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CIVIL ENGINEERING DEPARTMENT

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Contents

From the Principal

It is a great pleasure to see the creative expressions of students who had contributed to Sandarbh. Civil Engineering Department has grown abundantly in the recent past. It continues to sustain its growth. People reading this magazine will realize the tremendous changes that are happening in the Department. The magazine is presenting a glimpse of the growth of the Department on many fronts. The Department has been simply unstoppable in its progress as it has been actively involved in various activities that have brought to light the hidden talents of the students and staff. The highly qualified and dedicated members of staff have always stood shoulder with the management and have carried out their duties with a level of commitment. This magazine has recorded achievements such as: conferences attended by staff members and students, competitions won by the hugely talented students, innovative projects carried out by students with the guidance of staff, among others. They stand as a witness to the monumental efforts taken by the management to make the college a centre of excellence in education and research.
I wish the management, staff and students of the college success in their future endeavors.

Dr. Archana Keerti Chowdhary Principal

From the HOD

It has given enormous gratification to coordinate the editorial team of —SANDARBH , our Civil Engineering Department magazine in all aspects, covering academic activities, technical events of the students in contributing articles to the magazine.
This magazine would not have been concluded without the constant support of our principal who stood as a pillar of strength and support at all times. We would genuinely place thanks to our editorial team whose dedication and diligent towards completion of magazine was always part of the process. We would like to congratulate and express our hearty thanks and gratitude to our head of the department in believing the quality policy of educate enrich and excel in imparting professional education. This magazine is reflecting of our department quality in terms of all round excellence.
Last but not the least we want to express earnest gratitude to all the faculty members who gave constant support and guidance to enlighten young minds of the people through this magazine.
Dr. Amit Sharma

Vision

Be the preferred destination locally, regionally and internationally for the Civil Engineering society as a eading department providing high quality programs and services in Civil Engineering fields.

Mission

M1. To offer value based education to meet global tandards to the students to develop their professional skills.

M2. To inculcate a spirit of entrepreneurship and nnovation in students so that they can better serve the society.

M3. To prompt sponsored research and provide Testing/Consultancy services in Civil Engineering fields for society.

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Engineering Mechanics Lab
Strength of Material Lab
Structures Lab
Transportation Lab
Geotechnical Engineering Lab
Engineering Geology Lab
Fluid Mechanics & Machinery Lab
Environmental Engineering Lab
Materials Testing Lab
Survey Lab
Instrumentation Lab
Computer Lab
Software Lab
Heavy Structural Lab

Major Softwares Available

CIVIL 3D
PRIMAVERA
ANSYS
SAP 2000
GMS 6.5
Abaqus 6.12
LS-DYNA
MIDAS-Gen

Major Equipments Available

Total Station
UTM & CTM
Pumps & Turbines
Benkingum Beam
Bituminous testing apparatus
Plate Load test apparatus
SCPT
DCPT
CBR
FFT ANALYSER
DATA LOGER
POLARISCOPE

MAJOR EQUIPMENT

Total Station

UTM &CTM

Weather Station

CBR Test Apparatus

Pumps and Turbines

Bituminous Testing Apparatus

Polariscope

DCPT

SCPT

Data Logger

SPATIO-TEMPORAL MAPPING OF KANH RIVER IN INDORE REGION, MP USING REMOTE SENSING & QGIS

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Abstract— India's water resources have been declining since 1951, with availability per person dropping from 5177 cubic metres to 1500 cubic metres. This puts India on the brink of a water crisis, falling below the World Bank's 1500 cubic metres threshold. By 2050, India may face even greater scarcity, intensifying conservation and rejuvenation efforts. The spatio-temporal mapping of the Kanh River, spanning approximately 20 kilometers through Indore, is crucial for water resource management and conservation. The project uses advanced technologies like remote sensing and QGIS software to analyze the river's dynamics and devise strategies for its rejuvenation and sustainable management. The project's success can serve as a blueprint for water management strategies nationwide, mitigating the impending water crisis and ensuring equitable access to water resources.

Keywords—Water scarcity, Kanh River, Remote sensing, Sustainable management

1. INTRODUCTION

Water The Kanh River, originating in the Malwa Plateau and flowing through the Indore region of Madhya Pradesh, bears immense ecological, agricultural, and communal importance. It's a vital lifeline, sustaining diverse ecosystems, facilitating agriculture, and meeting the essential water needs of local communities. However, its well-being faces daunting challenges posed by rapid urbanization, expanding agricultural practices, and environmental degradation.

Cities expanding along its banks alter the natural course of the river, changing its shape, disrupting the flow, and disturbing adjacent habitats. In tandem, intensified farming and chemical usage influence the river's health, exacerbated by pollution and environmental damage.

To comprehend the river's transformations over time, this study harnesses advanced technology—utilizing satellite images and computer programs. The analysis of images spanning various seasons and years aims to unravel the impacts of human activities on the river's dynamics.

Through detailed analysis using computer programs, we aim to depict how human actions have altered the surrounding land and, consequently, the river's evolution. This research surpasses mere map creation; it seeks a comprehensive understanding of the river's changes, aiding informed decision-making to safeguard its integrity while balancing human necessities and environmental sustainability.

Water scarcity, a global concern, arises from factors like population growth, excessive agricultural irrigation, and environmental deterioration. With limited freshwater available, responsible water resource management becomes crucial to sustain ecological and economic health.

Water quality, encompassing physical, chemical, thermal, and biological aspects, requires continual monitoring and assessment. Anthropogenic activities, notably industrial, substantially impact water bodies, necessitating thorough evaluation through modern techniques integrating in-situ measurements and laboratory analysis of water samples.

Remote sensing techniques, reliant on spectral signatures, effectively assess water quality parameters, while GIS plays a pivotal role in monitoring and analyzing water quality globally. Satellite data provides extensive coverage, aiding in understanding evolving risks essential for resource management.

Geo-informatics technologies like remote sensing and GIS offer vital tools for comprehensive water quality assessment and management. These datasets provide a broad view of earth surface processes, aiding in understanding stresses on aquatic ecosystems.

Our research aims to evaluate the water quality of the Kahn River in the Indore region, employing remote sensing and GIS. This endeavor seeks to illuminate its historical and present state, facilitating informed strategies to conserve this invaluable natural resource amidst changing landscapes and growing human influence.

2. MATERIALS & METHODS

Our methodology begins with the acquisition and analysis of Landsat satellite images to assess the current state of the Kanh River. Using QGIS, we delineate the area of interest and obtain precise dimensions of the river and its surroundings. Subsequently, we calculate the Water Quality Index (WQI) incorporating various parameters indicative of water health. Spearman correlation tests are then employed to evaluate the relationships between different variables and the overall water quality. This integrated approach utilizing QGIS and remote sensing facilitates a comprehensive understanding of the Kanh River's condition and guides the rejuvenation effectively.

QGIS is instrumental in water quality analysis due to its multifaceted capabilities:

1. Spatial Analysis: Identifying spatial patterns and trends in water quality parameters across different locations.
2. Remote Sensing Integration: Incorporating satellite imagery and aerial photographs to assess environmental influences on water quality.
3. Data Visualization: Creating maps, graphs, and charts to effectively communicate water quality data.
4. Modeling Capabilities: Developing predictive models to forecast future water quality scenarios.
5. Geographic Information System (GIS) Tools: Utilizing advanced GIS functionalities for spatial analysis and data manipulation.
6. Open-Source Platform: Providing accessibility and affordability for researchers and stakeholders.
7. Interdisciplinary Applications: Supporting collaboration between hydrologists, ecologists, and policymakers for holistic water management.

Using an online water quality parameter calculator streamlines the process of analyzing and interpreting water quality data. By inputting the relevant data points into the calculator, researchers can quickly obtain results such as correlation coefficients, indices, or other statistical measures. This efficient tool not only saves time but also ensures accuracy in assessing the health of water bodies and identifying potential areas for improvement. Additionally, the accessibility of online calculators promotes transparency and facilitates collaboration among stakeholders involved in water resource management. Overall, leveraging online water quality parameter calculators enhances the effectiveness of monitoring and decision-making processes, ultimately contributing to the conservation and sustainable management of freshwater ecosystems.

$$\rho = 1 - \frac{6\Sigma\, d_i^2}{n(n^2-1)}$$

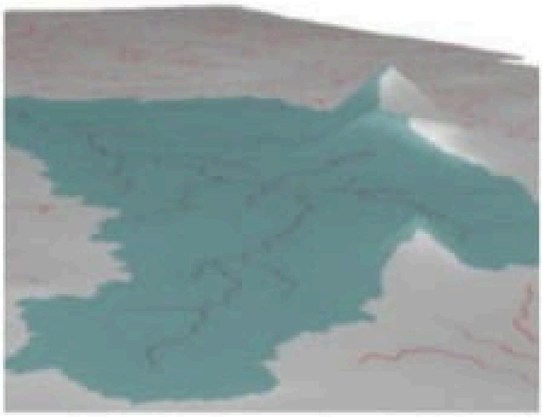
ρ- spearman correlation coefficient

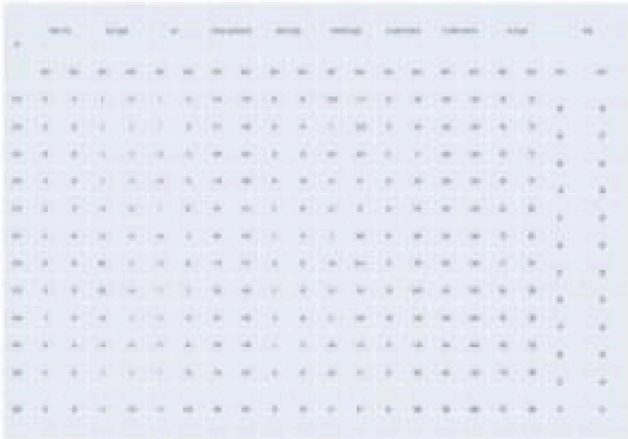
d - square of difference between the ranks

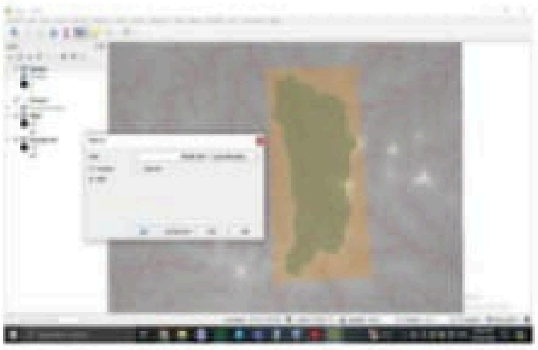
n - no. of observations

3. RESULTS

- Based on the Spearman correlation analysis conducted using the provided data, the following conclusions can be drawn:
- Temperature and Dissolved Oxygen (DO): The Spearman correlation coefficient (rs) is 0.01, indicating a very weak positive correlation. This suggests that there is no significant relationship between temperature and DO levels in the Kanh River.
- pH and Dissolved Oxygen (DO): The Spearman correlation coefficient (rs) is -0.59, indicating a moderate negative correlation. This suggests that higher pH levels are associated with lower levels of dissolved oxygen, which may indicate poorer water quality conditions for aquatic life.
- Conductivity and Dissolved Oxygen (DO): The Spearman correlation coefficient (rs) is 0.39, indicating a moderate positive correlation. This suggests that higher conductivity levels are associated with higher levels of dissolved oxygen, which may indicate better water quality conditions.
- BOD and Dissolved Oxygen (DO): The Spearman correlation coefficient (rs) is 0.23, indicating a weak positive correlation. This suggests that higher levels of biochemical oxygen demand (BOD) are associated with higher levels of dissolved oxygen, which may seem counterintuitive. However, this could be due to complex interactions within the ecosystem.
- Nitrate and Dissolved Oxygen (DO): The Spearman correlation coefficient (rs) is 0.24, indicating a weak positive correlation. This suggests that higher nitrate levels are associated with higher levels of dissolved oxygen, which may also seem counterintuitive. Again, this could be due to various ecological factors at play.
- Overall, while some correlations were observed between water quality parameters, the strength of these correlations varied, indicating complex interactions within the Kanh River ecosystem. Further research and monitoring efforts are necessary to fully understand these relationships and develop effective management strategies for improving water quality in the river.







