubeM20gradeofconcretemixtureofsand,cement&Aggregatewith0.45watercementratio. But75%replacetheaggregatetoCDwaste(recycleAggregate)bytotalweightofaggregate.In fivecube onebyonemix0.5%,1%,1.5&2%humanhairbytotalweightofconcrete.Take28days&7day curing for ten cube,after 0%moisturecondition testthecubein CTM.
- 50%RA&50%RAofweightconcreteinKg/m^3+0.5,1,1.5&2%offiber Prepare4cubeM20gradeofconcretemixtureofsand,cement&Aggregatewith0.45watercementratio. But50%replacetheaggregatetoCDwaste(recycleAggregate)bytotalweightofaggregate.In fivecube onebyonemix0.5%,1%,1.5&2%humanhairbytotalweightofconcrete.Take28days&7day curing for ten cube,after 0%moisturecondition testthecubein CTM.
- 25%RA&75%NAofweightconcreteinKg/m^3+0.5,1,1.5&2%offiber Prepare4cubeM20gradeofconcretemixtureofsand,cement&Aggregatewith0.45watercementratio. But25%replacetheaggregatetoCDwaste(recycleAggregate) bytotalweightofaggregate.In fivecube onebyonemix0.5%,1%,1.5&2%humanhairbytotalweightofconcrete.Take28days &7daycuring for ten cube,after 0%moisturecondition testthecubein CTM.

No	Aggregate contains	Haircon-tains	7 Days Curing Load	Strength	28 Days Curing Load	Strength
1.	RA-25% NA-75%	0%	293x10^3 N	13.01 N/mm^2	486x10^{3}N	21.6 N/mm^2
2.	RA-50% NA-50%	0%	313x10^3 N	13.91 N/mm^2	499x10^{3}N	22.18 N/mm^2
3.	RA-75% NA-25%	0%	280x10^3 N	12.44 N/mm^2	400x10^{3}N	17.8 N/mm^2
4.	RA-100% NA-0%	0%	249x10^3 N	11.08 N/mm^2	477x10^{3}N	21.2 N/mm^2
5.	RA-0% NA-100%	0%	314x10^3 N	13.98 N/mm^2	589x10^{3}N	26.18 N/mm^2

Table2.Recycledaggregate(RN)+NaturalAggregate(NA)+Humanhair(H1)

No	Aggregate contains	Hair contains	7 Days Curing LoadStrength		28 Days Load Strength	
1.	RA-25% NA-75%	0.5%	$291x10^3$N	12.94 N/mm^2	$399x10^3$N	17.73 N/mm^2
2.	RA-50% NA-50%	0.5%	$300x10^3$N	13.44 N/mm^2	$442x10^3$N	19.64 N/mm^2
3.	RA-75% NA-25%	0.5%	$260x10^3$N	11.56 N/mm^2	$437x10^3$N	19.42 N/mm^2
4.	RA-100% NA-0%	0.5%	$252x10^3$N	11.2 N/mm^2	$383x10^3$N	17.02 N/mm^2
5.	RA-0% NA-100%	0.5%	$315x10^3$N	14.00 N/mm^2	$460x10^3$N	20.44 N/mm^2

Table3.Recycledaggregate(RN)+NaturalAggregate(NA)+Humanhair(H2)

No	Aggregate contains	Hair contains	7Days Curing LoadStrength		28Days Load Strength	
1.	RA-25% NA-75%	1%	294x10^{3}N	13.10 N/mm^2	401x10^{3}N	17.80 N/mm^2
2.	RA-50% NA-50%	1%	303x10^{3}N	13.50 N/mm^2	446x10^{3}N	19.80 N/mm^2
3.	RA-75% NA-25%	1%	264x10^{3}N	11.75 N/mm^2	434x10^{3}N	19.30 N/mm^2
4.	RA-100% NA-0%	1%	249x10^{3}N	11.08 N/mm^2	384x10^{3}N	17.08 N/mm^2
5.	RA-0% NA-100%	1%	317x10^{3}N	14.09 N/mm^2	452x10^{3}N	20.40 N/mm^2

Table4.Recycledaggregate(RN)+NaturalAggregate(NA)+Humanhair(H3)

No	Aggregatecon-tains	Hairco n-tains	7Days Curing LoadStrength		28Days Load Strength	
1.	RA-25% NA-75%	1.5%	247x10^{3}N	11.01 N/mm^2	380x10^{3}N	16.9 N/mm^2
2.	RA-50% NA-50%	1.5%	281x10^{3}N	12.51 N/mm^2	419x10^{3}N	18.64 N/mm^2
3.	RA-75% NA-25%	1.5%	251x10^{3}N	11.16 N/□□^{2}	371x10^{3}N	16.5 N/□□^{2}

4.	RA-100% NA-0%	1.5%	$226x10^3$ N	10.5 N/□□2	$402x10^3$N	17.9 N/□□2
5.	RA-0% NA-100%	1.5%	$293x10^3$ N	13.02 N/□□2	$438x10^3$N	19.5 N/□□2

Table5.Recycledaggregate(RN)+NaturalAggregate(NA)+Humanhair(H4)

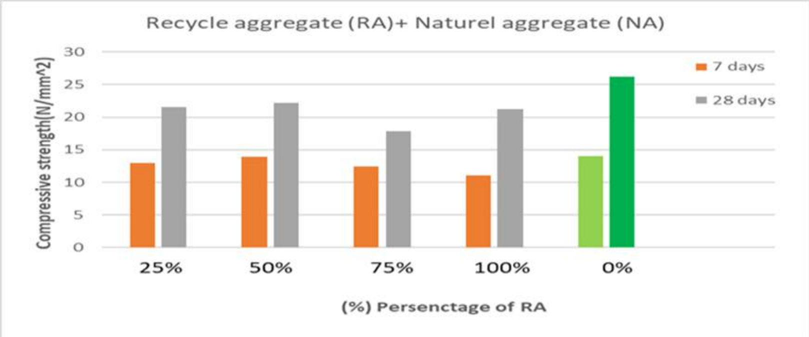
No	Aggregate contains	Hair contains	7Days Curing LoadStrength		28Days Load Strength	
1.	RA-25% NA-75%	2%	$114x10^3$ N	5.1 N/□□2	$213x10^3$N	9.5 N/□□2
2.	RA-50% NA-50%	2%	$155x10^3$ N	6.89 N/□□2	$226x10^3$N	10.08 N/□□2
3.	RA-75% NA-25%	2%	$121x10^3$ N	5.4 N/□□2	$240x10^3$N	10.7 N/□□2
4.	RA-100% NA-0%	2%	$132x10^3$ N	5.89 N/□□2	$225x10^3$N	10.01 N/□□2
5.	RA-0% NA-100%	2%	$157x10^3$ N	7.02 N/□□2	$258x10^3$N	11.5 N/□□2

3 Discussions

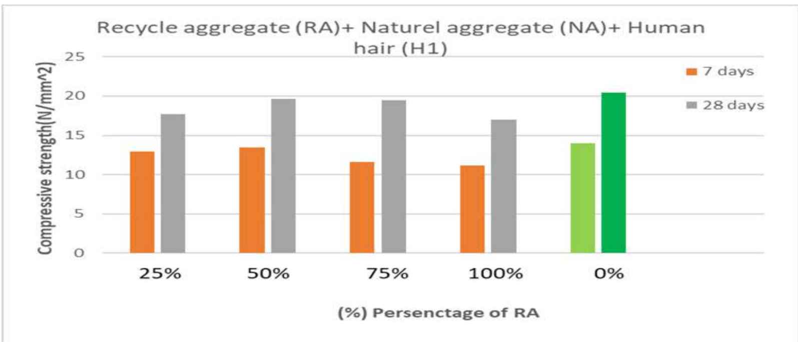
1. 50%recycled aggregateinM20gradeofconcrete byweightofNaturalaggregates,after 7days &28days curing it is give 13.91 N/□□2 & 22.18 N/□□2 strength respectively.

