PROJECT TITLE: EXPLORING THE USE OF COMMON EFFLUENT TREATMENT PLANT (CETP) SLUDGE AS AN ECO-FRIENDLY SUBSTITUTE FOR FINE AGGREGATES TO DEVELOP ADVANCED CONCRETE PAVER BLOCKS

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College : Sri Siddhartha Institute Of Technology, Tumkur
Branch : Department Of Civil Engineering
Guide(S) : Dr. Usha S
Student(S): Mr. Ajith Kumar N

Keywords:

CETP sludge, Eco-friendly construction, Fine aggregate replacement, Concrete paver blocks, Sustainable materials

Introduction:

1. Investigate the use of CETP sludge as a sustainable alternative to fine aggregate in concrete.
2. Enhance eco-friendly construction practices by incorporating waste materials.
3. Promote sustainable construction and reduce the environmental footprint.

Objectives:

1. To design and produce hexagonal paver blocks of M30 grade concrete with a thickness range of 60-80 mm, incorporating varying percentages (5%, 10%, 15%, 20%, 25%) of CETP sludge as a partial replacement for fine aggregates.
2. To conduct a chemical analysis of the CETP sludge sample using EDAX Methodology to determine its chemical composition and suitability for use in concrete applications.
3. To perform a leaching test on the CETP sludge to assess its potential environmental impact and ensure that the incorporation of the sludge does not result in harmful contaminants leaching from the concrete.

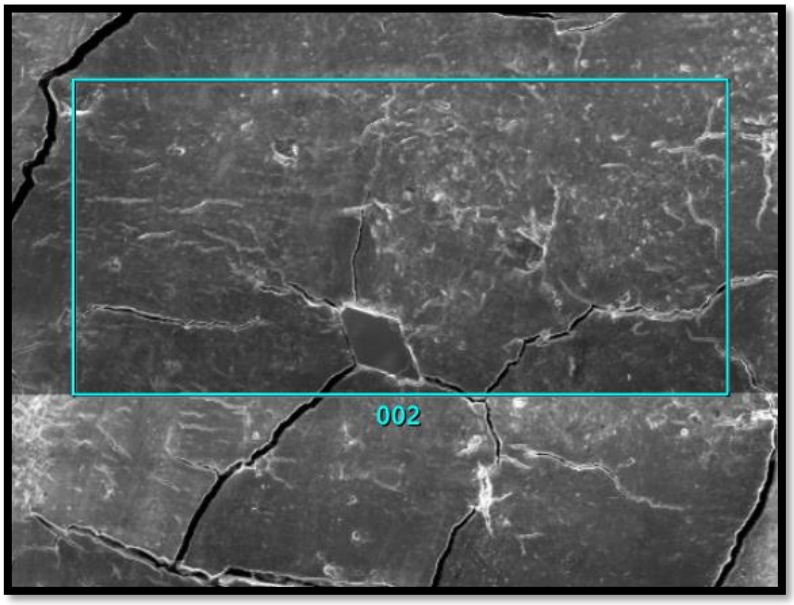
4. To evaluate the mechanical properties of the paver blocks, including compressive strength, flexural strength, workability and density, in relation to varying CETP sludge replacement percentages.
5. To assess the durability of the paver blocks by conducting water absorption test, alternative wet and dry cycling tests, along with sulphate attack and chloride attack tests, to determine their long-term performance and resistance to environmental factors.

Methodology:

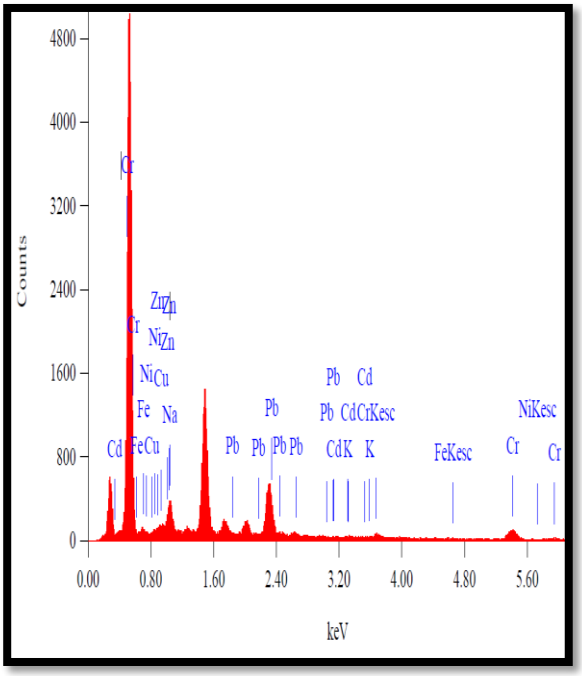
1. CETP sludge will be collected from Eco Green Solution, and its chemical composition will be analysed using EDAX Process to assess its suitability for use in concrete. Leaching tests will be conducted to evaluate potential environmental risks.
2. M30 grade concrete will be prepared with a 1:0.75:1.5 mix ratio, replacing fine aggregates with CETP sludge at 5%, 10%, 15%, 20%, and 25%. Hexagonal paver blocks (60-80 mm thick) will be cast and cured for 28 days.
3. Mechanical properties of the paver blocks will be tested, including compressive strength at 7, 14, and 28 days, and flexural strength to assess resistance to bending. Workability will be measured using the slump test.
1. Water absorption will be tested by immersing the paver blocks in water for 24 hours and measuring the increase in weight to determine porosity and water retention.
2. Durability tests such as alternate wet and dry cycles, sulphate attack, and chloride attack will be conducted to evaluate the paver blocks' resistance to environmental factors and their long-term durability.
3. The results will be analysed to determine the optimal percentage of CETP sludge that provides the best balance of strength, durability, and environmental sustainability, comparing the findings with industry standards.