4. **DISCUSSIONS**

- As we can see in the above shown figures, in previous years, the water quality of the Kanh River has exhibited concerning trends, as highlighted by various studies.

- For instance, data from 2014-2015 indicated that a staggering 50% of the river water was deemed unsuitable for drinking, signifying a severe degradation in water quality.

- Subsequent assessments in 2018-2019 showed some improvement, with the percentage of water categorized as poor quality decreasing to 30%.

- However, despite these modest gains, the current study reveals that the Kanh River continues to face significant challenges, with approximately 60% of the water now classified as average quality. This persistent decline underscores the urgency of implementing effective rejuvenation measures.

- By leveraging advanced techniques such as QGIS analysis and remote sensing, this study provides valuable insights into the evolving dynamics of the river ecosystem, enabling stakeholders to formulate targeted interventions aimed at reversing the downward trajectory of water quality in the Kanh River.

- This deterioration in water quality poses grave threats to both human health and the surrounding ecosystem, jeopardizing the livelihoods of local communities and the survival of aquatic life.

- Urgent rejuvenation efforts are imperative to mitigate the adverse effects of pollution and restore the Kanh River to a healthy and sustainable state.

- Implementing targeted interventions informed by advanced techniques such as QGIS analysis and remote sensing can provide crucial insights into the root causes of pollution, guiding effective rejuvenation strategies.

- Revitalizing the Kanh River is not only essential for safeguarding the well-being of local populations and ecosystems but also holds broader regional and national significance in the context of water security and environmental sustainability.

5. CONCLUSIONS

In conclusion, urgent action is imperative to address the pressing challenges facing the Kanh River and India's broader water resources. The Kanh River's decline in water quality underscores the critical need for immediate and concerted efforts to reverse its degradation. By harnessing advanced technologies such as QGIS and remote sensing, we can gain crucial insights into the complex dynamics of the river system, enabling us to formulate targeted and effective rejuvenation strategies.

Furthermore, revitalizing the Kanh River has the potential to serve as a beacon of hope and inspiration for nationwide water management initiatives. As one of India's iconic rivers, its restoration not only holds intrinsic value for the local communities and ecosystems but also sets a precedent for sustainable water resource management practices across the country.

However, achieving this ambitious goal requires a multifaceted approach that emphasizes sustainability and collaboration. Implementing sustainable practices, such as watershed management and pollution control measures, is essential for safeguarding the long-term health of the Kanh River and ensuring the resilience of India's water resources as a whole. Additionally, fostering collaboration among government agencies, local communities, NGOs, and other stakeholders is paramount to mobilizing resources, sharing knowledge, and fostering collective action towards river rejuvenation.

In essence, revitalizing the Kanh River is not just a local endeavor but a shared responsibility that demands unwavering commitment, innovation, and cooperation. By rising to this challenge, we can pave the way for a future where clean and abundant water resources sustainably support the needs of both present and future generations.

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CONCRETE STRENGTH FEASIBILITY ANALYSIS USING TREATED WASTEWATER

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Abstract— ***The escalating scarcity of fresh potable water, make worsens condition by diminishing groundwater levels, underscores the urgency for sustainable water management practices. Concrete, the second most consumed material globally, further inflames this issue, utilizing vast quantities of fresh water for various processes such as aggregate washing, concrete production, and curing. To address this challenge, this study proposes a solution by advocating for the utilization of treated wastewater from effluent treatment plants [ETP] as a viable alternative.***
This paper investigates the physical and chemical impacts of treated wastewater on M20-grade concrete cubes, focusing on their hardened properties and durability. Test cubes were subjected to curing periods of 3, 7, 14, and 28 days, followed by measurement of compressive strength for both categories: cubes cast from treated wastewater and cubes cast from potable water. Study show using treated wastewater in concrete production doesn't affect its strength, reducing freshwater consumption. Additionally, the paper analyzes properties such as water absorption, resistance to elevated temperatures, acid attack, and salt attack on the concrete cubes. This research aims to contribute to sustainable water management efforts.

Keywords: *Treated wastewater, potable water, concrete, compressive strength, water absorption.*

1. INTRODUCTION

Concrete, an omnipresent building material worldwide, has witnessed extensive utilization due to burgeoning population growth and rapid development. However, this surge in demand has brought forth substantial environmental concerns, notably air and water pollution, and the depletion of vital resources. Among these issues, the scarcity of potable water resources stands as a prominent global challenge. This challenge is underscored by projections indicating that industrial water consumption will surge to 1500 billion m^3 by 2030, up from 800 billion m^3 in 2009. In this context, regions like India, grappling with water scarcity issues, confront critical circumstances, exacerbated by delayed monsoons and overexploitation of groundwater resources.

Notably, the construction sector contributes significantly to water consumption, utilizing approximately one trillion cubic meters of freshwater annually. Moreover, the manufacturing of concrete alone requires around 500 L of freshwater per cubic meter. The industry's broader water requirements span from aggregate cleansing to curing, culminating in environmental impact. To mitigate this, exploring alternative water sources, specifically wastewater, gains importance.

Given the escalating wastewater generation due to rapid industrialization and population growth, the potential for wastewater integration in concrete production emerges as a promising avenue. Developing countries like India, with inadequate wastewater treatment infrastructure, grapple with pollution issues due to improper discharge. Consequently, leveraging wastewater for concrete production presents a dual advantage—alleviating water scarcity and minimizing contamination risks.

However, there exists a research gap in comprehending the long-term effects of wastewater-derived concrete on factors such as sulphate resistance, acid attack, water absorption, chloride permeability, and carbonation. This review paper addresses this gap, exploring the viability of wastewater-inclusive concrete and its potential to revolutionize sustainable construction practices. Through an in-depth analysis of existing studies, this paper aims to contribute insights into the durability and compatibility of different wastewater sources with concrete production, ultimately striving for holistic water resource conservation across diverse sectors. The oceans, comprising the largest single body of water, encompass 70.8% of the Earth's surface area [1, 2] and store 97.6% of the Earth's water resources. Unfortunately, this huge volume of water is saline and it is not only just unreadily available for various uses, but it also further affects the quality of the surface and groundwater near coastal areas through saline water intrusions. This further reduces the volume of available freshwater around such areas and also increases the costs of providing fresh water for day-to-day routine activities to the people in the vicinity at the cost of heavy investment in infrastructures and technical expertise to avoid or minimize the saline water intrusion from the oceans. Out of the 2.4% available freshwater, 68.7% is stored in the ice caps and glaciers and 30.1% is stored as groundwater. This implies that only about 1.2% of the available freshwater is stored in the soil moisture, ground ice and permafrost, lakes, atmosphere, swamps, rivers, and biological water. Just like ocean water, the freshwater stored in ice caps and glaciers is not also readily available for use and even if it were available, it is not well spatially distributed as they are only concentrated in the North and South Poles of the Earth. The problem of freshwater availability is further aggravated by the fact that only 50% of the groundwater can be easily and economically extracted (i.e., up to a depth of 800 m only). Deducting the ocean water, water stored in the ice caps and glaciers, and groundwater stored in aquifers deeper than 800 m from the Earth's surface, makes the volume of fresh water available for domestic use and other usages stand at a meager 0.39% of the total global water resources.

This meager proportion of freshwater is also rapidly getting depleted due to too much pressure on it due to rapid population increase, urbanization, industrialization, prolonged drought, and changes in land use cover. Concomitantly, rivers, lakes, ponds, glaciers, and freshwater bodies are suffering from pollution due to the unregulated discharge of contamination into them.

Water scarcity is an ongoing water crisis and it is affecting nearly 1 million people each year. Several factors have combined to put excessive pressure on the finite available freshwater resources. These include increasing population, rapid urbanization, industrialization, etc. The construction industry is the second largest consumer of freshwater just after agriculture. Concreting alone consumes, annually, over a trillion cubic meters of freshwater globally. Wastewater reuse is seen as the main long-term strategy for the conservation of limited freshwater resources.

Ocean stores 97.6% of the Earth's water resources and only 2.4% of fresh water is available of the total water present on Earth. Out of the 2.4% available freshwater, 68.7% is stored in the ice caps and glaciers and 30.1% is stored as groundwater. This implies that only about 1.2% of the available freshwater is stored in the soil moisture, lakes, rivers, and biological water. The freshwater stored in ice caps and glaciers is not also readily available for use and groundwater up to 800m is economical to use. The volume of fresh water available for domestic use and other usages stands at a meager 0.39% of the total global water resources. This paper reviews the current state of knowledge and practices related to the use of recycled wastewater for concrete production and allied activities.

2. LITERATURE REVIEW

Ghair et al. (2016) researched Domestic Wastewater Reuse in Concrete Using Bench-Scale Testing and Full-Scale Implementation. Based on the research study, the Authors have concluded that by use of PTW and STW for concrete and mortar production in bench and full scales. The water quality analysis showed that STW is suitable for concrete and mortar production according to permissible limits of mixing water for concrete while PTW is not [2].

Jabri et al. (2011) worked on the Effect of using Wastewater on the Properties of High Strength Concrete. Based on the research study, the Authors have concluded that the chemical composition of the wastewater is generally higher than tap water, but within the standard limits specified in ASTM. The high concentrations of some substances could raise concerns about the potential for corrosion and sulphate attack in reinforced concrete structures [3].

Ahmad et al. (2021) experimented on secondary-treated wastewater as a concrete component and its impact on the basic strength properties of the material based on the research study, authors have concluded that the organic content present in secondary-treated wastewater might be playing a role as a dispersing agent, improving the dispersion of particles. In addition, this increase could be due to the filling effect of solid particles, which may have contributed to the concrete strength increase [5].

Gupta et al. (2022) researched the Effect of Treated Wastewater on the Properties of Concrete, based on the research study, the Authors concluded that the compressive strength of a cement cube prepared with treated sewage water is 6% more than the cement prepared by freshwater while the tensile strength of cement prepared by treated sewage water is 1.63% more than the cement cube prepared by freshwater.