2. properlymix 1%human hairbytotalweight ofconcrete and50%recycle Aggregatebyweight ofNatural aggregates, after 7 days & 28 days curingit is give 13.50 N/□□2 & 19.80N/□□2 strength respectively.

3. From table no.1, concrete compressive strength is high for 100% natural aggregate as compare to other mix proportion.But whenadd50%recycledaggregateand50% naturalaggregateoftotal weightofconcrete(7.66kg) is found to be 13.91 N/□□2 & 22.18 N/□□2 respective to 7days &28 days this proportion is suitable for sustainable construction (see Fig. 1).

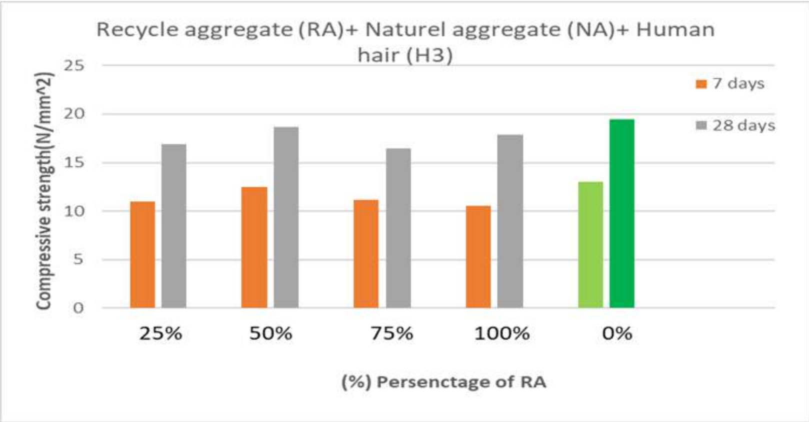


4. From table no.2, concrete compressive strength of mix H1in that 100% natural aggregate with 0.5% hair fiberis found tobe14.00N/□□2&20.44N/□□2respec-tiveto7days &28 days.7days curingstrength hasincreasedto 0.85%afteraddingwith0.5%haircontent(seeFig.2).

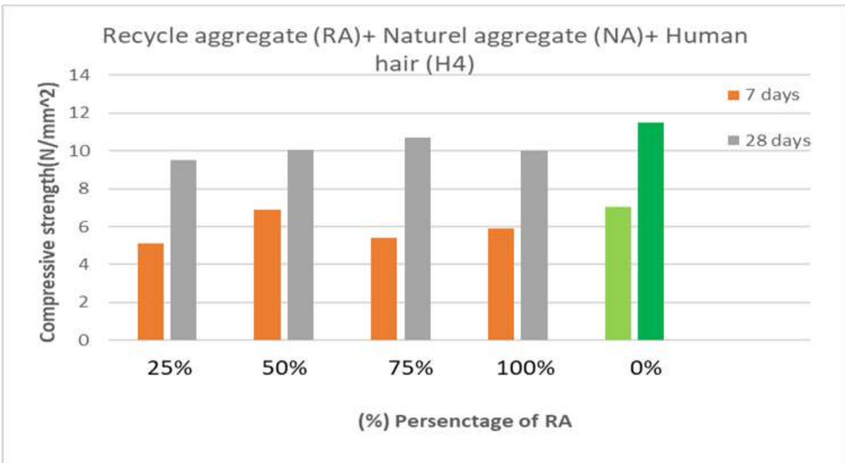


5. From table no.3, concrete compressive strength of mix H2in that 100% natural aggregate with 1% hair fiber is found tobe14.09N/□□2&20.40N/□□2respec-tiveto7days &28 days. 7days curingstrengthhasincreasedto 1.57%afteraddingwith1%haircontent(seeFig.3).

6. Fromtable no.4,concrete compressivestrengthofmixH3inthat100%naturalaggregate with1.5%hair fiberis found to be 13.2 N/□□2& 19.5 N/□□2 respective to 7days &28 days. 7 days curing strength has decreased to 5.57%afteraddingwith1.5%haircontent(seeFig.4).



7. From table no.5, concrete compressive strength of mix H4in that 100% natural aggregate with 2% hair fiber is foundtobe7.02N/□□2&11.5N/□□2respectiveto7days &28 days. 7 days curingstrengthhasdecreasedafter adding with 2% hair content (see Fig. 5).



4 Conclusions

8. Finallyresulttobe foundis proportionof50%RA&50%NAis give high compressivestrengthisnearto100% NA, this proportion is not only give high strength but also it achieve a sustainability.

9. Adding0.5%and 1%hair contain with50% RA&50%NAinM20(1:1.5:3) grade ofconcreteisgive high com-pressive strength is near to 100% NA.

10. Thisresearchisproperlyutilizetheconstructiondemolitionwasteandhumanhair.

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7) EXPERIMENTAL STUDY AND ANALYSIS OF FOUNDRY SAND & WASTE PLASTIC AS BINDING MATERIAL IN MANUFACTURING OF BLOCKS

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Abstract : We investigated substituting some of the fine aggregate in concrete blocks with waste plastic and foundry sand. We replaced fine aggregate with varying percentages of waste plastic and foundry sand, from 10% to 80%. Next, we evaluated the strength and performance of the concrete mixes.M20 grade concrete with a mix ratio of 1:1.5:3 and a water-to-cement ratio of 0.4 was used for the test. The process included sieve analysis, casting blocks, and testing their compressive strength after 7, 14, and 28 days. What we found was that some replacement levels gave us about the same or even better compressive strength compared to regular concrete blocks. The strength went up to a certain point, and then it started to drop. This is a good way to get rid of foundry sand and plastic waste, and it also helps with environmental issues related to landfills. So, it’s good for both building stuff and managing waste.

IndexTerms - Foundry sand, waste plastic, concrete block, compressive strength

I.INTRODUCTION

It can be used as a partial replacement of fine aggregate. In this investigation, fine aggregate has been replaced by foundry sand and Waste Plastic accordingly in the range of (10-80% at the interval of 10%). Concrete mixes were cost and tested for workability and compressive strength. If waste material like foundry sand and Waste plastic is used as construction material, it can help to reduce the amount of disposal material. Foundry sand and Waste Plastic consists primarily of silica sand, coated with a thin film of burnt carbon, residual binder (sea coal, resins) and dust. It can be used as a partial replacement of fine aggregate.

II.OBJECTIVE

1. Replacement of Foundry Sand and Waste Plastic to Fine Sand Partially Ways.

2. Test to Carried out Partially Replaced in Concrete Blocks.

3. Comparative Analysis between Conventional Concrete Block and Partially Replaced Concrete Block.

III. METHODOLGY

The systematic collection of raw materials, specifically waste plastic, foundry sand, crushed sand, cement, and coarse aggregates. The experimental design utilizes an M20 grade concrete mix as the baseline for comparison. A series of trial mixes are prepared by integrating waste plastic and foundry sand in varying proportions, ranging from 10% to 80% replacement levels.

The production phase involves casting conventional concrete blocks alongside the specialized experimental blocks. During manufacturing, the waste plastic acts as a binding agent to modify the block's properties. Once the blocks are cured, they undergo a rigorous testing and evaluation phase to measure structural integrity. The primary focus of these tests is to determine the ultimate block strength and load-bearing capacity.

Detailed mathematical calculations are performed to quantify the performance differences between the samples. Finally, a comprehensive data analysis is conducted to interpret the experimental results. This analytical phase leads to the final conclusion regarding the feasibility of using these waste materials in construction. The entire process aims to provide a sustainable alternative to traditional masonry units.

3.1. SIEVE ANALYSIS

Sieve analysis is a method that is used to determine the grain size distribution of soils that are greater than 0.075 mm in diameter. It is usually performed for sand and gravel but cannot be used as the sole method for determining the grain size distribution of finer soil. The sieves used in this method are made of woven wires with square openings. Sieve analysis which is used for particle sizes larger than 0.075mm in diameter.

