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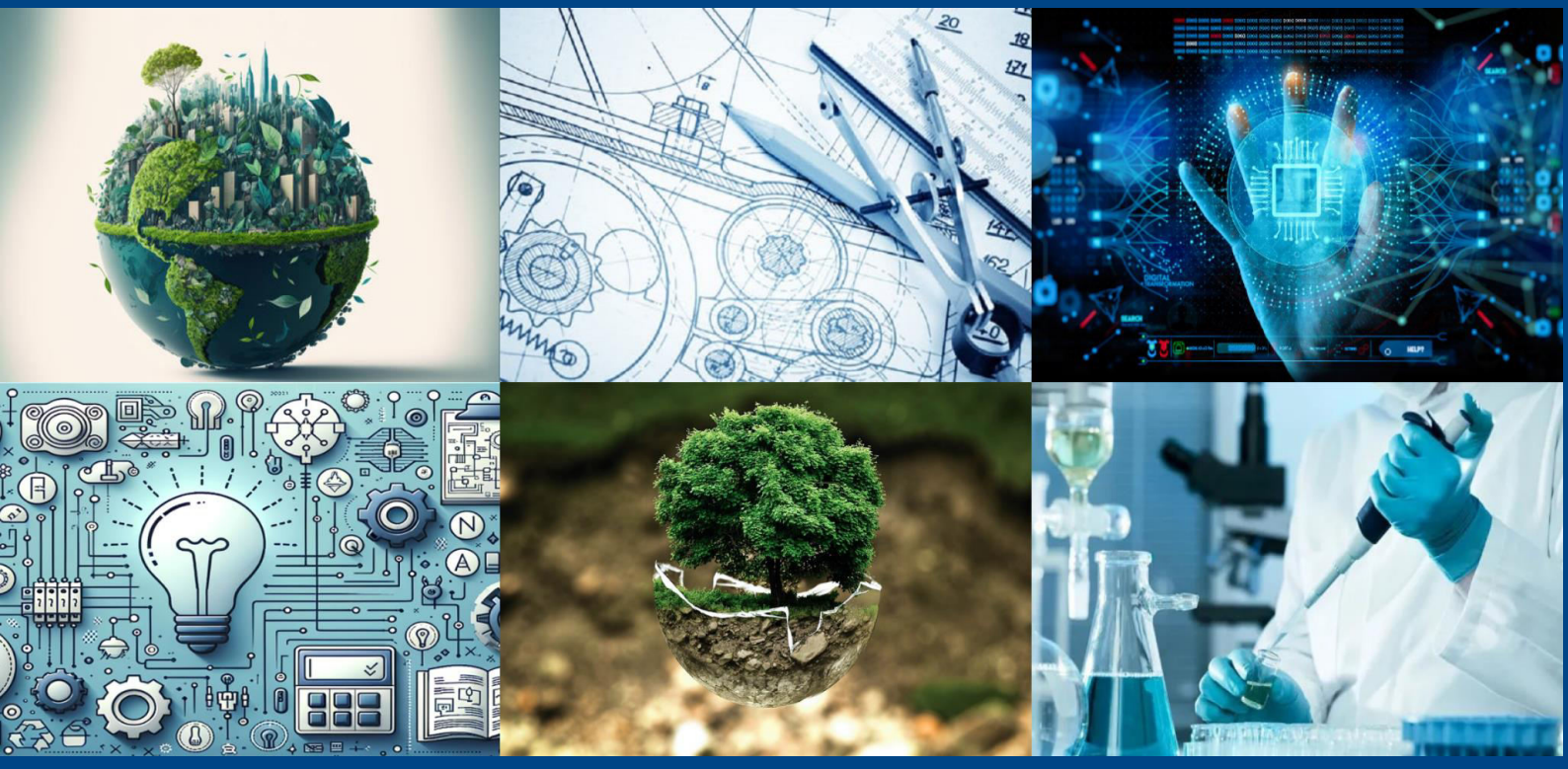

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Comprehensive Study of Sustainable Construction Material: Slag Sand

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ABSTRACT: Global material resources are quickly being drained by the demands of global economic development. Simultaneously, the environmental impacts of the massive amounts of waste generated globally every year are also growing exponentially. As such, the implementation of waste recycling through its utilization as a component of a construction material, particularly one with a global demand as high as concrete, is a strategy which acts in both planes: material efficiency and waste generation. Due to ever increasing quantities of waste substances and industrial by-products, strong waste management is the high concern in the world.