Hegazy et al. (2020) worked on the Effect of using secondary treated wastewater in the production and curing of concrete. Based on the research study, the Authors have concluded that using Treated Waste Water in a concrete mixture reached the maximum compressive strength value faster than the Potable Water concrete, especially in the first 28 days of mixing concrete. The major problem of wastewater is that it includes a huge amount of pollution that has a huge influence on the properties of water [7].

Mane et al. (2019) experimented on the Use of Sewage Treated Water in Concrete. Based on the research study, the Authors have concluded that Sewage water is used to prepare concrete cubes under normal conditions, then those cubes give satisfactory results of compressive strength.it is observed that the compressive strength of the cubes made with treated sewage water is greater than those made with normal tap water [8].

Nagaraja et al. (2021) researched on Quality Assessment of concrete utilizing treated wastewater. Based on the research study, the Authors have concluded that the use of treated wastewater in concrete does not affect the consistency of the cement. The compressive strength of concrete made from treated wastewater is about the same as the compressive strength of concrete made from freshwater The tap water can therefore be replaced by treated wastewater, especially in places where freshwater is scarce [6].

3. OBJECTIVES OF THE STUDY:

The objectives of the present research study are as follows;

a. To determine the physical and chemical properties of raw materials
b. Preparation of concrete samples using potable water and treated waste water
c. Determination of Strength and durability characteristics of prepared samples.
d. Comparison of results between concrete with potable water and treated waste water.

4. METHODOLOGY

The methodology of the proposed research study is shown in Fig. 1.

Figure1: Methodology

The method for the proposed research are as follows: -

- ➢ Accumulation of raw materials: -
- Sample water has been collected from ETP of Sanchi Doodh Dairy RW37+8X5, Manglaya Sadak, Indore, Madhya Pradesh 453771
- Sand, cement, C.A., F.A., and potable water have been taken from the IPS Academy campus.
- ➢ Determination of properties of raw materials;
- Physical properties.

- Chemical properties of potable and sample water are shown in table 1.

Table 1: Chemical Properties of Water

Properties	Potable water	Untreated water	Treated water
PH	7.9	8	7.5
T.S.	182	1652	1322
T.D.S.	164	1417	1241
Suspended Solid	18	235	81
COD	-	245	80
DO	8		
BOD	-	70	25
Oil and Greece	-	13	03
Chloride Ion	-	620	435
Alkalinity	67	-	-
Hardness	-	638 ppm	568

➢ Preparation of concrete:

The design has been done for the standard mix of M-20 grade & then all the raw materials are mixed in a proper ratio as per the calculation with the help of a miller. Used a vibrating table to make sure there was no air pocket present inside the casted cube.

The present study utilized standard mix M-20 grade concrete mix proportions as listed in Table 2.

Table 2: Mixed Proportion Ratio

Standard Mix M20 (1:1.5:3)		
Particulars	Dry Material Ratio	Unit
Cement	403	Kg/m^3
Water	190	Kg/m^3
M-Sand	303	Kg/m^3
R-Sand	454	Kg/m^3
20 mm C.A.	1382	Kg/m^3
W/C	0.47	-

Each constituent was weighed separately in buckets and mixed in a miller for approximately ten minutes, following the IS10262 standard. Workability was analyzed by measuring the slump of the fresh concrete to ensure it meets design requirements and to investigate the impact of wastewater replacement.

After 24 hours, the specimens were demolded, cured in water, and subsequently tested at room temperature, at the required age. To determine the unconfined compressive strength, 15 cubes measuring 150mm x 150mm x 150mm were cast for each mix and water-to-binder ratio. Three samples from each mix were tested after 3, 7, and 28 days of curing.

➢ Pre-Testing Procedure

After curing, the following tests were carried out on the concrete specimens:

3rd day, 7th day, 14th day and 28th day cube compressive strength test was conducted in accordance with IS:456:2000 using a loading rate of 2.5 kN/s;

Holding a cube on the 3rd day, 7th day, 14th day, and 28th day of curing for water absorption test oven temperature must hold at least 100°C of temperature for at least 24 hours.

➢ Determination of strength and durability characteristics of concrete

To assess the strength and durability of concrete, M-20 grade concrete cubes were cast using potable water and sample water. For strength determination cubes were tested in the compressive testing machine (CTM) on the 3rd, 7th, 14th, and 28th day completion of curing, as per the guidelines provided in IS 456:2000. And for the determination of the durability of concrete, water absorption, acid attack, salt attack, and elevated temperature test were conducted.

5. Experimental Setup:

➢ To characterize the physical and chemical properties of the raw materials, representative samples underwent a series of tests. Additionally, relevant values from the IS code were consulted to supplement the gathered information. Moreover, the treated wastewater from the Sanchi plant was analyzed for its specific properties.

- For assessing the desirable outcomes, M-20 grade cubes were prepared using both ETP water and potable water. Subsequently, various tests were conducted to illustrate any discrepancies between the two water categories.
- The compressive strength of the cubes was evaluated using a compression testing machine. This technique, well-established in materials science, allows for the investigation of how materials respond to compressive forces. By subjecting samples to pressure using specialized tools mounted on a universal testing machine, properties such as strength and deformation were determined. The insights gathered from these tests are crucial for informing the design and engineering of diverse structures and products.
- In the water absorption test, cubes were placed in a dry oven at 110 degrees Celsius for 24 hours to assess their water absorption capacity.
- Subsequently, acid attack with sulfuric acid (H2SO4) and salt attack with sodium chloride (NaCl) were conducted on two sample water cubes and two potable water cubes, maintaining a curing water pH of 2.6for acid attack and 10% NaCl was used for salt attack. This analysis aimed to evaluate the durability of the concrete cubes after 28 days.
- Additionally, an elevated temperature test was performed after 28 days of curing the cubes to further examine their properties under different environmental conditions.

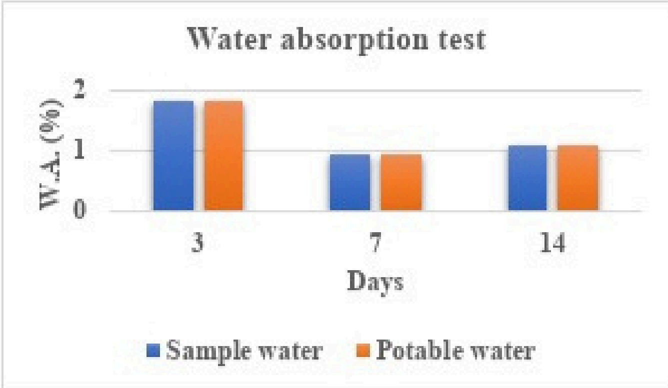
6. Outcomes and Results

We researched to find solutions for the scarcity of drinkable water on our planet. One of our findings was the reusability of ETP water for large-scale construction projects such as making concrete. To test water absorption, we took a sample from both categories of water and dried them in the oven at 110°C for 24 hours before performing the test. And the result shown in below table 3 and figure 2.

Table 3: Water Absorption

Water Absorption		
Days	Sample water	Potable water
3	1.84	1.84
7	0.936	0.936
14	1.10	1.10

Figure2: Water Absorption chart

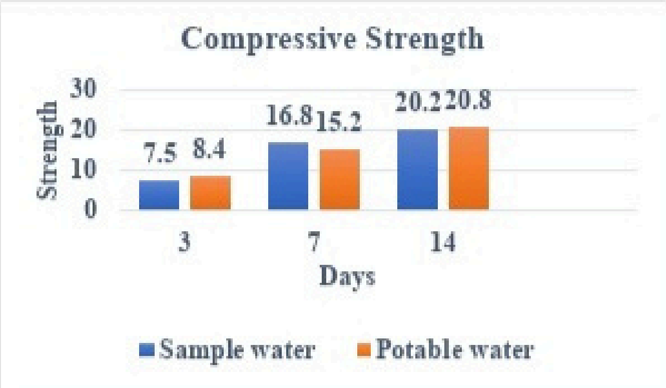


The compressive tests, conducted using a Compression Testing Machine (CTM), yielded results indicating that the samples treated with wastewater showed comparable performance to those treated with potable water. This outcome suggests that the use of treated wastewater does not significantly compromise the compressive strength of the concrete compared to potable water treatment. This finding holds significant implications for sustainable water management practices, indicating that treated wastewater can be a viable alternative without compromising the structural integrity of concrete materials. And the result shown in below table 4 and figure 3.

Table 4: Compressive strength test

Compressive strength M20 Grade (N/mm²)		
Days	**Sample water**	**Potable water**
3	7.5	8.4
7	16.8	15.2
14	20.2	20.8

Figure3: Compressive strength chart



7. Conclusion

Based on the experimental results and analysis, the following conclusions can be drawn regarding the effect of wastewater usage on the strength of concrete:

The chemical composition of wastewater generally surpasses that of potable water but remains within the standard limits specified in IS-10500. While certain substances are present at higher concentrations, potential concerns regarding corrosion and sulfate attack in reinforced concrete structures are noted.

With prolonged curing periods, the compressive strength of concrete increases, regardless of the percentage of wastewater used. This suggests that extended curing enhances the overall strength characteristics of concrete, irrespective of the source of water. There was no significant variance observed in the cube compressive strength of concrete among different mixes after 3rd day, 7th day, 14th day and 28th days of curing. This implies that the use of wastewater does not adversely affect the compressive strength of concrete compared to traditional potable water usage.

Concrete mixtures incorporating wastewater replacement displayed similar water absorption rates to the control mixture. This indicates that the use of wastewater does not significantly alter the water absorption properties of concrete.

The study suggests that the utilization of wastewater has a negligible effect on the strength of concrete.

In summary, while the immediate compressive strength and water absorption properties of concrete are not significantly affected by the use of wastewater, continued monitoring and assessment are necessary to evaluate the long-term durability and performance of concrete in real-world applications.

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Case study on Ancient Architecture of India

Yashu Yadav
Manya Madhu
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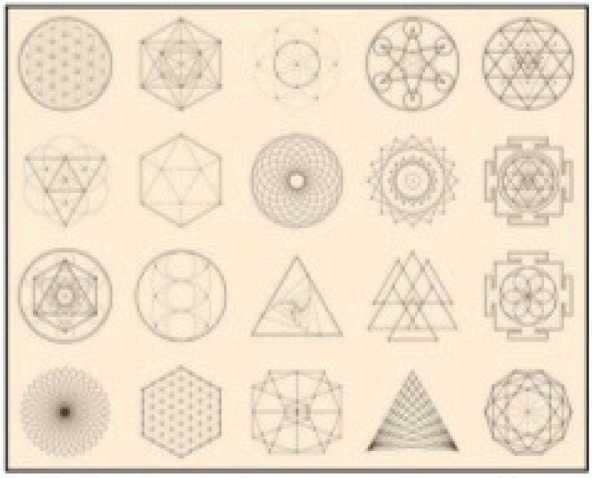
Introduction :-

From ancient South Indian temples to the finest Mughal ruins, Indian architecture is as old as civilization itself. The earliest traces of recognizable building activity in India can be traced back to the settlements of the Indus Valley. India is home to a myriad of temples, Baroque, and modernistic structures that tell the stories of their era. UNESCO lists 830 World Heritage Sites, 26 of which are on Indian soil.