Foundry Sand -1kg

Table no.1. Foundry Sand

Size	Weight
4.75 mm	10g
2.36 mm	10g
1.18 mm	15g
600 microns	140g
425 micros	175g
300 microns	520g
150 microns	35g
75 microns	70g
Pan	25g

Crushed Sand -1kg

Table no.2 Crushed Sand

Size	Weight
4.75 mm	159g
2.36 mm	285g
1.18 mm	250g
600 microns	180g
425 micros	25g
300 microns	29g
150 microns	19g
75 microns	19g
Pan	15g

IV. RESULTS AND ANAYSIS

For M20 Grade Ratio:- 1:1.5:3

Water cement ratio:- 0.4%

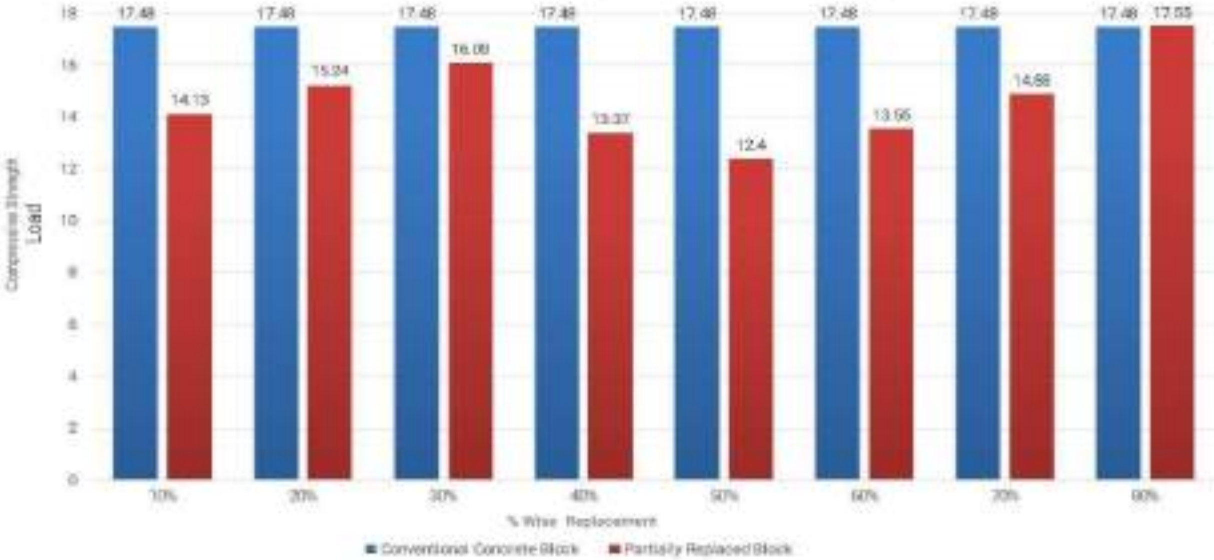
Table no 3. Compressive Strength Test on Conventional Concrete Block

Load (KN)	NO. Of Days.	Compressive Strength (N/mm²)
393.33kN	7days	17.48N/mm²
496.66kN	14 days	22.07N/mm²
520.00kN	28 days	23.11N/mm²

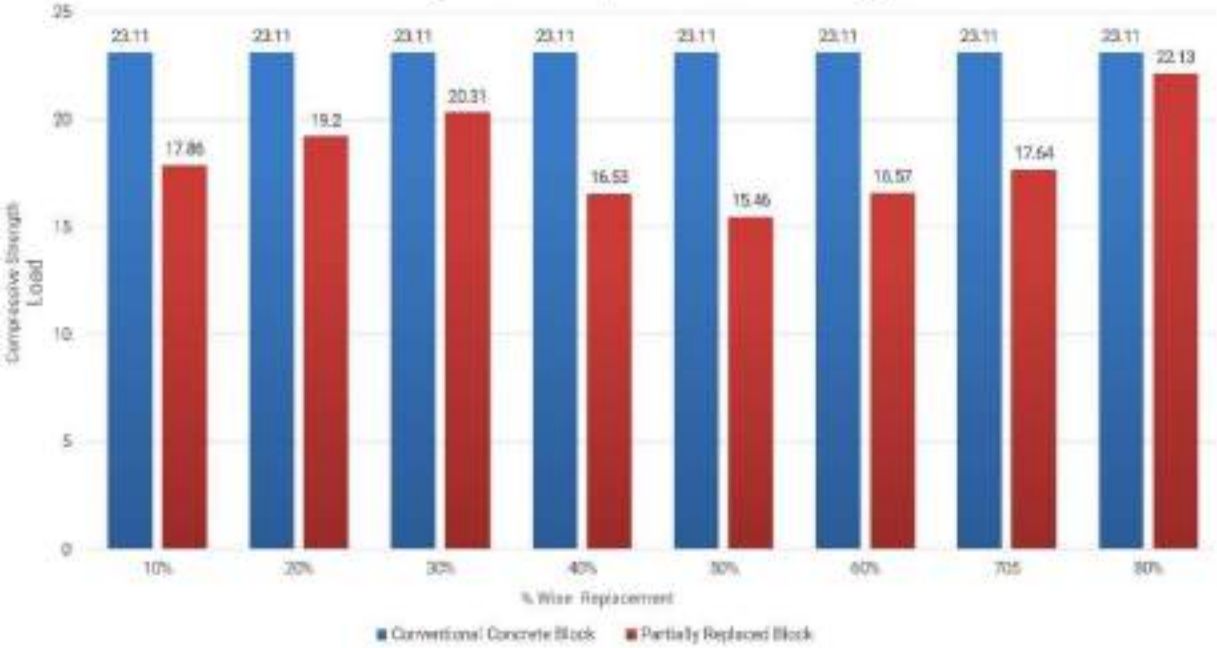
Table no 4. Compressive Strength Test on Partially Replaced Block

Foundry Sand And Waste Plastic (%)	7 Days	14 Days	28 Days
0%	17.48N/mm²	22.07N/mm²	23.11N/mm²
10%	14.13N/mm²	17.86N/mm²	18.84N/mm²
20%	15.24N/mm²	19.20N/mm²	20.22N/mm²
30%	16.08N/mm²	20.31N/mm²	21.33N/mm²
40%	13.37N/mm²	16.53N/mm²	17.37N/mm²
50%	12.4N/mm²	15.46N/mm²	16.22N/mm²
60%	13.55N/mm²	16.57N/mm²	18.26N/mm²
70%	14.88N/mm²	17.64N/mm²	19.33N/mm²
80%	17.55N/mm²	22.13N/mm²	23.28N/mm²

7 Days of Compressive Strength



14 Days of Compressive Strength



V. CONCLUSION

Removal of waste plastic products thus remove land requirement problem for dumping plastic. Foundry sand and Plastic concrete block is a productive way of disposal of plastic waste.

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8) IMPROVEMENTS OF LATERITE WASTE BLOCKS AND BRICKS WITH NANO SILICA AND SUBSTITUTE MATERIALS

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Abstract:.
The experiment focused on sustainable utilization of laterite waste as a byproduct of laterite stone or brick for the preparation of eco friendly construction materials. By using different sustainable elements like fly ash, , waste plastic (different forms shredded, melted), eco fibers such as coconut fibers, water hyacinthfibers , sugarcane waste fibers,rice husk ash with cement and the objective is to enhance the mechanical, physical, and durability characteristics of laterite waste blocks. Bacillus subtilis (a bio-mineral) and nano silica were employed as crucial additives to improve the pore structure, inhibit bacterial growth, and improve the material's overall performance. The findings of the experiment showed that adding nano silica greatly increased compressive strength and decreased water absorption, while adding bio-mineral further improved structural stability. This experiment includes two stages of research- one with improved properties of laterite brick or stone by spraying nano silica with cement paste with 1%,2%,3%,4%,5% proportion of nano silica with Bacillus subtilis (bio-mineral). Which increased properties such as, compressive strength, water repulsion capacity, enhanced appearance, reduces pores which results to reduction of bacterial infection. Also the study comes to the conclusion that the modified laterite waste blocks have better mechanical qualities and environmental advantages, encouraging low-cost and sustainable building methods by combining nanotechnology and bio-based materials with different proportions.