In this research work presents a decade review on sustainable concrete with a focus on virgin materials being replaced with waste materials. In this study, the slag sand is replaced with standard sand by 20%, 30%, and 40%, and the relevant properties and strength will be compared. The results show a slight increase in concrete strength and, with a beneficial scheme, a reduced volume of normal sand that is continuously being used and will one day become non-available material.

I. INTRODUCTION

Concrete is a crucial component of structural engineering construction practice, which is critical and influences the stability and efficiency of various structures. The compressive strength of the concrete is a test conducted with the aid of a universal test machine or some other compressive strength machines to find the concrete cube strength. The concrete mix specification is the basic quantity of the various materials used to blend and produce the appropriate concrete properties. The fine and coarse aggregate is the major and prominent ingredients of the concrete and the properties of concrete change by changing its size, texture, and properties. The quality and strength of the concrete solemnly depending upon the adjustment of the water cement ratio. The appropriate water-cement ratio is assumed around 0.5-0.70. Optimal amounts and sizes of the concrete mix product elements are achieved to produce improved post-concrete performance and to enhance the technique. The aggregate size (uniform graded, distance graded, incorrectly graded) must be tested to build the sample for proper examination. This research procedure includes calculating the size of the fine and coarse aggregate sample, specific gravity, and other tests.

1.1 ASSUMPTIONS AND LIMITATIONS

For the sake of accurate statistics, the reports are often cross-checked. The key point is that the source of the Slag Sand is satisfactory and can be used for building purposes. It is believed that there is a lot of testing needed to verify the source, and this is performed squarely in large-scale building projects. In this works, we will completely rely upon the industry provider documentation.

As mentioned previously, the mix design is prepared as per standards, but it should be kept in mind that the water-cement ratio is the major to a scheme of concrete strength. The minimum water-cement ratio produces more strength as it is workable and cost-effective. On the other hand, cement is the most expensive component in concrete ingredients.

II. MATERIALS AND METHODOLOGY

2.1 RESEARCH DESIGN:

To carry out a thorough review of the research subject and to meet the goals set at the outset of the project, a possible conceptual set-up for the testing and assessment of different materials and mixtures was possible. For the good quality

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materials, an appropriate sample of the aggregate should be collected from the source, and after proper testing, the source is stated as approved. For sample preparation, the product should be thoroughly mixed and reduced to the required size. The degree of gradation would be calculated by the sand Slag and its applicability.

2.2 CONCEPT DESIGN:

To design the sample for proper testing, the aggregate must be tested. This test method covers the determination of relative density (specific gravity), sieve analysis of course and fine aggregate, silica fume, material properties, and the absorption of fine aggregates.

2.3 MATERIALS:

For cube specimen; The material used for casting of concrete specimen was:

a) Cement (Double bull Cement 53 Grade)
b) Aggregate
c) Water
d) Slag Sand (SL)

a) Cement

Cement, in general, adhesive substances of all kinds, but, in a narrower sense, the binding materials used in building and civil engineering construction. Cements of this kind are finely ground powders that, when mixed with water, set to a hard mass. Setting and hardening result from hydration, which is a chemical combination of the cement compounds with water that yields sub microscopic crystals or a gel-like material with a high surface area.

b) Aggregate

Literature reveals that concrete compressive strength increases up-to a maximum aggregate size of 1.5 inches. From the standpoint of minimum void space, round aggregate is more desirable than irregular.