The scope of ancient architecture in India is vast, reflecting the subcontinent's varied geography and cultural multiplicity. It's an amalgamation of structural design and symbolic elements where every edifice is a sanctum of aesthetic splendour and divine presence. The engineering techniques employed were revolutionary, involving advanced concepts of mathematics and town planning.

The earliest Indian buildings were made of wood and then brick. Few examples of such ancient structures, especially those of wood, have survived the severity of the Indian climate. By about the 6th century BC, stone architecture was being created on the subcontinent. Indian architects soon became highly skilled in the carving and construction of stone buildings. By the 7th century AD, the use of stone had become popular for important buildings of great size. Numerous stone temples from the medieval period still stand in India.

The architecture of India thus is a confluence of art, science and spirituality. Each structure a microcosm of the universe reflecting the ancient architects' quest for harmony between the earthly and the divine.



The architecture further got improved even during the British rule and even to this day.

.Here we are discussing about the three incredible ancient architecture structure – RaniKi Vav , Sanchi Stupa and Ellora Caves with their detailed study.

1. RANI KI VAV

1.1 INTRODUCTION

Rani ki Vav, also known as the Queen's Stepwell, is a magnificent and intricately designed stepwell located in the town of Patan in the state of Gujarat, India. This remarkable architectural marvel dates back to the 11th century AD and is a UNESCO World Heritage Site since 2014.

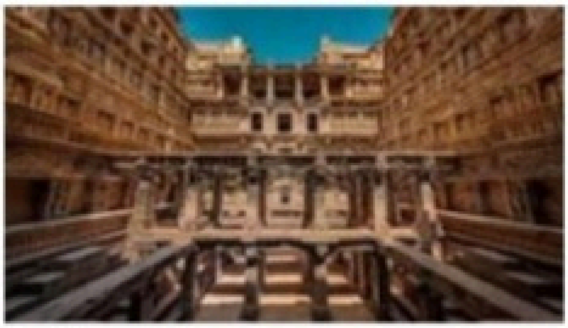
Stepwells, or vavs, are unique to the Indian subcontinent, serving not only as sources of water storage but also as spaces for social gatherings, rituals, and relaxation, particularly during hot and dry seasons. Rani ki Vav is one of the most elaborate and ornately decorated stepwells, known for its stunning craftsmanship and architectural beauty.

The construction of Rani ki Vav is attributed to Queen Udayamati, the wife of King Bhimdev I of the Solanki dynasty, in memory of her husband. The stepwell is designed in the form of an inverted temple, extending several stories deep into the ground. It features seven levels of stairs leading down to the water, with intricately carved panels, pillars, and niches adorning the walls at each level.

The carvings at Rani ki Vav are renowned for their exquisite detail and artistic finesse. They depict various mythological themes, including scenes from the Ramayana, Mahabharata, and other Hindu scriptures, as well as depictions of deities, celestial beings, and intricate floral motifs. The sculptures are remarkably well-preserved and offer insights into the religious, cultural, and artistic traditions of medieval India.

Rani ki Vav fell into disuse and was buried under layers of silt for centuries until its rediscovery in the 20th century. Subsequent restoration efforts have helped unveil its splendor, making it a popular tourist destination and a testament to India's rich architectural heritage.

Today, Rani ki Vav stands as a testament to the ingenuity and craftsmanship of ancient Indian artisans and continues to captivate visitors with its awe-inspiring beauty and historical significance.



1.2 LOCATION DETAILS

Rani ki Vav is located in the town of Patan, which lies in the northern part of the Indian state of Gujarat. Here are more specific details about its location:

- **Town**: Patan
- **State**: Gujarat
- **Country**: India
- **Latitude**: Approximately 23.8491° N
- **Longitude**: Approximately 72.1279° E

The stepwell is situated on the banks of the Saraswati River, which is now a dry riverbed. Patan itself is around 130 kilometers northwest of the state's largest city, Ahmedabad, and is easily accessible by road. Once in Patan, Rani ki Vav is a prominent landmark and can be reached via various modes of transportation

1.3 STRUCTURAL DETAILS

Rani ki Vav is an architectural masterpiece known for its intricate design and structural ingenuity.

1. **Stepwell Design**:
   - The stepwell is ingeniously designed to facilitate access to water at different levels depending on the water table. Each step or level leads deeper into the ground towards the water source.
   - The stepped corridors are not just functional but also serve an aesthetic purpose, with intricate carvings and decorative elements adorning the walls.
2. **Pillars and Columns**:
   - Rani ki Vav features numerous pillars and columns that provide structural support to the stepwell. These pillars are intricately carved with motifs such as floral designs, mythical creatures, and deities.
   - The pillars are strategically placed to distribute the weight of the structure evenly and to create visually appealing vistas within the stepwell.
3. **Carvings and Sculptures**:
   - The carvings at Rani ki Vav are among its most remarkable features, showcasing exceptional craftsmanship and artistic skill.
   - The carvings depict a wide range of subjects, including episodes from Hindu mythology, scenes from everyday life, celestial beings, and intricate floral patterns.
   - Each carving is meticulously executed, with fine details and delicate features that showcase the mastery of the artisans.

4. **Decorative Elements**:
   - In addition to carvings, Rani ki Vav is adorned with various decorative elements such as geometric patterns, friezes, and relief work.
   - These decorative elements serve to enhance the visual appeal of the stepwell and create a sense of grandeur and elegance.
5. **Water Management System**:
   - Rani ki Vav incorporates a sophisticated water management system designed to collect and store rainwater during the monsoon season.
   - The stepwell features intricate channels, reservoirs, and aqueducts that channel water from the surface into underground storage tanks, ensuring a steady supply of water throughout the year.
6. **Symmetry and Proportion**:
   - The layout of Rani ki Vav is characterized by a sense of symmetry and proportion, with carefully balanced architectural elements and spatial arrangements.
   - The proportions of the various structural components, including pillars, columns, and

staircases, are meticulously calculated to create a harmonious and visually pleasing composition.

7. **Entrance Pavilion**:
   - The entrance pavilion, or 'Nagara Torana,' serves as the gateway to Rani ki Vav and is adorned with elaborate carvings and sculptural panels.
   - The pavilion features a towering archway supported by intricately carved pillars, creating a grand and imposing entrance to the stepwell.

These detailed structural elements showcase the complexity and beauty of Rani ki Vav, highlighting its significance as a masterpiece of Indian architecture and craftsmanship.

1.4 COMPONENT OF STRUCTURE

2. **Foundation**: The foundation is the base upon which the entire structure of Rani ki Vav rests. It provides stability and support, ensuring that the stepwell remains intact despite its considerable size and weight.
3. **Walls**: The walls of Rani ki Vav form the outer perimeter of the structure and enclose the stepped corridors and chambers within. They are constructed using locally sourced sandstone, which is known for its durability and weather resistance.
4. **Pillars and Columns**: Pillars and columns are essential structural elements that provide vertical support to the ceilings and roof of Rani ki Vav. These pillars are intricately carved with motifs and designs, adding to the architectural beauty of the stepwell.
5. **Stairs and Steps**: The stairs and steps of Rani ki Vav allow visitors to descend into the depths of the stepwell and access the water reservoir at the lower levels. These stairs are constructed in a stepped manner, with each level gradually descending deeper into the ground.
6. **Ceilings and Roofs**: Ceilings and roofs cover the various levels and chambers of Rani ki Vav, protecting them from the elements. The ceilings may feature decorative elements such as relief work and carvings, adding to the aesthetic appeal of the interiors.
7. **Carvings and Sculptures**: Carvings and sculptures adorn the walls, pillars, and ceilings of Rani ki Vav, depicting scenes from Hindu mythology, celestial beings, and intricate floral patterns. These artistic elements serve both decorative and symbolic purposes, reflecting the cultural and religious significance of the stepwell.

1.5 MATERIALS USED

The construction of Rani ki Vav utilized various materials, each chosen for its durability, aesthetic appeal, and suitability for the architectural style prevalent during the time of its construction. Here are the primary materials used in making Rani ki Vav:

1. **Sandstone**: The predominant material used in the construction of Rani ki Vav is sandstone. Locally sourced sandstone, known for its strength and weather resistance, was extensively quarried and carved to create the walls, pillars, and decorative elements of the stepwell. The sandstone used in Rani ki Vav varies in color from light beige to pinkish hues, adding to the visual richness of the structure.
2. **Lime Mortar**: Lime mortar was used as a binding agent to join the individual stone blocks and carvings together. Lime mortar, made from limestone and water, hardens over time and provides structural integrity to the masonry work while allowing flexibility and resilience to the structure.
3. **Wood**: While not as prevalent as stone, wood was also used in certain structural elements and features of Rani ki Vav. Wooden beams and supports may have been incorporated into the ceilings and roofs to provide additional reinforcement and stability.
4. **Metal**: Metal elements such as iron may have been used for fixtures, fittings, and reinforcements in certain parts of Rani ki Vav. However, due to the corrosive nature of the environment, many original metal components may have corroded or been replaced during restoration efforts.
5. **Decorative Materials**: Various decorative materials were used to embellish Rani ki Vav, including semi-precious stones, such as marble and granite, for inlay work. These materials were used sparingly but added intricate detailing and richness to the carvings and sculptures.

These materials, carefully selected and skillfully crafted by the artisans of the time, contribute to the enduring beauty and structural integrity of Rani ki Vav, making it a masterpiece of Indian architecture and craftsmanship

1.6 CONCLUSION

In conclusion, Rani ki Vav stands as a magnificent testament to the architectural ingenuity, artistic finesse, and cultural heritage of ancient India. Located in the town of Patan, Gujarat, this UNESCO World Heritage Site is a remarkable example of a stepwell, showcasing elaborate craftsmanship and structural sophistication.

Constructed in the 11th century AD by Queen Udayamati in memory of her husband, Rani ki Vav is a stunning blend of functionality and aesthetics. Its design, featuring seven levels of stairs leading down to the water, intricate carvings depicting mythological themes, and advanced water management system, reflects the engineering prowess and artistic sensibilities of its builders.

The materials used in the construction of Rani ki Vav, including locally sourced sandstone, lime mortar, and decorative elements such as wood and metal, contribute to its durability, beauty, and historical significance. Over the centuries, Rani ki Vav has endured as a symbol of India's rich cultural heritage, captivating visitors with its grandeur and elegance.

Through extensive conservation efforts and recognition as a cultural treasure, Rani ki Vav continues to inspire awe and admiration, serving as a reminder of the remarkable achievements of ancient

2. Sanchi Stupa

2.1 Introduction

Sanchi is a world heritage site situated about 50 kilometres from Bhopal, Madhya Pradesh. There are three stupas in Sanchi: Stupa-1, Stupa-2 and Stupa-3. Stupa-1 is believed to have relics of Buddha. Stupa-2 has relics of the less famousarhats, and Stupa-3 has the relics of Sariputta and Mahamougalayana. Stupa-1, also called the great stupa, is the oldest among the three.SanchiStupa was constructed in the 3rd Century BC. It was said to be built under the direct supervision of King Ashoka's wife, Queen Devi, and his daughter.