Indexterms:-Laterite Waste Utilization, Nano Silica Enhancement, Sustainable Construction Materials, Bio- Mineral (Bacillus subtilis)

I. INTRODUCTION

Laterite is a type of soil that has a lot of iron and aluminium. It is usually found in hot and wet tropical areas. Most laterites look rusty-red because they have a high amount of iron oxide. They form when the parent rock underneath is weathered a lot over a long time, especially in places with high temperatures and heavy rain that comes and goes with dry periods. This process is called laterization. Tropical weathering is a slow process that creates different types of soil interms of thickness, quality, chemical makeup, and minerals. Most of the land with laterite is between the tropics of Cancer andCapricorn. Laterite is often seen as a type of soil, but it is also considered a rock type.

This has led to some confusion, and some researchers have suggested that the term should be used less or even stopped. There are many different perspectives on laterite, such as the idea that it is a complete layer of weathering or a theory about weathering. As a result, the name has created too much confusion, according to some experts. Indian laterite-like materials can be found all over the world. Laterite was once shaped like bricks and used to construct monuments. Laterite, bricks, and stone were used in the construction of temples such as Angkor Wat in Southeast Asia after the year 1000 CE.Some roads have been using laterite as a base layer rather than stone since the 1970s. In rural areas, thick laterite layers can serve as subterranean water sources because they are porous and allow water to pass through. Laterite is also utilized in some sewage treatment facilities, where it is combined with acid to aid in the removal of heavy metals and phosphorus. Many Indian states, including Kerala, Karnataka, and Andhra Pradesh, use laterite bricks.

They are used for walls, foundations, and other buildings. This compacted and hardened soil can be easily cut into brick shapes for construction. Laterite bricks are made from laterite crusts found in mines and then cut into stones using machines. Laterite is of a rusty-red color because it contains a lot of iron oxide.

Laterite waste from quarrying is usually thrown away because it is weak and has lots of tiny holes. Regular bricks harm the environment, so there is a need for better options. This study seeks to make laterite waste blocks tougher, longer-lasting, and more eco-friendly by employing nano silica, Bacillus subtilis, and other elements.

II. METHODOLOGY

1. Material Collection
2. Study of Material
3. Selection of Mix Proportion
4. Material Collection
5. Testing Comparison

III. TESTS AND RESULTS

1. WATER ABSORPTION TEST

Table.1Water Absorption Test (Laterite Bricks with Nano Silica Paste)

Brick No	Percentage of Nano Silica	Wet Weight (kg)	Dry weight (kg)	Water Absorption (%)
1	Regular	31.225	27.025	15.55%
2	1%	31.110	27.000	15.22%
3	2%	31.100	26.911	15.57%
4	3%	30.965	26.903	15.10%
5	4%	29.885	26.885	11.16%
6	5%	29.315	26.904	8.96%

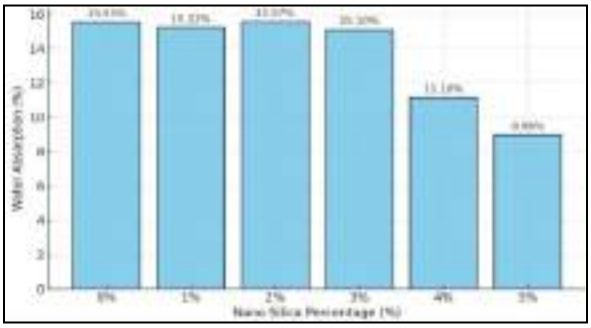

Figure 1: Water Absorption Graph

2. POTENTIAL OF HYDROGEN TEST

Table.2Water Absorption Test (Laterite Bricks with Nano Silica Paste)

Material	pH Value	Nature
Laterite Soil	5	Acidic
Nano Silica	8	Alkaline
Cement	14	Strongly Alkaline
Final Mix	12	Alkaline

3. COMPRESSIVE STRENGTH

Table.2Compressive Strength Test (Laterite Bricks with Nano Silica Paste)

Brick No	% of Nano Silica	Strength
1	Regular	10.05 N/mm2
2	1%	10.06 N/mm2
3	2%	10.06 N/mm2
4	3%	10.40 N/mm2
5	4%	10.52 N/mm2
6	5%	10.89 N/mm2

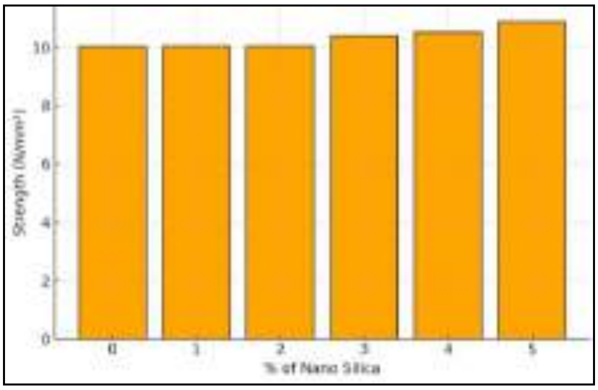

Figure 2: Compressive Strength Graph

Figure 3: Brick’s filled with mixture of Nano Silica and Bio mineral

4. WATER ABSORPTION TEST

Table.3Water Absorption Test (Laterite Blocks made from wastage)

Material Replaced	Percentage of Replacement	Wet Weight (kg)	Dry Weight (kg)	Water Absorption (%)
Regular	-	8.20	7.85	5.56%
Fly Ash	10%	8.12	7.70	5.45%
	20%	8.05	7.65	5.23%
	50%	7.92	7.55	4.90%
GGBS	10%	8.15	7.74	5.30%
	20%	8.20	7.80	5.12%
	50%	8.30	7.90	5.06%
Rice Husk	10%	7.95	7.52	5.72%
	20%	Failed	Failed	Failed
	50%	Failed	Failed	Failed
Shredded Plastic	10%	7.90	7.48	5.61%
	20%	7.75	7.28	6.45%
	50%	7.30	6.65	9.77%
Natural Coir Fibre	10%	7.85	7.36	6.65%
	20%	7.70	7.15	7.69%
	50%	7.25	6.55	10.68%
Water-hyacinth Fibre	10%	7.65	7.16	6.65%
	20%	7.71	7.16	7.69%
	50%	7.05	6.48	10.36%
Nano Silica	10%	8.22	7.80	5.40%
	20%	8.26	7.83	5.49%
	50%	8.39	7.93	5.80%

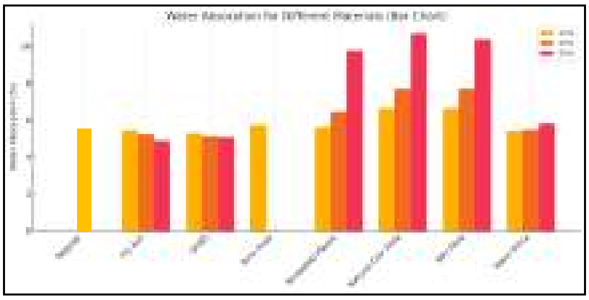

Figure 4: Water Absorption Graph

Figure 5:Laterite blocks kept in mould

5. COMPRESSIVE STRENGTH

Table.4 Compressive Strength Test (Laterite Blocks made from wastage)