The cement to be used is ordinary Portland cement (OPC) and sulphate-resistant cement (SRC). The justification for choosing this cement is that it is readily accessible and that it is one of the finest and highest performing cement that satisfies the necessary specifications and fulfils the requirements.

c) Water

Water is also one of the important ingredients of concrete. As the strength, workability is depending on water, the quantity and quality of water is required to be taken very carefully. The potable water is used for the experiment.

d) Slag Sand (SL)

Slag Sand will be obtained from the source nearby area. The tests for the quality of sand including fineness and the presence of any impurities. Then different mix designs except the use of plasticizer will be established to check the different characteristics and strength properties of using Slag Sand in concrete.

2.4 MATERIAL TESTING:

2.4.1 Gradation test

Sieve analysis gives an idea regarding the gradation coarse and fine aggregate. It is used to proportion the selected sample to obtain the design properties and strength. The test is conducted according to the IS383 Standard.

a) Gradation of fine aggregate (sand)

The sieve analysis for the fine aggregate (natural sand and Slag sand) used in the casting of concrete cubes is carried out. The sieve analysis for the Slag sand. The sieve analysis test plays a vital contribution to produce strength in the concrete. The below described Figure describes the graph for both the sand and Slag Sand to depict the material's distribution size. The graph is drawn between the sieve size on the x-axis and % percent of passing on the y-axis.

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Sr No	Sieve size (mm)	Retain weight(gm)	%Retain	Cumulative % Retain	% Finer	Permissible limits (Zone 1)
1	4.75	180	9	9	91	90-100
2	2.36	197	9.85	18.85	81.15	60-95
3	1.18	597	29.85	48.7	51.3	30-70
4	0.6	604	30.2	78.9	21.1	15-34
5	0.3	300	15	93.9	6.1	5-20
6	0.15	110	5.5	99.4	0.6	0-10
7	pan	12	0.6	100	0	
	Total	2000				
				FM=4.487	WA=0.401%	SG=2.62

Table: Gradation of fine aggregate (sand) with the help of sieve analysis

2.5 Procedure of trial mix design

1) Properties of material
a) Cement: specific gravity=3.15
b) Coarse aggregate:

Water absorption=2.46%
Specific gravity=2.98

a) Fine aggregate:

- Natural sand:

Water absorption=0.401% Specific gravity=2.62

- SL:

Water absorption=1.6% Specific gravity=2.4

1) Target strength: fck'= fck + 1.65 * ϵ =25 + 1.65 * 4 = 31.6 MPA
2) Selection of water cement ratio=0.5
3) Calculation of cement content
4) Proportion of fine and coarse aggregate

2.6 Mix calculation:

a) Volume of concrete for 1 cu. m.
b) Volume of water=157.6 kg
c) Volume of cement=350 kg
d) Volume of fine aggregate=775kg
e) Volume of coarse aggregate=1127. Kg

1. SPECIMEN SPECIFICATIONS:

Experimentation involved the study of compression strength of concrete cubes and cylinders after expose to atmospheric temperature. The mix proportion of 1:1.5:2.67 concrete cubes and were tested.

1. Size of Test Specimens:- For cube test, the size of specimen is 150 * 150 * 150 (All dimensions are in mm).
2. Molds:- In assembling the mold for use, the joints between the section of molds where thinly coated with oil and similar coating was applied between the contact surface of the bottom of the mold and the base plate in order to ensure the zero leakage during the filling. The interior surface of the assembled mold was thinly coated with oil to prevent

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adhesion of concrete. This concrete is poured in the mold and tempered properly so as not to have any voids. After 24 hours these molds are removed and a test specimen are put in water of curing. These specimens are tested by the compression testing machine after 7,14- and 28-days curing.