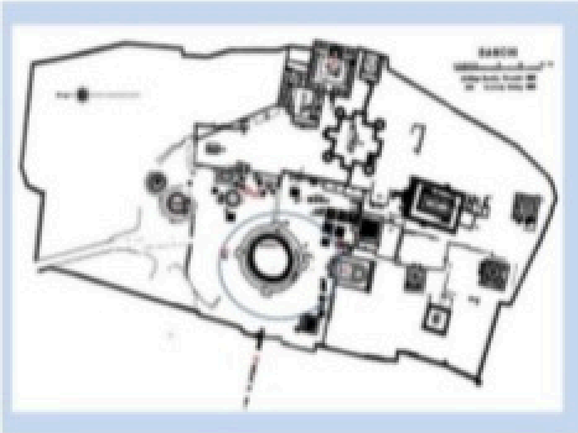
The present hemispherical edifice is double in diameter of the original brick structure built by Ashoka, consisting of the relics of Lord Buddha. A chatra that is an umbrella like structure made of stone crowned the hemispherical brick structure that was surrounded by a wooden railing.

2.2 Location details

It is located, about 23 kilometers from Raisen town, district headquarter and 46 kilometres (29 mi) north-east of Bhopal, capital of Madhya Pradesh.The building is 120 feet (37 metres) wide and 54 feet (17 metres) high.

It is a larger hilltop complex with additional stupas, monasteries, temples and pillars.

Buddhists worship it by walking around it in a clockwise direction. This follows the path of the sun and is in harmony with the universe. The stupa has the names of more than 600 people, who donated money for its construction, carved on it.



2.3 Structural Details

- It is **enclosed by a massive stone railing pierced by four gateways,** which are adorned **withelaborate carvings** (known as Sanchi sculpture).
- The stupa itself **consists of a base bearing a hemispherical dome** (anda), symbolizing the dome of heaven enclosing the earth.
- It is **surmounted by a squared rail unit (harmika)** representing the world mountain, from which rises a mast (yashti), symbolizing the cosmic axis.
- The **mast bears umbrellas (chatras)** that represent the various heavens (devaloka).

2.4 Components of Structure

The inside of the SanchiStupa is based on the mentioned below components:

- **Anda**

The hemispherical mound built in the Great Stupa at Sanchi is known as Anda. The domed-shaped hemisphere with the highlights of green colour showcases the dirt mount which was used to cover the remains of Lord Buddha. The solid core, which can not be entered, also makes the part of the Anda. The first built Stupa under king Ashoka contained the actual relics of Lord Buddha. The chamber of the relic is still there and buried deep inside the Anda, known as Taberna. With the passing of time, the hemispherical mound has taken the shape of a symbolic connection. It symbolises the home of Gods in the universe's centre inside the mound.

- **Harmika**

Inspired by the railing of square shapes, Harmika has highlights of red which surround the hemispherical mound, Anda. The Harmika makes Anda a hollowed space for burial.

- **Chhatra**

Chhatra is a central pillar providing support to the three umbrellas present at the great Stupa of Sanchi. This pillar was procured from the triple umbrellas to protect the Anda from the other elements. Since the symbolism of the hemispherical mound changed with time, the central pillar was also brought to represent the pintle of the universe. The umbrellas like three disks represent the three-major jewels of Buddhism. These jewels are Sangha, Dharma, and Buddha.

Apart from the three major components of SanchiStupa, below are the two other components that make up the site:

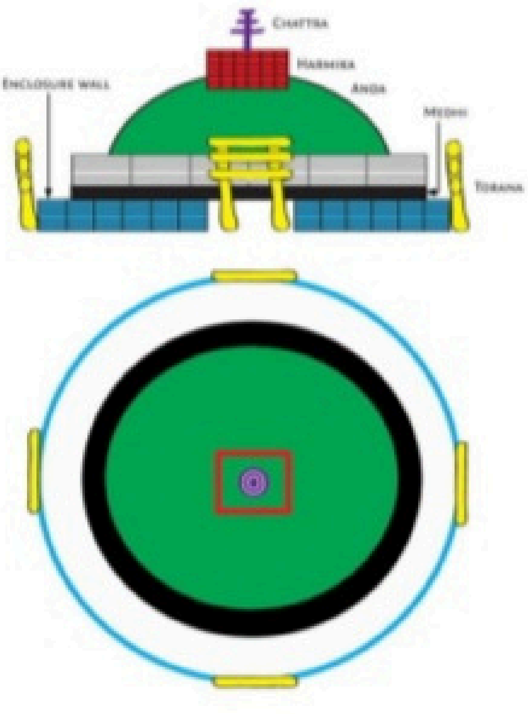
- **Medhi**

The terrace that surrounds the triple bar railings is called Medhi in the great StupaSanchi India. The Anda needs support to keep off itself from the ground, which is provided by this terrace. Additionally, the terrace is also used as a space for ritual circumvents.

- **Toranas**

Toranas are the wall of the Stupa with trademarks on them. These trademarks are three horizontal bars of stones which surround the entire site of the Stupa. The wall has highlights of light blue colour, with toranas highlighted with yellow.

The ashokan pillar with schism edict is in the ornamental shankanlipi of the gupta period. SanchiStupa is the oldest structure constructed of stone in India.



2.5 Materials Used In Construction

The bricks made structure looked like a hemispherical dome. The Shungas later enlarged the Ashokan construction during 1st century BC. Vedikas are the polished stone slab railings that enclose the main structure. Harmika is another sandstone made railing.Lion capital pillar of Sanchi is another creation of King Ashoka in 3rd century BCE. A finely polished sandstone forms the pillar, erected just aside the main Torana of Great Stupa.

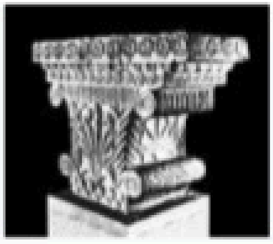
However, unlike the more rounder brick structure, the stone one has a flattened top surmounted with a three-tier chatra symbolic of the Wheel of Dharma. A flight of double staircase was introduced to let one walk around the sacred dome and get to the elevated rounded drum that came to be the seat of the structure.Bricks were used in the construction of the Stupa, which expanded over time. It was eventually covered with stones due to the construction of toranas and vedikas (low walls). The design of Stupa'storan and fencing reminds of Bamboo craft.

2.6 Architecture: evolution of the load-bearing pillar capital

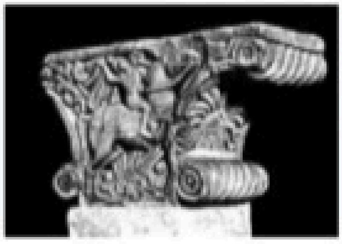
The Sarnath capital is a pillar capital discovered in the archaeological excavations at the ancient Buddhist site of Sarnath .The pillar displays Ionic volutes and palmettes. It has been variously dated from the 3rd century BCE during the Mauryan Empire period, to the 1st century BCE, during the Sunga Empire period. One of the faces shows a galopping horse carrying a rider, while the other face shows an elephant and its mahaut.

The pillar capital in Bharhut, dated to the 2nd century BCE during the Sunga Empire period, also incorporates many of these characteristics, with a central anta capital with many rosettes, beads-and-reels, as well as a central palmette design. Importantly, recumbent animals (lions, symbols of Buddhism) were added, in the style of the Pillars of Ashoka.

Evolution of the Indian load-bearing pillar capital, down to 1st century Sanchi

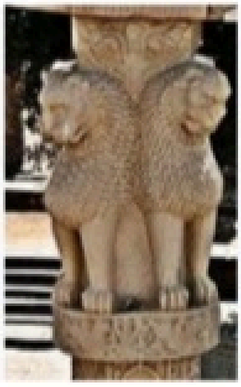


Mauryan capital (Pataliputra capital) 4th-3rd c. BCE



Sarnath capital, Sarnath, c.3rd-1st c. BCE

Bharhut capital 2nd c. BCE



Sanchi lion capital 1st c. BCE

3.5 Materials Used in Construction

The construction of the Ellora Caves predominantly employed basalt rock, sourced from the surrounding Charanandri Hills. Using basic stone-cutting tools such as chisels and hammers, ancient artisans meticulously carved the rock to create the intricate cave structures, chambers, and ornate facades. Basalt's durability and hardness made it an ideal material for rock-cut architecture, ensuring the longevity of the caves over the centuries.

While the primary construction material was basalt, softer stones like limestone or sandstone may have been utilized for decorative elements and intricate carvings. Additionally, some caves may have been adorned with painted frescoes or murals, created using natural pigments derived from minerals or plants. Through the skillful manipulation of these materials, the Ellora Caves emerged as a masterpiece of architectural and artistic achievement, showcasing the ingenuity and craftsmanship of ancient Indian artisans.

3.6 Conclusion

The Ellora Caves, nestled in the Charanandri Hills of Maharashtra, India, epitomize the pinnacle of architectural and artistic achievement of ancient civilizations.

Carved meticulously into solid basalt rock over centuries, these caves represent a harmonious fusion of Hindu, Buddhist, and Jain religious traditions, each adorned with intricate sculptures, ornate facades, and majestic halls. From the awe-inspiring Kailash Temple, hewn from a single rock, to the serene viharas and the elegant Jain shrines, the Ellora Caves showcase the diverse cultural tapestry of India.

Designated as a UNESCO World Heritage Site, these caves continue to captivate visitors with their timeless beauty, serving as a testament to human ingenuity, devotion, and the enduring legacy of India's rich cultural heritage.

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NON-CONVENTIONAL APPROACHES TO ENGINEERING MATERIALS

A Pathway to Green Building Practices

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Abstract: In the wake of increasing environmental concerns and the urgency to mitigate climate change, there is a growing imperative to transition towards sustainable materials across various industries. This abstract presents a comprehensive review of sustainable materials, encompassing their sources, properties, manufacturing processes, and applications. This paper contains a review of the innovation on traditional building materials that are sustainable in nature, including Eco-Bricks, Green-Cement, Environment friendly Concrete and Tiles.

1. INTRODUCTION

In recent years, the global construction industry has witnessed a paradigm shift towards more sustainable and environmentally friendly building materials. Among these innovative solutions are Eco-Bricks, Green Cement, Environmentally Friendly Concrete, and Tiles. These advancements represent a significant departure from traditional construction materials, offering a promising pathway towards reducing carbon footprints, conserving natural resources, and mitigating environmental impact throughout the building lifecycle. This is a theoretical paper that elaborates on the following:

Eco-Bricks:

These bricks are made of recycled or waste products present a suitable alternative to the traditional clay bricks that harm the environment. This includes Sugarcane Bagasse Ash bricks, Fly Ash bricks, Zeolite Rock-Sawdust bricks and Recycled plastic bricks.

Environment Friendly Tiles:

Tiles are essential elements in interior and exterior design, but their production often involves energy-intensive processes and the consumption of finite resources. Environmentally Friendly Tiles offer a sustainable alternative these include, Bamboo tiles, Cork tiles, Recycled Porcelain tiles, Terrazzo Tiles etc.

Green Cement:

Traditional cement production is notorious for its high carbon emissions and extensive use of non-renewable resources such as limestone and clay. In contrast, Additionally, Green Cement offers comparable or even superior performance to conventional cement, making it a viable choice for eco-conscious construction projects.

Environmentally Friendly Concrete:

Concrete is one of the most widely used construction materials globally, but its production is associated with significant environmental drawbacks, including high energy consumption and CO2 emissions. Environmentally Friendly Concrete can be tailored to specific project requirements, offering versatility and sustainability in construction applications.