Material	Percentage of Replacement	Max Load (kN)	Compressive Strength
Regular	-	283.95	12.58
Flyash	10%	280.56	12.47
	20%	252.40	11.22
	50%	142.30	6.32
GGBS	10%	233.55	10.38
	20%	281.10	12.49
	50%	239.95	10.66
Rice Husk	10%	122.85	5.46
	20%	Failed	Failed
	50%	Failed	Failed
Shredded Plastic	10%	210.90	9.37
	20%	178.26	7.92
	50%	170.56	7.58
Natural Fiber (coir)	10%	202.5	9.0
	20%	225.0	10.0
	50%	168.8	7.5
Water-hyacinth (WH) Fiber	10%	142.30	6.32
	20%	159.26	6.96
	50%	148.96	6.52
Nano Silica	10%	292.50	13.10
	20%	315.00	14.53
	50%	202.50	9.26

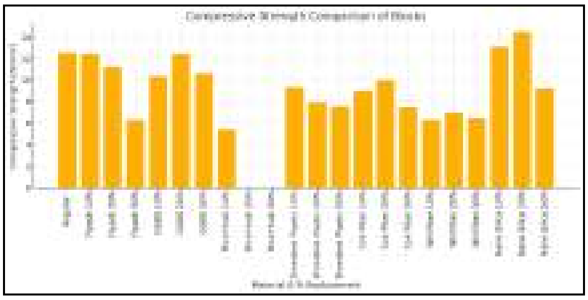

Figure 5: Compressive Strength Graph

Figure 5:Crushing of laterite brick, Fine aggregates <4.75mmCoarse aggregates >4.75mm

CONCLUSION

The research demonstrates that laterite waste may be effectively utilized in the production of eco-friendly blocks when combined with materials such as fly ash, GGBS, rice husk ash, shredded plastic, natural fibers, and nano silica.

1. Nano silica performed best, delivering a compressive strength of up to 14 MPa when applied at 20% replacement. This shows that it is quite excellent at making things stronger.

2. Fly ash and GGBS also benefited a lot when used in small amounts (10–20%), but when used in large amounts (50%), the strength went down.

3. Rice husk ash didn't work as well as the others, therefore it's not as useful for making blocks.

4. Shredded plastic and natural fibers, like coir, WH, gave some improvement but not as much as the other materials.

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9) ENHANCEMENT OF CONCRETE BY USING BACILLUS MEGATERIUM BACTERIA

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Abstract : Concrete is one of the most important material which is used during construction. Once we have done with

concreting it will automatically subjected to crack formation, because of wear and tear, hydration and overloading. This paper

presents the partial addition of Bacillus Megaterium Bacteria with concrete mix which helps to increase the Compressive

Strength of Concrete. The concrete containing the bacterial dosage of 1% of weight of cement, which are encapsulated in

silica gel in two layers protects the bacteria during mixing operation. The increase of Compressive Strength is examined by

testing the Concrete Cubes under Universal Testing Machine (UTM). The test showed an increment in Compressive Strength

of 25% as compared to Conventional Concrete.

IndexTerms - Bacillus Megaterium, Compressive Strength.

I. INTRODUCTION

Cracking significantly affects the durability and service life of concrete by allowing the ingress of water and harmful

substances. To address this issue, self-healing concrete using Bacillus Megaterium has gained attention. This bacterium

remains dormant within the concrete matrix and becomes active in the presence of moisture, producing calcium carbonate

($CaCO_3$) that seals cracks. In this study, 1% bacteria by weight of cement is incorporated and protected through silica gel

encapsulation to ensure survivability. Experimental results show improved compressive strength, reduced permeability, and enhanced crack-healing performance compared to conventional concrete. This approach offers a sustainable method to

enhance durability and reduce maintenance in concrete structures.

II. OBJECTIVE

1. To study Bacillus bacteria for use in bio-concrete production.

2. To compare the Conventional concrete and Bio-concrete. (Compressive Strength Test)

3. Analysis and Result.

III. METHODOLOGY

Preparation of Bacillus megaterium for Bio-Concrete

The bacterium Bacillus megaterium was cultivated to obtain an active culture suitable for bio-concrete application. Initially,

the bacteria were grown on a solid agar medium to develop well-defined colonies. A small amount of these colonies was then

carefully transferred into a sterile liquid medium such as nutrient broth. The inoculated broth was incubated at a controlled

temperature of 30–37°C for a period of 24–48 hours under continuous shaking to ensure proper aeration and uniform

bacterial growth. The increase in bacterial population was indicated by the turbid appearance of the solution.

To enhance the survival of bacteria in the highly alkaline concrete environment, the cultured cells were immobilized using a

gel-based encapsulation method. Materials such as sodium alginate or guar gum were used to form protective beads

containing the bacterial cells. This encapsulation technique helps maintain bacterial viability and ensures their activation for

crack-healing when moisture becomes available.

IV. RESULTS AND ANALYSIS

Calculation of mix design for M20 grade of concrete:

Wet volume = 1 m^3

Dry volume = 1 x 1.54 = 1.54 m^3

1) Cement = 1/5.5 x 1.54 = 0.28 m^3

Mass = 0.28 x 1440 = 403.2kg

2) Sand = 1.5/5.5 x 1.54 = 0.42 m^3

Mass = 0.84 x 1550 = 1302kg
W/C ratio = 403.2 x 0.50 = 201.6kg = 201.6lit
Volume for 15cm Cube
Wet volume = 0.15 x 0.15 x 0.15 = 0.003375 m^3
Dry volume = 0.003375 x 1.54 = 0.005198 m^3
Parts ratio = 1 + 1.5 + 3 = 5.5
1) Cement = 1/5.5 x 0.00954 x 1440 = 1.36kg
2) Sand = 1.5/5.5 x 0.005198 = 2.26kg
3) Aggregates = 3/5.5 x 0.005198 = 4.39kg
4) Water = 0.5 x 1.36 = 0.68kg = 680ml
Calculation of Bacterial Dosage:
1) The bacteria is used 1% of cement quantity (Liquid Form)
= 1360 x 1/100 = 13.6ml
2) The bacteria is used 1.5% of cement quantity (Encapsulated)
= 1360 x 1.5/100 = 20.4gm
Table 1. Quantity of material required for one cube of 0.15 x 0.15 x 0.15 m.
Material Quantity
Cement 1.36kg
Sand 2.26kg
Coarse Aggregate 4.39kg
Water 0.68kg
Testing and Monitoring
Compressive strength testing was performed on conventional and bacterial concrete specimens using a Universal Testing
Machine (UTM) at curing intervals of 7, 14, and 28 days.
Table 2. Compressive Strength Table
Sr.No Days Conventional Concrete Bio Concrete
1. 07 days 12.95 N/mm² 15.32 N/mm²
2. 14 days 13.82 N/mm² 18.16 N/mm²
3. 28 days 19.76 N/mm² 25.78 N/mm²
V. CONCLUSION
The compressive strength of conventional concrete is 20 N/mm², which increased to 25.77 N/mm² with the use of
encapsulated Bacillus bacteria, indicating significant enhancement in strength and durability.

10) FLOOD MITIGATION MEASURES – CASE STUDY

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Abstract.Flood mitigation is a critical component of disaster risk management, aimed to reduce the damage and loss of life caused by flooding. Flooding in the Krishna River basin causes significant damage annually at the Shirol–Kurundawad region. This area, situated at the critical confluence of the Krishna and Panchaganga rivers, is exceptionally vulnerable to severe flooding, leading to extensive losses of life, property, and agricultural output, necessitating an effective mitigation strategy. This study analyzes the hydraulic behavior during the severe 2019 flood event using the HEC-RAS (Hydrologic Engineering Center – River Analysis System) software. The one-dimensional unsteady flow model simulates the flood discharge data and water surface profiles to identify the key hydraulic mechanisms contributing to inundation, specifically in the reach between Shirol and Kurundawad. Results confirm a distinct M1 Backwater Curve and reverse flow due to the downstream Rajapur Weir, aggravated by severe "Hydraulic Locking" at the Krishna-Panchaganga confluence. This study evaluates the feasibility of structural measures, such as the construction of protective levees and the restoration of natural drainage channels, to alleviate these hydraulic constraints.