Fig: Concrete mold

3. CYLINDER :- Size of cylinder-30cm height, 15cm diameter In assembling the cylinder for use, the joints between the section of cylinder where thinly coated with oil and similar coating was applied between the contact surface of the bottom of the cylinder and the base plate in order to ensure the zero leakage during the filling. The interior surface of the assembled cylinder was thinly coated with oil to prevent adhesion of concrete. This concrete is poured in it and tempered properly so as not to have any voids. After 24 hours these cylinders are removed and a test specimen are put in water of curing.

4. BEAM :- Size of beam-50*10*10cm. In assembling the beam for use, the joints between the section of cylinder where thinly coated with oil and similar coating was applied between the contact surface of the bottom of the beam and the base plate in order to ensure the zero leakage during the filling. The interior surface of the assembled cylinder was thinly coated with oil to prevent adhesion of concrete. This concrete is poured in it and tempered properly so as not to have any voids. After 24 hours these beam are removed and a test specimen are put in water of curing.

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2.7 MIX PROPORTION

During the investigation, the SL was added with respect to the volume of the sand.
The SL added as 20%,30%,40%with respect of sand volume.

Sr. No.	No of cubes	Cement (Kg)	Sand (FA) (Kg)	SL (Kg)	CA 20mm (Kg)	CA 10mm (kg)	Water (liter)	Comment
1	3	4.374	6.505	0	6.942	4.628	1.952	Ordinary cubes
2	3	4.374	5.529	0.975	6.942	4.628	1.952	15% replacement sand
3	3	4.374	5.204	1.301	6.942	4.628	1.952	20% replacement sand
4	3	4.374	4.878	1.626	6.942	4.628	1.952	25% replacement sand

Table: Mix proportions

2.8 MIXING

Thorough mixing of materials is essential for the production of uniform course. The mixing should ensure that the mass becomes homogeneous, uniform in color and consistency. In this project, we adopted machine mixing. As the mixing cannot be thorough, it is desirable to add 10% more materials.

2.9 POURING OF CONCRETE

After the materials have been mixed, the molds are filled immediately by pouring the concrete in to it. Concrete is filled in three layers, and each layer is compaction well by using a mechanical vibrator, so as to avoid entrapped air inside the concrete cubes and honey combing effect on the sides. During pouring of concrete it is better to avoid washing of concrete for effective and economical usage. In order it avoid wastage, small trowels are used in the process.

2.10 COMPACTION OF CONCRETE

Compaction of concrete is the process adopted for expelling the entrapped air from the concrete. In the process of mixing transporting and placing of concrete, air is likely to get entrapped in the concrete. Here, we adopted mechanical compaction by using a mechanical vibrator. When compaction is adopted, the consistency of concrete is maintained at a higher level. Concrete is filled in layers of IS-20 mm, and each layer is compaction well using the compaction. After the top layer has been compaction, a strike-off bar is used to strike out the excess concrete, and a trowel is used to finish off the surface with the top of the molded the outside of the mold should be wiped clean.

2.11 DE-MOLDING

Test cube specimens are de-molded after 24 hours from the process of moulding. If, after this period of time, the concrete has not achieved sufficient strength to enable de-molding without damaging the cube specimens, then the process must be delayed for another 24 hours. Care should be taken not to damage the specimen during the process because, if any damage is caused, the strength of the concrete may get reduced. After de-molding, each specimen is marked with a legible identification on any of the faces by using a waterproof paint. The mold is then thoroughly cleaned after the process.

2.12 CURING

The test specimens after compaction were kept as such for period of 24 hours. After that period of time the molds were removed and the specimens were kept in ordinary curing tank and allowed to cure for a period of 7,14 and 28 days.