2. ECO – BRICKS

Eco-Bricks, also known as recycled bricks or plastic bricks, are a revolutionary alternative to conventional clay or concrete bricks. They are crafted from recycled plastic waste and from waste like saw dust or sugarcane bagasse ash By diverting plastic waste from landfills and oceans, Eco-Bricks contribute to waste reduction and promote a circular economy. Moreover, these bricks possess excellent insulation properties and can be used for various construction applications, from walls and pavements to modular structures.

2.1 Sugarcane Bagasse Ash (SBA) as brick material

The bricks were developed using the quarry dust (QD) as a replacement to natural river sand and lime (L) as a binder. The SBA–QD–L bricks are lighter in weight, energy efficient and satisfy the compressive strength requirements of IS 1077:1992. The bricks also serve the purpose of solid waste management and innovative sustainable construction material. The bricks can be used in local construction especially for non-load-bearing walls.

Type of brick	Flexural strength (kg/cm^2)	Combined compressive strength (MPa)	Shear bond strength (kg/cm^2)
Burnt clay	60.82	3.53	3.18
Fly ash	81.85	7.55	3.24
SBA–QD–L (Trail 7)	72.18	6.84	3.59

Figure 1: Advanced physio-mechanical properties of SBA–QD–L brick versus commercially available burnt clay and fly ash– cement bricks.

The flexural strength of the commercially available fly ash bricks was maximum (81.85 kg/cm2) whereas the SBA–QD–L bricks also met the minimum requirement of Class II bricks (70 kg/cm2) for flexural strength according to IS 4860:1996. The combined compressive strength of SBA–QD–L bricks was 6.84 MPa, which is approximately equal to the combined compressive strength of commercially available fly ash brick (7.55 MPa) and double the combined compressive strength of commercially available burnt clay bricks. Physical characterization of SBA shows lower specific gravity than the OPC and quarry dust present in the building bricks, making the bricks lighter in weight SBA bricks have lower density compared to conventional burnt clay and fly ash bricks. Particle size analysis indicates that 75% of SBA is distributed in the range of fine aggregate which shows the potential of SBA as replacement of fine aggregate material. The QD below 6 mm was used as replacement for fine aggregates. Characterization of QD shows the presence of crystalline silica (59.10%), which

imparts compressive strength in the SBA–QD–L building brick. These bricks have a significant potential and scope for utilizing the agricultural solid waste for manufacturing of building materials that are energy-efficient, lightweight and sustainable.

2.2 FLY ASH BRICKS

At present, India has production capabilities of over 10,000 Crore bricks through around 45,000 local kilns, in the unorganized sector. So the use of industrial waste products such as fly ash, for making bricks is ecologically and economically advantageous since apart from saving precious top agricultural soil, it meets the social objective of disposing industrial waste i.e. fly ash which otherwise is a pollutant and a nuisance.

Type of Bricks	Average Crushing Strength (N/mm^2)
Class A Clay Bricks	8.14
Fly Ash Bricks	18.81

Figure 2: Average Crushing strength of fly ash and clay bricks

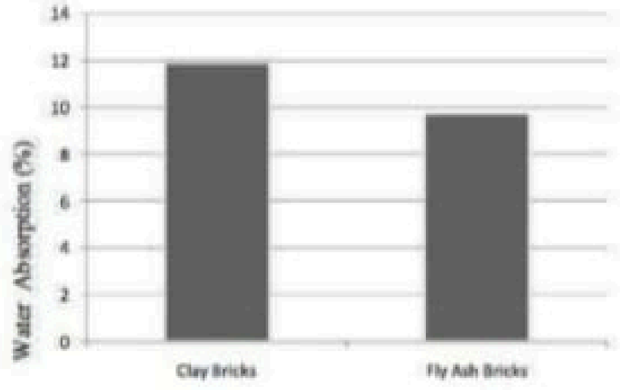


Figure 3: Water Absorption test on Bricks.

Fly ash bricks demonstrate considerable potential as a sustainable construction material with favorable compressive strength properties. By leveraging the insights from this study, stakeholders can confidently integrate fly ash bricks into building designs, contributing to environmentally responsible and resilient construction practices.

3. Environment Friendly Tiles:

These tiles are manufactured using energy-efficient methods and eco-friendly glazes, reducing environmental impact while maintaining aesthetic appeal and functional properties. Environmentally Friendly Tiles are available in a wide range of designs, sizes, and finishes, making them suitable for diverse architectural styles and applications. Tiles are essential elements in interior and exterior design, but their production often involves energy-intensive processes and the consumption of finite resources. Environmentally Friendly Tiles offer a sustainable alternative by utilizing recycled materials, such as glass, ceramics, and industrial by-products.

3.1 Recycled Porcelain tiles:

Recycled porcelain tiles offer a sustainable solution for interior and exterior design projects by repurposing post-consumer and post-industrial waste materials. These tiles are manufactured using recycled porcelain, often sourced from discarded sanitary ware, ceramics, and other porcelain products. The recycling process involves crushing and reprocessing the porcelain waste into fine particles, which are then mixed with binders and pigments to form new tile products. Recycled porcelain tiles boast a range of environmental benefits, including reduced demand for raw materials, energy conservation, and waste diversion from landfills. By repurposing porcelain waste, these tiles contribute to circular economy principles, minimizing environmental impact while promoting resource efficiency.

Recycled porcelain tiles are made from post-consumer and post-industrial waste materials, primarily sourced from discarded sanitary ware, ceramics, and porcelain products.

Then, the cleaned porcelain waste is crushed into small particles using crushers and pulverisers. The crushed porcelain is then finely ground into a powder using ball mills or other grinding equipment. This process helps to achieve a consistent particle size distribution and ensures uniformity in the final tile product.

Mixing and Formulation: The ground porcelain powder is mixed with binders, additives, and pigments to create a homogeneous mixture.

Pressing or Extrusion: The prepared mixture is fed into a hydraulic press or extruder machine to shape the tiles.

Drying: The pressed or extruded tiles are dried in kilns or drying chambers to remove excess moisture and stabilize the tile body.

Firing: The dried tiles are fired in kilns at high temperatures, typically between 1200°C to 1400°C, to vitrify the porcelain material.

Firing transforms the raw materials into dense, durable tiles with a non-porous surface and excellent mechanical properties.

3.2 Recycling of Waste Glass as Aggregate for Clay Used in Ceramic Tile Production

Ceramic tiles are widely used in homes as wall and floor tiles, WC, Jugs, plates, etc. The main constituent of clay is silica (SiO_2) and alumina (Al_2O_3) used in the production ceramic wares with the addition of other materials to attain the desire product standard. Other materials, such as, glass wastes which were sometimes being disposed in landfills have been used as substitutes of conventional raw materials in ceramic production (i.e. clay, sand and feldspar) for economic purposes. This is aimed at converting waste to wealth leading to zero waste.

The most familiar type of glass used for centuries is Soda lime glass made up of about 75% Silica (SiO_2) plus about 15% Sodium Oxide (Na_2O),12% Calcium Oxide (CaO) and several minor additives, More than 95% of all manufactured glass is made from sodium oxide, calcium oxide, and silicon dioxide, commonly referred to as a soda-lime-silica glass . Soda lime glasses are vitreous silicates which are formed during the maturation of clay bodies (during firing) and these serve as fluxes, reducing clay body maturation temperature. The glass wastes can be used to substitute the conventional flux materials, such as, feldspar and feldspathoid rocks used in the composition of ceramic masses.

It was seen in previous studies that Addition of 10% of waste glass can reduce the clay firing temperature by 55°C, . Glass powder can be used for improving the properties of wall tiles by the ceramic industry. The addition of 12 and 10% glass powder, in general, showed better results compared to 5%. The variation in the particle size of the glass powder does not change significantly the ceramic properties. The addition of broken glass to clay for the production of ceramic tiles had economic value because the firing temperature of the biscuits was reduced by about 3.9%, an indication that the addition of broken glass to clay at controlled proportion will drastically reduce the firing temperature and consequently the time of firing.

4.Green Cement:

Green Cement represents a more sustainable approach to cement manufacturing. It utilizes alternative materials like fly ash, slag, and calcined clays, reducing the carbon intensity of production and minimizing environmental impact, such as Rice husk ash cement, Calcinated clay cement etc.

4.1 Rice Husk Ash (RHA) as Cement Replacement:

Rice husk is an agricultural residue which accounts for 20% of the 649.7 million tons of rice produced annually worldwide. The produced partially burnt husk from the milling plants when used as a fuel also contributes to pollution and efforts are being made to overcome this environmental issue by utilizing this material as a supplementary cementing material. The chemical composition of rice husk is found to vary from one sample to another due to the differences in the type of paddy, crop year, climate and geographical conditions. Burning the husk under controlled temperature below 800 °C can produce ash with silica mainly in amorphous form.

It was shown in earlier research that at early ages the strength was comparable, while at the age of 28 days, finer RHA concrete exhibited higher strength than the concrete with coarser RHA. This is due to the fact that the higher fineness of RHA allowed it to increase the reaction with $Ca(OH)_2$ to produce more calcium silicate hydrate (C-S-H) resulting in higher compressive strength, in addition to that, the fine RHA particles contributed to the strength development by acting as a micro filler and enhancing the cement paste pore structure.

Oxide composition (% by mass)	OPC	RHA
SiO_2	20.99	88.32
Al_2O_3	6.19	0.46
Fe_2O_3	3.86	0.67
CaO	65.96	0.67
MgO	0.22	0.44
Na_2O_3	0.17	0.12
K_2O	0.60	2.91
LOI	1.73	5.81
Specific gravity	2.94	2.11

Figure 4: Chemical properties of RHA

The RHA is efficient as a pozzolanic material; it is rich in amorphous silica (88.32%). The loss on ignition was relatively high (5.81%). The compressive strength of the blended concrete with 10% RHA has been increased significantly.

4.1 Calcinated Clay Cement:

Calcined Clay Cement (CCC) has emerged as a promising sustainable alternative to conventional Portland cement due to its potential to reduce carbon emissions and enhance the durability of concrete. This comprehensive study aims to investigate the properties, performance, and environmental impact of CCC, providing valuable insights for its widespread adoption in construction applications.

The research methodology encompasses laboratory experiments, field studies, and literature reviews to comprehensively analyze various aspects of CCC. Key parameters such as compressive strength, durability, workability, and environmental impact are evaluated and compared with those of Portland cement-based concrete.

The production process of CCC, which involves calcination of kaolinite-rich clays at temperatures ranging from 600°C to 800°C, followed by grinding to produce a fine powder. The use of calcined clay as a supplementary cementitious material in concrete mixtures offers several advantages, including reduced clinker content, lower energy consumption, and decreased CO2 emissions during production. Furthermore, the study investigates the mechanical properties of CCC, including compressive strength, tensile strength, and flexural strength, through laboratory testing and statistical analysis. Comparative studies between CCC and Portland cement concrete reveal the potential for CCC to achieve comparable or even superior mechanical performance under certain conditions.