Keywords:Flood Mitigation, HEC-RAS, Backwater Effect, Hydraulic Locking.

1 Introduction

The monsoon season of July and August 2019 witnessed unprecedented hydrological extremes in the state of Maharashtra, triggering severe flood conditions in the Krishna sub-basin. The districts of Sangli and Kolhapur were particularly affected, experiencing prolonged inundation that resulted in significant damage to agriculture, infrastructure, and loss of life. While these districts have a history of flooding, notably in 2005 and 2006, the 2019 event was distinct in its severity and duration.
The hydraulic behavior of the Krishna River in this region is influenced by complex interactions between heavy rainfall, reservoir operations, and local topographical constraints. The Rajapur Weir, located at the state border, has been a subject of technical scrutiny regarding its potential to create backwater effects during peak discharge. Furthermore, the confluence of the Panchaganga tributary with the Krishna River at Narsobawadi creates a critical hydraulic junction prone to "Hydraulic Locking".

Currently, flood management faces challenges due to rapid urbanization along riverbanks and encroachments in floodplains. The Vadnere Committee Report[1] highlighted the need for advanced hydrodynamic modeling to understand these flow dynamics. This paper aims to simulate the 2019 flood event using the HEC-RAS (Hydrologic Engineering Center - River Analysis System) model to identify the root hydraulic causes of flooding and propose scientific mitigation strategies.

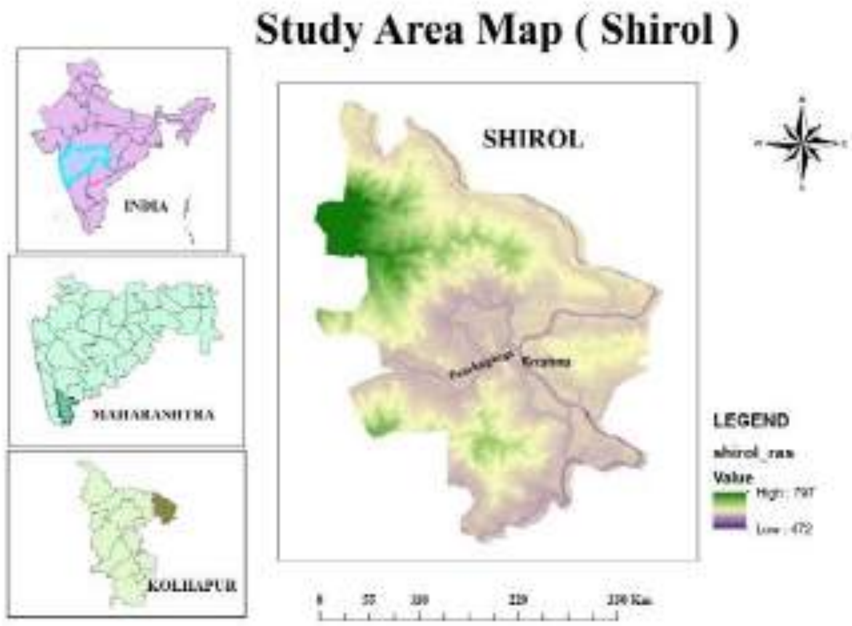
The recurrence of severe floods in the Krishna River Basin has prompted extensive research into hydrological modeling and flood mitigation strategies. The Vadnere Committee Report [1] provided a comprehensive analysis of the 2019 flood, identifying backwater effects from reservoir operations and topographical constraints as primary causative factors. The committee strongly recommended the adoption of hydrodynamic modeling to quantify these effects scientifically. Complementing this, the Central Water Commission (CWC) Study Report [12] provided essential raw hydrological data and identified the specific critical water levels at the Rajapur barrage. Further research by Bouwer et al. [7] explored the long-term hydrological impacts of climate variability and increasing water consumption, predicting a future increase in the frequency of extreme events. Additionally, Visweswararao and Viswanath [13] analyzed the trap efficiency of the Almatti Reservoir, a crucial element in understanding the downstream hydraulic control which influences upstream water surface profiles. Hydraulic modeling, particularly using HEC-RAS, has become the standard tool for flood risk assessment, with principles rooted in the classical works of Chow [14] on Open Channel Hydraulics. Biradar and Bhave [3] successfully utilized 1D HEC-RAS modeling to map flood lines at Sangli, demonstrating the software’s capability to simulate complex river reaches. Pradhan et al. [10] and Parashuram et al. [9] further validated the utility of HEC-RAS for floodplain mapping in similar Indian river contexts. More recently, Kulkarni and Kale [4] developed a coupled 1D-2D hydrodynamic model for the Panchganga River, confirming that hybrid modeling approaches provide superior accuracy in determining flood depths in confluence zones. Regarding mitigation, Patil et al. [2] studied flood management strategies for Sangli city, emphasizing the need for integrated reservoir operation. Sathe et al. [6] conducted a rainfall analysis for the Upper Krishna Basin, establishing crucial design flood parameters. Similarly, Kale [8] investigated the specific causes of floods in the Upper Krishna basin, pointing to localized constrictions and anthropogenic factors. On a broader scale, Singh et al. [5] offered a systematic review of flood management, advocating for flood resilience. However, limited research has specifically quantified the "Hydraulic Locking" phenomenon at the Narsobawadi confluence. This study addresses that gap by simulating the interaction between the Krishna main stem and the Panchganga tributary using the HEC-RAS 6.6 model [11]. Finally, the proposed structural mitigation measures, specifically levees, are evaluated in accordance with the guidelines set by the Bureau of Indian Standards [15].

2 Methodology

The study adopts a deterministic approach using One-Dimensional (1D) Unsteady Flow analysis to simulate the river behavior.

2.1 Data Collection and Pre – Processing

The primary hydrological data, including Annual Peak Discharge and High Flood Levels (HFL) for the years 2019–2025, was obtained from the Water Resources Department (WRD), Sangli. The 2019 flood data was selected as the "Design Flood" due to its historical magnitude. To accurately represent the river terrain, a Digital Elevation Model (DEM) was generated using ArcGIS software. This DEM served as the foundation for extracting geometric data, including the river centerline, bank lines, flow paths, and cross-section cut



lines.

Fig. 1.Study Area Map of Shirol-Kurundwad Region showing the Krishna and Panchganga River Confluence.

2.2 HEC-RAS Model Setup

The hydraulic simulation was performed using HEC-RAS Version 6.6. The geometric data from ArcGIS was imported into the RAS Mapper tool.

Roughness Coefficients

Based on field observations and standard guidelines, a Manning's roughness coefficient (n) of 0.031 was assigned to the main channel to represent a clean riverbed. A higher value of n=0.07 was assigned to the overbanks (floodplains) to account for the high friction caused by standing crops (sugarcane) and vegetation.

Boundary Conditions

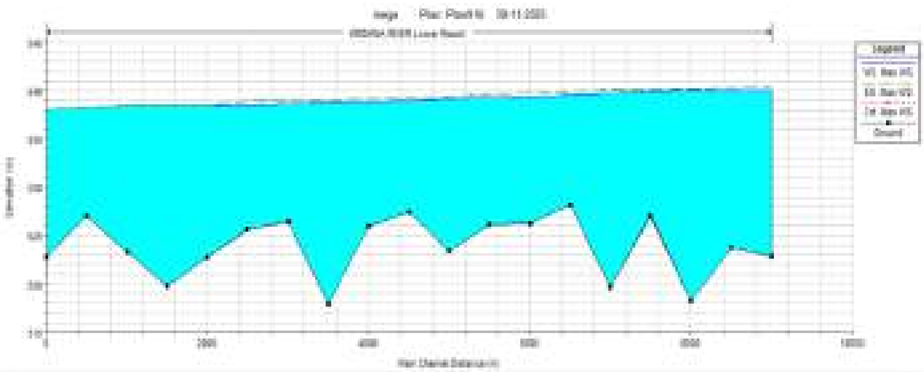
The model utilized an Unsteady Flow analysis. The upstream boundary was defined using the Flow Hydrograph of the 2019 flood, while the downstream boundary was defined using the Normal Depth method based on the riverbed slope.