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2.13 TESTING ON SPECIMEN

➢ **Compressive Test:**

Compressive strength of concrete is a measure of its ability to resist load, which tends to crush it. Most common test on hardened concrete is compressive strength test. It is because the test is easy to perform. Furthermore, many desirable characteristics of concrete are qualitatively related to its strength and the importance of the compressive

Fig: Compressive testing machine

➢ **Flexural strength**

Flexural strength, also known as modulus of rupture, or bend strength, or transverse rupture strength is a material property, defined as the stress in a material just before it yields in a flexure test. The transverse bending test is most frequently employed, in which a specimen having either a circular or rectangular cross-section is bent until fracture or yielding using a three-point flexural test technique. The flexural strength represents the highest stress experienced within the material at its moment of yield. It is measured in terms of stress, here given the symbol.

➢ **Split tensile strength**

The tensile strength of concrete is one of the basic and important properties which greatly affect the extent and size of cracking in structures. Moreover, the concrete is very weak in tension due to its brittle nature. Hence. It is not expected to resist the direct tension. So, concrete develops cracks when tensile forces exceed its tensile strength. Therefore, it is necessary to determine the tensile strength of concrete to determine the load at which the concrete members may crack. Furthermore, splitting tensile strength test on concrete cylinder is a method to determine the tensile strength of concrete.

➢ **DURABILITY:**

Concrete can be described as durable if it can withstand weathering action, chemical attack, abrasion and any other deterioration process. In adverse environments, durable concrete must maintain its original form and serviceability. The durability of concrete can be detected through various tests, such as water absorption, density, acid attacks, dry shrinkage, ultra-sonic pulse velocity, etc.

➢ **Density**

It is well known that concrete's mechanical properties are greatly influenced by the density of the concrete. In general, dense concrete provides higher strength and less porosity and voids. Figure 4.6 shows the density of concrete with various doses of WFS. The density of concrete was enhanced with the substitution of WFS. It is expected that the micro filling effect of WFS fills the voids in concrete ingredients leading to more dense concrete.

III. RESULT AND DISSCUSION

M30 GRADE RESULTS FOR CUBE

Details for M30 grade concrete with slag sand (30% replacement)						
Particulars	Days	Grade	Compressive strength in (mpa)	Avg strength (mpa)	Strength after 30% replacement	Remark
Cube 1	7	M30	27.9	30.1	32	**5.94% more in slag**
Cube 2			32.5			
Cube 3			30.9			
Cube 1	28		48.6	46.3	49.2	**5.89 % more in slag**
Cube 2			47.09			
Cube 3			43.1			

Table - Details for M30 grade concrete with slag sand (40% replacement)

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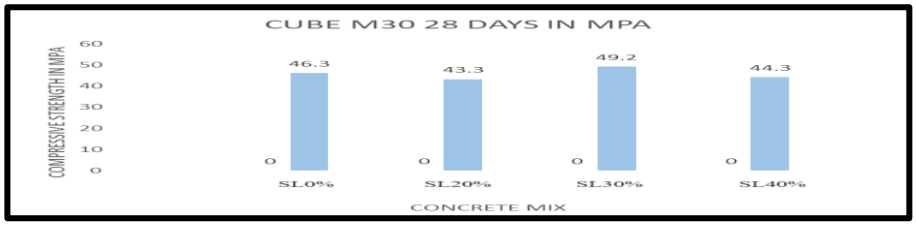


Compressive strength of concrete for 28 days

M30 GRADE RESULTS FOR CYLINDER

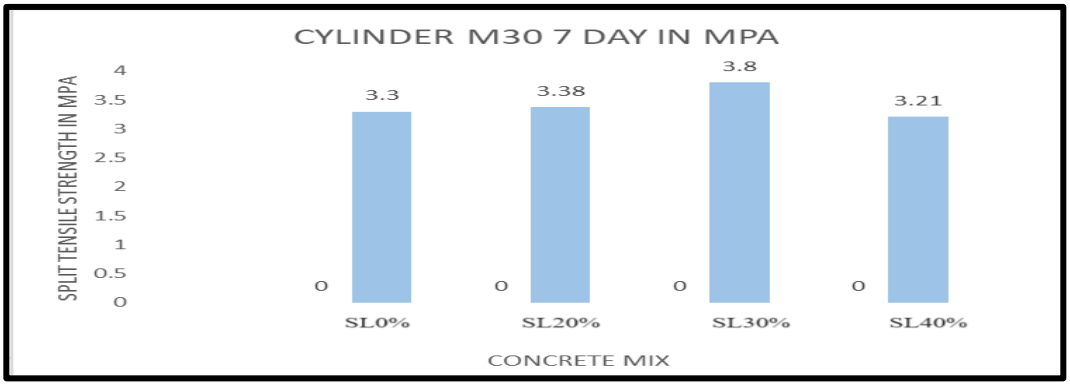
Table - Details for M30 grade concrete with slag sand (20% replacement)