The durability of CCC is examined through accelerated aging tests, freeze-thaw resistance tests, and chloride penetration tests. The results indicate that CCC exhibits enhanced durability characteristics, including improved resistance to sulphate attack, alkali-silica reaction (ASR), and carbonation, compared to conventional concrete.

CCC generally exhibits good workability characteristics, allowing for ease of mixing, placing, and finishing during concrete construction. Proper adjustment of water-to-binder ratio and use of suitable admixtures can optimize the workability of CCC mixes to meet specific project requirements.

CCC exhibits comparable compressive strength to Portland cement-based concrete. The calcination process enhances the pozzolanic reactivity of clay minerals, resulting in the formation of additional binding compounds that contribute to the strength of CCC.

CCC offers enhanced durability properties, including resistance to sulphate attack, alkali-silica reaction (ASR), and carbonation. The presence of calcined clay in the cementitious matrix improves the microstructure of concrete, reducing the permeability and enhancing the resistance to aggressive chemical environments

5.Environment Friendly Concrete:

Environmentally Friendly Concrete addresses these challenges by incorporating recycled aggregates, supplementary cementitious materials, and advanced admixtures. This results in concrete with reduced carbon footprint, improved durability, and enhanced performance characteristics. Recycled aggregate concrete, Agricultural waste concrete etc.

5.1 Recycled aggregate concrete:

Recycled aggregate concrete (RAC) is a sustainable construction material that incorporates recycled aggregates obtained from demolished concrete structures, industrial by-products, or post-consumer waste. RAC offers several environmental and economic benefits compared to conventional concrete made with normal aggregates.

The manufacturing process of recycled aggregate concrete (RAC) involves several steps, from the collection and processing of recycled aggregates to the production of concrete mixtures. Here is an overview of the typical manufacturing process:

a) Aggregate Collection and Processing: Recycled aggregates used in RAC are obtained from crushed concrete rubble generated from demolition activities, construction sites, or industrial by-products. The collected concrete waste is sorted, cleaned, and processed to remove contaminants such as wood, metal, and other impurities. This may involve crushing, screening, and sieving to produce recycled coarse aggregates (RCA) and recycled fine aggregates (RFA) of desired sizes and gradations.
b) Mix Design and Proportioning: The mix design of recycled aggregate concrete is formulated based on the desired performance requirements and

specifications of the project. Recycled aggregates are proportioned with cement, water, and supplementary cementitious materials (SCMs) such as fly ash or slag to achieve the desired concrete properties, including strength, workability, and durability.

c) Concrete Mixing: Recycled aggregates, cement, SCMs, water, and any other additives or admixtures are batched and mixed together in a concrete mixer. The mixing process ensures thorough blending of all ingredients to achieve a uniform and consistent concrete mixture.

d) Testing and Quality Control: Quality control measures are implemented throughout the manufacturing process to ensure the performance and durability of recycled aggregate concrete. Recycled aggregates are tested for properties such as gradation, particle size distribution, aggregate crushing value, and moisture content to assess their suitability for concrete production. Concrete mixtures are tested for workability, slump, compressive strength, and other mechanical properties to verify compliance with project specifications and industry standards.

e) Concrete Placement and Curing: The freshly mixed recycled aggregate concrete is transported to the construction site and placed into formwork or moulds according to the project requirements. Proper curing methods, such as moist curing or curing compounds, are applied to the concrete to maintain adequate moisture levels and promote hydration of cementitious materials. Curing helps ensure optimal strength development and durability of the concrete.

Compressive Strength: RAC can achieve compressive strength values comparable to conventional concrete, provided proper mix design and quality control measures are employed. The compressive strength of RAC may vary depending on factors such as the quality and characteristics of recycled aggregates, the water-to-cement ratio, and curing conditions.

Tensile Strength: RAC typically exhibits tensile strength properties similar to conventional concrete, although it may vary depending on factors such as aggregate quality and mix design

RAC generally exhibits good workability characteristics, although it may require adjustments to the mix design parameters to achieve desired consistency and flow properties. The use of high-quality recycled aggregates, proper grading, and optimization of the water-to-cement ratio can enhance the workability of RAC mixtures.

RAC typically exhibits good bond strength properties, enabling reliable adhesion between concrete layers and reinforcement elements. Proper surface preparation and application of bonding agents may be necessary in some cases to optimize bond strength in RAC structures.

5.2 Agricultural waste concrete:

Agricultural waste concrete is a sustainable building material that incorporates agricultural residues or by-products as partial replacements for traditional aggregates or cementitious materials. By utilizing agricultural waste in concrete production, this eco-friendly material helps reduce environmental impact, conserve natural resources, and promote circular economy principles.

Agricultural waste concrete utilizes various agricultural residues or by-products, including rice husk ash, sugarcane bagasse ash, coconut shell ash, palm oil fuel ash, and other organic materials. These agricultural wastes are typically obtained from processing plants or agricultural operations and are often considered as low-cost or readily available materials.

A. Oil palm shell

The colour of oil palm shell (OPS) ranges from dark grey to black. Depending on the breaking pattern of the nut, the shape of the shells differs in a range from angular to polygonal

Properties	Oil Palm Shell
Specific gravity	1.17–1.37
Bulk density (uncompacted) (kg/m^3)	510–550
Bulk density (compacted) (kg/m^3)	590–600
Void ratio (uncompacted) (%)	63
Void ratio (compacted) (%)	57
24 h water absorption (%)	21–33
Aggregate impact value (%)	4–8
Aggregate crushing value (%)	5–10
Los Angeles abrasion value (%)	3–5
Flakiness index (%)	65
Shell thickness (mm)	2–8
Thermal conductivity (W/mc)	0.19
Loss on ignition (%)	98–100

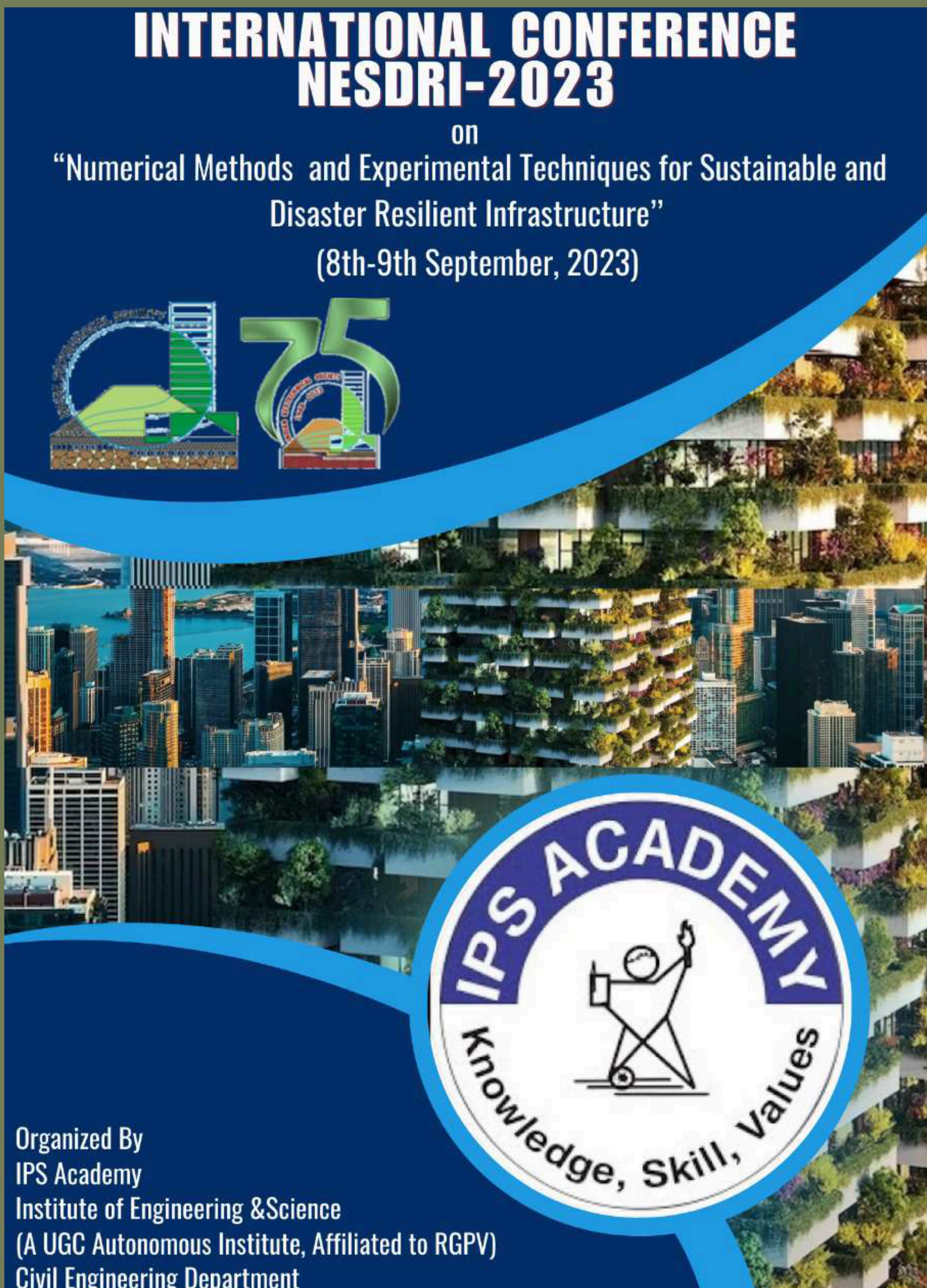
OPS is approximately 60% lighter than conventional coarse aggregates. The density of OPS is within the range of most typical lightweight aggregates. In most cases, it has been shown that the compressive strength of OPS lightweight concrete, with and without cementitious materials, is within the typical compressive strength for structural lightweight concrete (20– 35 MPa) with a density of about 20–25% lower than normal weight concrete.

B. Corn cob

Corn cob is an agricultural solid waste from maize and corn. The United States (the largest maize producer) and Africa produce 43% and 7% respectively of the world's maize [48]. Previous studies [48–50] show that the ash of corn cob has SiO_2 of more than 65% and a combination of Al_2O_3 and SiO_2 of more than 70%. This means that corn cob ash can be used as a cementitious material in blended cement concrete. Although the use of the ash of this waste in concrete technology started more than a decade ago, the use of corn cob grains as aggregate is only recently developing. With the increase in the world's population, sustainable development should be of particular importance and the concrete industry should contribute to this purpose. One approach can be through the use of by-products and agricultural wastes in concrete. Studies show the possibility of use and acceptable performance of certain agricultural solid wastes, e.g. oil palm shell, coconut shell, rice husks, and tobacco waste, as aggregate in making concrete. Since aggregate makes up about 60–80% of the volume of the concrete, the substitution of solid waste as full or partial replacement for conventional aggregate contributes significantly in cost effectiveness, energy saving and mitigation of the environmental impact of the construction industry. Considering the current criteria for a sustainable infrastructure, green building rating systems and related environmental benefits, making concrete using agricultural wastes as aggregate can help in making the concrete industry environmentally-friendly. Therefore, the development of existing knowledge and identification of other useful solid wastes to be used in making concrete will also provide a valuable contribution in the environmental sustainability of the industry.