3 Results and Discussion

The HEC-RAS simulation successfully reproduced the hydraulic conditions of the 2019 flood. The analysis of the output profiles provided critical insights into the flood mechanisms.

3.1 Longitudinal Profiles and Backwater Effect

The longitudinal water surface profile of the Krishna River Lower Reach revealed a distinct M1 Backwater Curve. As shown in the simulation results, the water surface slope is extremely mild and nearly horizontal. This profile confirms that the Rajapur Weir at the downstream boundary acts as a significant obstruction, causing the water to stagnate and pool



up (Afflux) for a distance of approximately 9 km upstream.

Fig. 2.Longitudinal Water Surface Profile of Krishna Lower Reach showing M1 Backwater Curve.

3.2 Analysis of Reverse Flow

A critical finding of the simulation is the evidence of reverse flow. The flow hydrograph at the Krishna Lower Reach shows discharge values dropping below zero in the initial 2 km stretch upstream of the weir. This negative flow serves as mathematical proof that the obstruction forces water to move backward against the natural gradient, aggravating flood levels in the upstream reaches.

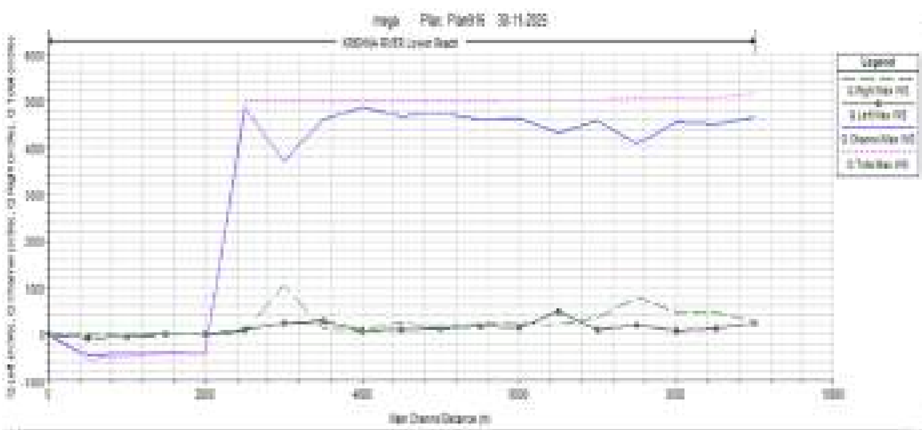


Fig. 3.Flow Hydrograph indicating Negative Discharge (Reverse Flow) near Rajapur Weir.

3.3 Hydraulic Locking at Confluence

The analysis of the Panchaganga River tributary revealed severe hydraulic instability. The velocity profile at River Station 1000 showed a significant negative velocity of -0.86 m/s. This confirms the phenomenon of "Hydraulic Locking," where the high stage in the main Krishna River acts as a hydraulic wall, preventing the tributary from draining. The collision of high-momentum tributary flow with the stagnant main river creates a "Hydraulic Surge" observed between chainage 1000m and 1500m.

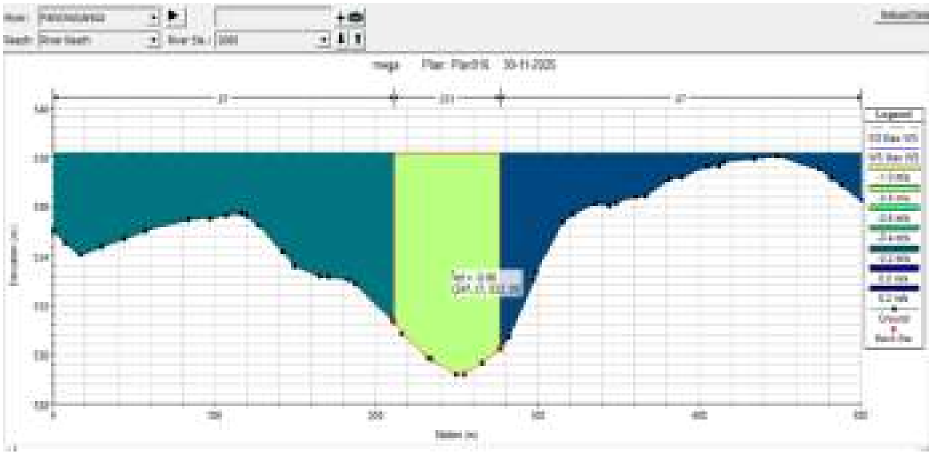


Fig. 4.Typical Cross-Sections of Panchaganga River Reach (RS-1000)

3.4 Flood Inundation Mapping

The inundation map successfully validates the hydraulic model by mapping the theoretical flood levels onto the real-world terrain. It provides a clear visual representation of the flood-prone areas in the Krishna-Panchganga confluence zone.

The geospatial map serves as a validation of the 1D Unsteady Flow model. It successfully identifies the high-risk zones near the confluence and the agricultural plains of the Sangli-Kolhapur border, providing a critical tool for flood plain zoning and emergency evacuation planning.

Fig. 5.HEC-RAS Simulated Flood Inundation Map of the 2019 Flood Event showing affected zones.

4 Conclusion

The hydrodynamic analysis of the Krishna River Basin using HEC-RAS 6.6 leads to the following conclusions:
*Backwater Dominance.*The 2019 flood was not solely driven by rainfall but was significantly aggravated by the backwater effect from the Rajapur Weir, which caused flow stagnation and swelling in the upstream channel.

Confluence Vulnerability. The Panchaganga-Krishna confluence acts as a critical choke point. The hydraulic locking effect creates a reverse flow condition, prolonging inundation in the Shirol region.

Mitigation Measures. To mitigate future disasters, structural interventions are recommended, specifically the construction of levees at River Stations 8500 and 3500 where bank overflow is dominant. Additionally, dredging of the riverbed upstream of the weir is essential to restore channel capacity and reduce the afflux.

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11) DAMAGE DETECTION IN STEEL STRUCTURE USING FREQUENCY RESPONSE

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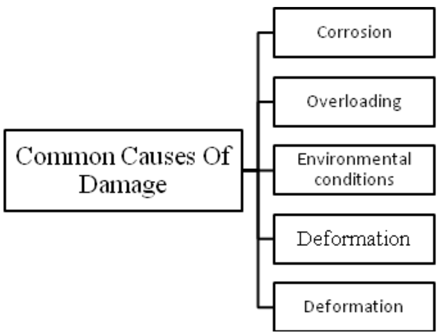
Abstract : Damage detection is a crucial part of structural health monitoring for steel structures, as it guarantees the longevity, security, and cost-effective maintenance of the infrastructure. This study focuses on a vibration-based approach to detect and evaluate damage in steel structures. Vibration data, including natural frequencies, mode shapes, and damping ratios, are analyzed to identify stiffness variations that may indicate potential damage. The method provides a rapid, efficient, and non-destructive means of evaluating structural integrity. By applying state-of-the-art data processing and pattern recognition techniques, the study aims to improve the sensitivity and accuracy of damage detection even under complex loading and environmental conditions. The results demonstrate that vibration-based monitoring offers a reliable way to identify structural deterioration early on, averting disastrous failures and extending the life of steel structures.

IndexTerms - SHM,FFTAnalysis,Modalparameter,Non-destructive..

IX. INTRODUCTION

Damage in Steel Structures are mainly related to the primary causes of damage to steel structures are abrupt or gradual changes in the geometry, properties, stability, and performance of the materials. boundary conditions, or how they are connected, which has a negative impact on the structural strength.