Details for 30 grade concrete with slag sand (20% replacement)						
Particulars	Days	Grade	Split tensile strength in (mpa)	Avg strength (mpa)	Strength after 20% replacement	Remark
Cylinder 1	7	M30	2.97	3.3	3.38	**2.36% more in slag**
Cylinder 2			3.51			
Cylinder 1	28		4.1	5.5	5.2	**5.455% lower in slag**
Cylinder 2			4.9			

Table - Details for M30 grade concrete with slag sand (30% replacement)

Details for M30 grade concrete with slag sand (30% replacement)						
Particulars	Days	Grade	Split tensile strength in (mpa)	Avg strength (mpa)	Strength after 30% replacement	Remark
Cylinder 1	7	M30	2.97	3.3	3.8	**13.16% more in slag**
Cylinder 2			3.51			
Cylinder 1	28		4.1	5.5	5.9	**6.78% more in slag**
Cylinder 2			4.9			

Table - Details for M30 grade concrete with slag sand (40% replacement)



Flexural strength of concrete for 7 days

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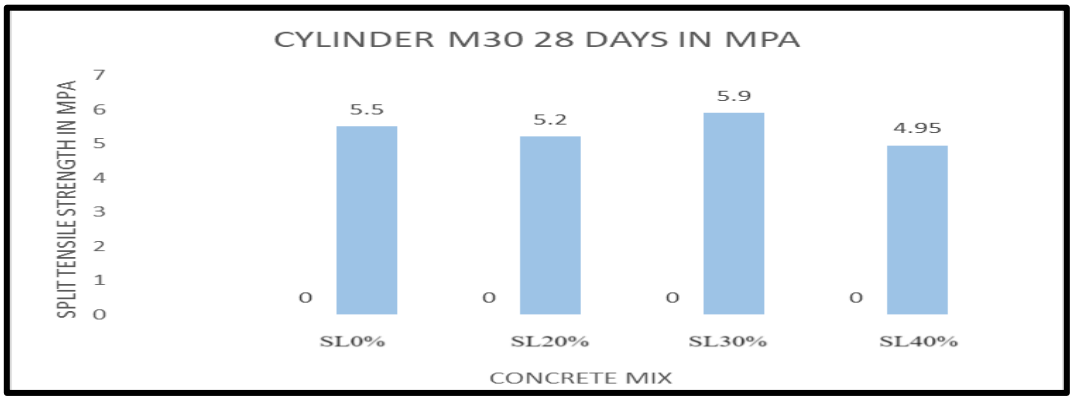

Flexural strength of concrete for 7 days

M30 GRADE RESULTS FOR BEAM

Details for M30 grade concrete with slag sand (20% replacement)						
Particulars	Days	Grade	Flexural strength in (mpa)	Avg strength (mpa)	Strength after 20% replacement	Remark
Beam 1	7	M30	5.2	7.75	7.69	**0.77% lower in slag**
Beam 2			10.3			
Beam 1	28		11.2	12.03	11.4	**5.24% lower in slag**
Beam 2			12.86			

Table - Details for M30 grade concrete with slag sand (30% replacement)