International Conference NESDRI 2023

International conference on "Numerical Methods and Experimental Techniques for Sustainable and Disaster Resilient Infrastructure" aims to bring together leading academic scientists, researchers and research scholars to exchange and share their experiences and research results on all aspects of Sustainable and Disaster Resilient Infrastructure. It also provides a premier interdisciplinary platform for researchers, practitioners and educators to present and discuss the most recent innovations, trends, and concerns as well as practical challenges encountered and solutions adopted in the fields of Sustainable and Disaster Resilient Infrastructure.
During the conference, extensive deliberations on various areas are expected by way of technical presentations, invited lectures and keynote lectures through both online and in-person modes.




INTERNATIONAL CONFERENCE - NESDRI-2023
on
"Numerical Methods and Experimental Techniques for
Sustainable and Disaster Resilient Infrastructure"
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(A UGC Autonomous Institute, Affiliated to RGPV)
Civil Engineering Department


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on
In Association with
Indian Geotechnical Society

Some glimpses of 2023-24 :-

SRUJAN

…………………. National Seminar.

"SRUJAN" aims to bring mutually professionals, architects, engineers, academicians, research scholars and students on a widespread dais and have interactive brain storming sessions and thereby attempts to be made for overlay technique to innovation with economy, quality and safety in the field of Civil Engineering .

The seminar is symphony of various events including Expert lectures, Panel Discussion, Paper presentation, Technical Hunt , Conundrum Model making, Bridg IT & various on the spot events.

Civilipsa organizes its annual affair "SRUJAN ", National Seminar since 2009.

IPS ACADEMY

Institute of Engineering and Science

(A UGC Autonomous Institute, Affiliated to RGPV Bhopal)

Civil Engineering Department

S R U J A N

SAMEEKSHA

SAMEEKSHA

……..annual quiz event.

Sameeksha tests the normal intelligentsia and knowledge in general civil engineering. The quiz is conducted for teams comprising of two members each. There is no limit to the number of teams from one college.

Civilipsa organises its annual quiz event "SAMEEKSHA" since 2009.

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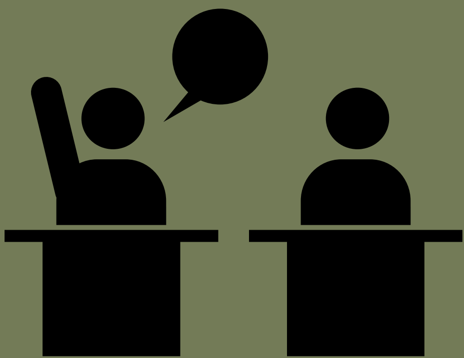
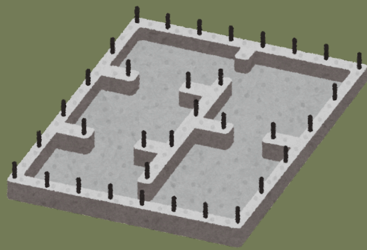
Civil Engineering Department



NEEV



NEEV

……….National Level Student's Paper Presentation.

"NEEV " aims to stimulate the spirit of inventiveness & managerial skill among students and to encourage innovative thoughts, creativity, exploration, technological & presentation skills and also to expand the decision-making skills among the students so that the creative talent of individuals could be harnessed for the benefit of the nation.

Civilipsa is organizes its annual event "NEEV", National Level Student's Paper Presentation since 2009.

IPS ACADEMY

Institute of Engineering and Science

(A UGC Autonomous Institute, Affiliated to RGPV Bhopal)

Civil Engineering Department

Two Day National Workshop

जियोटेक्निकल इन्वेस्टिगेशन और हाईवे मटेरियल टेस्टिंग पर कार्यशाला का आयोजन

हाईवे निर्माण के लिए मिट्टी की जांच जरूरी

खुलासा फर्स्ट...इंदौर

आईपीएस अकादमी, इंस्टिट्यूट ऑफ इंजीनियरिंग एंड साइंस, इंदौर के सिविल इंजीनियरिंग विभाग द्वारा जियोटेक्निकल इंवेस्टिगेशन और हाईवे मटेरियल टेस्टिंग पर दो दिवसीय कौशल विकास प्रशिक्षण कार्यक्रम आयोजित किया गया। यह कार्यक्रम भारतीय भू-तकनीकी सोसाइटी (आईजीएस), इंदौर लोकल चैप्टर और इंडेक्स लेबोरेटरी प्रा.लि. के सहयोग से संपन्न हुआ।

प्रिंसिपल डॉ.अर्चना कीर्ति चौधरी ने कहा कि, किसी देश के विकास में सड़कों और राजमार्गों के साथ बुनियादी ढांचा महत्वपूर्ण भूमिका निभाता है। अतः इस कार्यक्रम के माध्यम से हम छात्रों के कौशल विकास में मदद करेंगे ताकि वे आगे चल कर देश के विकास में अपना योगदान दे सकें। सिविल विभाग के प्रमुख डॉ.अमित शर्मा ने कार्यक्रम में उपस्थित सभी प्रतिभागियों का स्वागत किया और कहा कई वर्षों से आईपीएस अकेडमी में सिविल इंजीनियरिंग विभाग कौशल विकास के क्षेत्र में उल्लेखनीय कार्य कर रहा है।

इस कार्यक्रम में मिट्टी के नमूने, परीक्षण और विश्लेषण के विभिन्न तरीकों, सड़क के डिजाइन और प्रदर्शन को प्रभावित करने वाली मिट्टी के गुणों के बारे में बताया गया। आईआईटी इंदौर के डॉ. प्रियांक सिंह ने जियोटेक्निकल इंवेस्टिगेशन की नवीनतम तकनीकों पर प्रकाश डाला, साथ ही हाईवे मटेरियल टेस्टिंग की उन्नत विधियों पर जानकारी साझा की। उन्होंने कहा कि किसी भी हाईवे के निर्माण के पूर्व वहां की मिट्टी की जांच सबसे महत्वपूर्ण होती है। इसी जांच से यह तय होता है कि, बनने वाला स्ट्रक्चर किस तकनीक से बनाया जाएगा और कितने सालों तक वह टिक पाएगा। इंडेक्स लैब के प्रितेश महाजन ने प्रयोगशाला में प्रतिभागियों को हैंड्स ऑन प्रशिक्षण दिया। कार्यक्रम का आयोजन आईजीएस के आईपीएस एकेडमी स्थित स्टूडेंट चेप्टर ने इंडेक्स लैब के सहयोग से किया। कार्यक्रम का संचालन डॉ. नसीम, सोनम यादव, पल्लवी गुप्ता और दिवाकर सिंह ने किया।

'हाईवे निर्माण के लिए मिट्टी की जांच जरूरी'

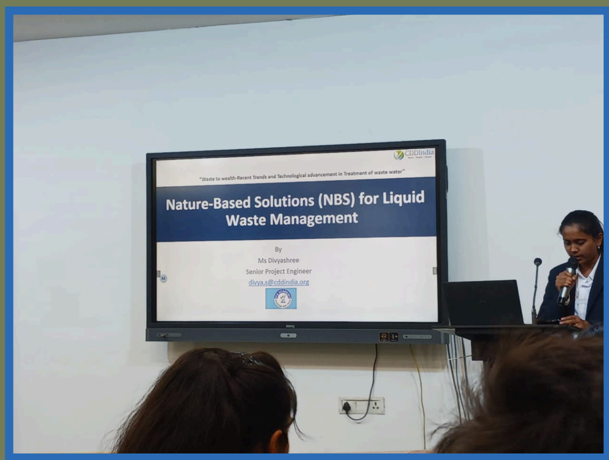
जियोटेक्निकल इन्वेस्टिगेशन और हाईवे मटेरियल टेस्टिंग पर हुई कार्यशाला

पीपुल्स संवाददाता ● इंदौर
मो.नं. 9009585701

किसी भी हाईवे के निर्माण के पूर्व वहां की मिट्टी की जांच सबसे महत्वपूर्ण होती है। इसी जांच से यह तय होता है कि बनने वाला स्ट्रक्चर किस तकनीक से बनाया जाएगा और कितने सालों तक वह टिक पाएगा।

यह बात आईआईटी इंदौर के डॉ. प्रियांक सिंह ने जियोटेक्निकल इन्वेस्टिगेशन की नवीनतम तकनीकों पर प्रकाश डालते हुए कही। आईपीएस अकादमी, इंस्टिट्यूट ऑफ इंजीनियरिंग एंड साइंस इंदौर के सिविल इंजीनियरिंग विभाग द्वारा भारतीय भू-तकनीकी सोसाइटी इंदौर लोकल चैप्टर और इंडेक्स लेबोरेटरी प्रालि के सहयोग से कार्यशाला का आयोजन किया गया। प्रिंसिपल डॉ. अर्चना कीर्ति चौधरी ने कहा कि किसी देश के विकास में सड़कों और राजमार्गों के साथ बुनियादी ढांचा महत्वपूर्ण भूमिका निभाता है। इस कार्यक्रम के माध्यम से हम छात्रों के कौशल विकास में मदद करेंगे, ताकि वे आगे चलकर देश के विकास में अपना योगदान दे सकें।

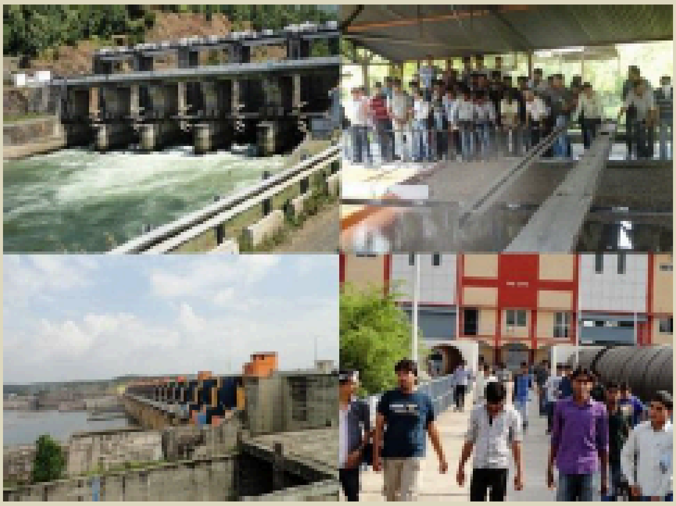
National Waste to Wealth Workshop 2023



STP Visit

Tours and Visits

TOUR –VISIT



As per the requirement of syllabus and complete exposure regarding Civil Engineering Civilipsa organizes technical visit & tour at different places like:

- Sardar Sarovar Dam
- Railway Staff Collage Vadodara & Railway Museum
- NHDC Limited Omkareshwar
- RMC Plant
- Kabitkhedi sewage treatment plant
- Jalud water treatment plant
- Nearby Construction Sites and many more.

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NEPRA Waste Recycling Plant Visit, Deoguradia

Biogas Plant

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Some of them are:

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Dr.Ashish Juneja	IIT Bombay
Dr.Mona Shah	NICMAR Pune
Prof.Nikhil Dixit	BITS GOA

…….and many more.

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Omkareshwar Dam Tour

Technical Visit to RRCAT Indore

Educational Trip

Nearby Construction sites visits

Doubt Solving Sessions

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2 Month Internship by Students at IITI

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