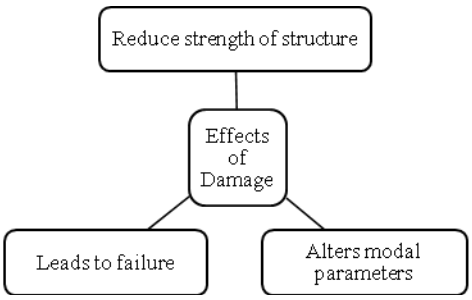


Figure 1: Causes of Damage Figure 2: Effects of Damage

Table.1: History of Damage Detection in Steel Structure

Era	Description
Ancient Times	The safety of structure was ensured through visual inspection. No instrument or data based analysis were used.
Mid of 20th Century (1950-1980)	Non-destructive testing (NDT) techniques such as ultrasonictesting,radiography for detecting external or internal cracks.
Late 20th Century (1980-2000)	Evolution of system like Structural health monitoring (SHM). Sensors like accelerometers were introduced to analyse structures.
21st Century (Modern Era)	Analysis using vibration data, wireless sensors, Artificial intelligence and Machine learning) for real time tracking of damage.

X. OBJECTIVE

1.To develop a damage and undamaged model.
2. To analyze the dynamic response.
3. Collection of data from accelerometer with respect to external excitation.

XI. METHODOLOGY

Models of steel structures are designed in accordance with standard specifications.

Data Collection: Experimental data are collected using appropriate testing methods and instruments.

Classification: The data collected is classified into undamaged and damaged states.

Modal Parameters: The data is used to extract the key modal parameters like natural frequency and mode shapes.

Damage Detection: The structural damage is found by comparing the modal parameters of the damaged and undamaged states.

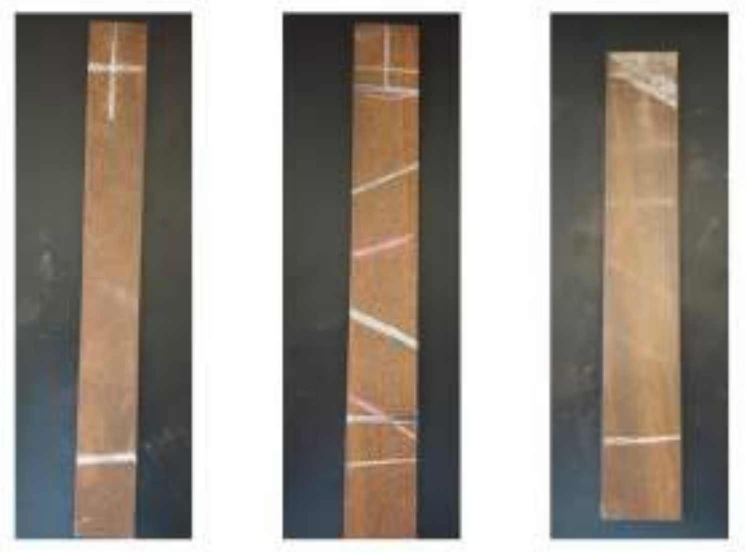


Figure 3: Sample beams

Figure 4: FFT Analyzer

Damage to the steel structure causes quantifiable changes in vibrational properties, including modal parameters, which again include modal damping, natural frequency, and mode shape.Damage can bereadilyidentified by analyzing the aforementioned parameters.It is one of the damage analysis non-destructive techniques that can beapplied without interfering with the workflow. This approach works well for ongoing and real-time monitoring.Both locally and globally, the damage can be identified. The vibration analysis method is used to analyze any steel structures, including offshore platforms, high-rise steel frames, cranes, bridges, and towers.

Accelerometer is one of the essential tool for vibration-based steel structure damagedetectionis an accelerometer sensor.Itgauges a structure's acceleration response to dynamic loads like wind, traffic, or vibrations from machinery. Accelerometers assist in detecting changes in natural frequencies, mode shapes, and damping ratiosparameters that are extremely sensitive to structural damageby logging these vibrations. Damage alters the structure's stiffness ,which results in different vibrational properties. Without the need for visual inspection, engineers can identify and evaluate the extent of damage by analyzing the accelerometer data to identify these changes.

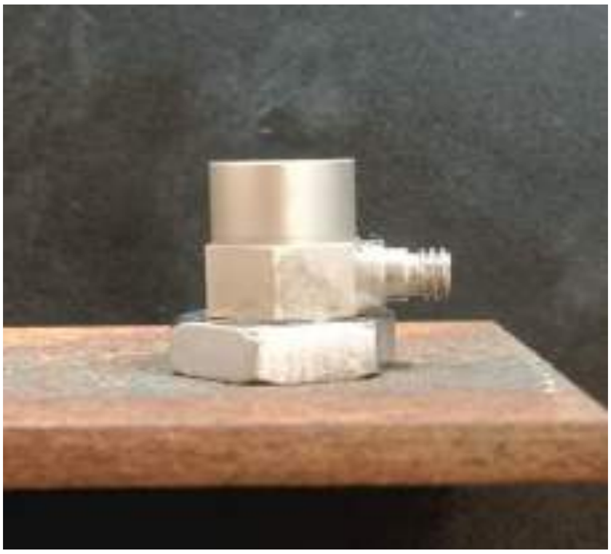


Figure 5: Accelerometer sensor

Figure 6: C- clamp

XII.RESULTS AND DISCUSSION

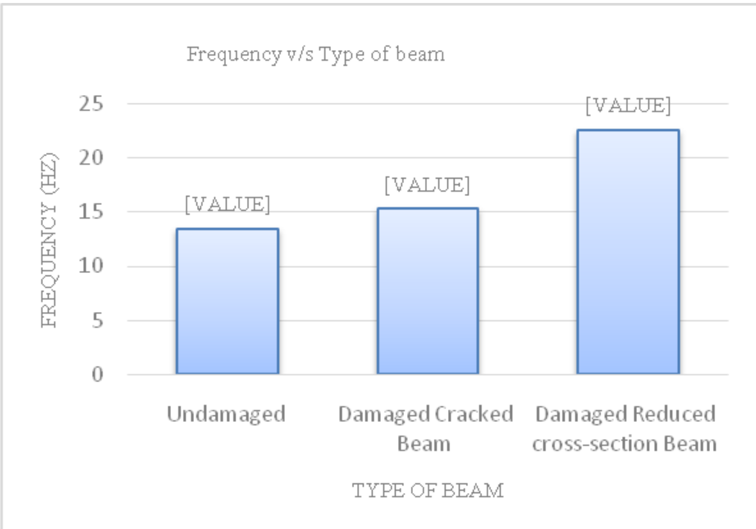


Figure 7: Graphical representation

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$$f = \frac{1}{2\pi} \times \sqrt{\frac{k}{m}} \quad \text{……………………………………….(1)}$$

f = Natural frequency of the system, measured in Heartz (Hz).
k = Stiffness constant of the material, measured in Newtons per meter (N/m).
m = Mass of the body, measured in Kilograms (Kg).
2π = A constant.

$$f \propto \frac{1}{m} \quad \text{………………………………………….(2)}$$

That is the frequency is inversely proportional to the mass of the body.

XIII. DISCUSSION

Results show that the natural frequency is reduced by the damage in steel structures due to the loss of stiffness. This frequency change can be used effectively for detection and monitoring of structural damage. The method is demonstrated to be sensitive and robust for the identification of structural degradation. Accuracyhowever,can be influenced by factors such as measurement errors and external influences. In general, it is a practical way for structural health monitoring.

XIV. CONCLUSION

Frequency for Undamaged beam is 13.43 Hz.

Frequency for damaged beam which are Cracked beam and Reduced cross section beam are 15.26 Hz and 22.58 Hz respectively.

According to the study's findings, frequency and body mass are inversely correlated. Simply put, the mass of the body acts in direct opposition to the frequency of vibrations that develop in the material's body; that is, if the mass of the body increases, the frequency decreases, and if the mass decreases, the frequency increases, resulting in structural damage. The more damage there is, the more damage there is, and the frequency is the only factor that determines whether damage is detected.Combining machine learning and deep learning can improve accuracy and allow for real-time damage identification.

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