Result and Conclusion:

EDAX analysis for CETP (Common Effluent Treatment Plant) sludge



- **Cr (Chromium):**
- **Zn (Zinc):**
- **Ni (Nickel):**
- **Cu (Copper):**
- **Fe (Iron):**
- **Na (Sodium):**
- **Pb (Lead):**
- **Cd (Cadmium):**
- **K (Potassium):**



PHYSICAL PARAMETER OF FINE AGGREGATE & CETP SULDGE

Sl.No	Properties	Fine aggregate	CETP sludge
1.	Specific gravity	2.67	1.49
2.	Fineness modulus	2.9	5.04
3.	Water absorption	2.12%	4.5%
4.	Bulk density (loose)	1580 g/cc	670%
5.	Bulk density (competed)	1800 g/cc	750%

SLUMP TEST

Sl.No	% of Sludge	Slump	W/C
1.	0%	105	0.45
2.	5%	100	0.5
3.	10%	98	0.5
4.	15%	96	0.55
5.	20%	98	0.55
6.	25%	95	0.55

COMPRESSION STRENGTH IN MPa

Replacement of sludge %	28days (MPa)
0%	35.2
5%	36.5
10%	37.8
15%	35.0
20%	32.6
25%	29.8

FLEXURAL STRENTH IN MPa

Replacement of sludge %	28days (MPa)
0%	4.2
5%	4.5
10%	4.8
15%	4.1
20%	3.8
25%	3.1

SPLIT TENSILE STRENGTH

Replacement of sludge %	28days (MPa)
0%	3.1
5%	3.3
10%	3.5
15%	3.0
20%	2.7
25%	2.2

DURABLE PARAMETER

Alternative wetting and drying test

Sl. No	% of CETP sludge	Alternative wetting and drying test
1.	0%	**32.8**
2.	5**%**	**33.6**
3.	10%	**34.5**
4.	15%	**31.0**
5.	20%	**28.6**
6.	25%	**26.8**

Sulphate attack test

Sl. No	% of CETP sludge	% Strength Loss Due To Sulphate Attack Test
1.	**0%**	**4.5**
2.	**5%**	**4.1**
3.	**10%**	**3.9**
4.	**15%**	**5.2**
5.	**20%**	**5.8**
6.	**25%**	**6.2**

Chloride attack test

Sl. No	% of CETP sludge	% Strength Loss Due To Chloride Attack Test
1.	0%	3.8
2.	5%	3.5
3.	10%	3.2
4.	15%	4.1
5.	20%	5.0
6.	25%	5.2

In conclusion,

1. EDAX analysis conducted revealed the presence of heavy metals in CETP sludge.
2. The inclusion of CETP sludge as a partial replacement for fine aggregate in M30 grade hexagonal paver blocks showed improved mechanical strength up to 10% replacement, with compressive strength reaching 37.8 MPa.
3. Split tensile and flexural strengths also peaked at 10% replacement, recording 3.5 MPa and 4.8 MPa respectively, indicating better bonding and matrix integrity at this level.
4. Compressive strength after alternate wet and dry cycles remained high for 10% replacement, suggesting good durability under cyclic environmental conditions.
5. Resistance to sulphate and chloride attacks was found to be optimum at 10% CETP sludge replacement, with minimum strength losses of 3.9% and 3.2% respectively.
6. Higher replacement levels (15% and 20%) resulted in a decline in both mechanical and durability performance due to increased porosity and reduced compactness.

7. Therefore, 10% CETP sludge replacement is considered the most effective and sustainable proportion for enhancing the strength and durability of concrete paver blocks.

Future Scope:

The present study opens up several avenues for future research. Long-term performance of CETP sludge-based paver blocks under real environmental conditions can be explored to assess durability. Microstructural analysis using tools like SEM and XRD may provide deeper insights into material behavior. Additionally, combining CETP sludge with other industrial by-products such as fly ash or GGBS could further enhance the properties of concrete. A cost-benefit analysis and life cycle assessment would help evaluate the economic and environmental impact, making the approach more viable for large-scale sustainable construction applications.

Project Outcome & Industry Relevance (10-15 lines):

The project successfully demonstrated that CETP sludge can be used as a partial replacement for fine aggregate in M30 grade hexagonal paver blocks, with 10% replacement showing optimum results in terms of both strength and durability. The mechanical properties such as compressive, split tensile, and flexural strength improved at this level, while resistance to sulphate and chloride attacks also remained within acceptable limits. The study contributes to sustainable construction practices by promoting the reuse of industrial waste, reducing dependency on natural resources, and addressing environmental concerns related to sludge disposal. This approach aligns with the goals of eco-friendly infrastructure development and waste management, making the project highly relevant in the current context of sustainable engineering solutions.

Working Model vs. Simulation/Study:

A *working model* involves the physical creation and testing of actual paver blocks using CETP sludge, providing real-time data on mechanical and durability properties under controlled laboratory conditions. It offers tangible evidence of material behavior and performance, ensuring accuracy through hands-on experimentation.

Project Outcomes and Learnings:

The project established that CETP sludge can effectively replace fine aggregate in M30 grade hexagonal paver blocks up to 10%, enhancing both strength and durability. The optimum replacement level yielded improved compressive, split tensile, and flexural strength, along with better resistance to sulphate and chloride attacks. This study promotes sustainable construction practices by utilizing industrial waste, contributing to environmental conservation and resource efficiency. Through this project, valuable insights were gained on material behavior, mix design optimization, and testing procedures. It also reinforced the importance of experimental validation and opened avenues for eco-friendly alternatives in civil engineering.