IV. CONCLUSION

- There was almost no difference in bulk density, specific gravity, or grain size distribution between slag sand and natural sand.
- Flowability of concrete reduced with the substitution of Slag. This is owing to the physical properties of Slag (porous and larger surface area) which increased water demand.
- However, up to 30% substitution of Slag shows acceptable workability but a higher dose (beyond 30%) needed a higher dose of admixture (retarder).
- Slag can be used up to 30% substitution instead of natural river sand with no harmful influence on concrete strength. This is owing to the micro filling which provides more dense concrete, leading to more resistance to load. However, a decrease in strength was observed at a higher dose of Slag (beyond 30%).
- For compressive strength of cubes, it is observed that the strength of concrete using 30% replacement of slag sand in M25 and M30 grade is 7.7% and 5.89% more than that of the conventional concrete respectively.
- For split tensile strength of concrete cylinder it is observed that strength using 30% replacement of slag sand in M25 and M30 grade is 2.22% and 6.72% more than that of the conventional concrete respectively.
- For flexural strength of concrete beam, it is observed that strength using 30% replacement of slag sand in M25 and M30 grade is 6.51% and 6.45% more than that of the conventional concrete respectively.

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- Finally, this overall review concluded that Slag Sand up to 30% can be used as fine aggregate in concrete production without any negative effect on the mechanical and durability performance of concrete.
- Further study was recommended to add fibers or some of the pozzolanic materials, such as fly ash or silica fume to improve the mechanical performance. As the traditional river sand takes decades to replenish and excessive mining of river sand is harmful for the environment, use of industrial slag sand is recommended.
- It can also help in minimizing the cost of construction as the industrial slag is cheaper.

REFRENCES

1. D. Padmalal, K. Maya (2014), Springer science, Sand Mining: Environmental Impacts and Selected Case Studies
2. E.S. Rentier, L.H. Cammeraat (2022), ELSEVIER, Science Direct, Science of total environment. The Environmental Impact of River Sand Mining
3. SCIENCE AND TECHNOLOGY OF MATERIAL BY ELSEVIER Volume 30. Issue 3 (September -December 2018) Eco-concrete with incorporation of blast furnace slag as natural aggregates replacement
4. ALEXANDRIA ENGINEERING JOURNAL Volume 57. Issue 2, June 2018 Substitution of the natural sand by crystallized slag of blast furnace in the composition of concrete
5. INTERNATIONAL JOURNAL OF LATEST TECHNOLOGY IN ENGINEERING, MANAGEMENT & APPLIED SCIENCE (IJLTEMAS) Volume 7, Issue 5, May 2018 Comparative Analysis of Slag Sand with Partial Replacement to Fine Aggregate
6. INTERNATIONAL JOURNAL OF ENGINEERING RESEARCH & TECHNOLOGY (IJERT) Volume 06, Issue 04 (April 2017) The Exploitation of Blast furnace Slag as Sand Replacement in Concrete
7. Durability Study of Concrete using Foundry Waste Sand, S. Gopinath, M. Arun, PG Student, Assistant Professor, Mahendra Engineering College, Namakkal, Tamil Nadu.
8. Use Of Waste Foundry Sand In Infrastructure Amar Shitole, Pradnya Pradhan, Sujal Haridas, Ashwini Shinde, Aishwarya Taru Pune, India. © 2021 Ijcrt | Volume 9, Issue 6 June 2021 | Issue: 2320-2882
9. Use of Foundry Sand in Concrete: A State Of Art Review Smit M. Kacha, Abhay V. Nakum, Ankur C. Bhogayata. India. Ijret: Eissn: 2319-1163 | Pissn:2321-7308
10. Waste Foundry Sand in Concrete Production Instead of Natural River Sand: A Review Jawad Ahmad 1, Zhiguang Zhou 1,Rebeca Martínez-García 2, Nikolai Ivanovich Vatin 3, Jesús de-Prado-Gil 2.
11. Review: Review of the Effects of Supplementary Cementitious Materials and Chemical Additives on the Physical, Mechanical and Durability Properties of Hydraulic Concrete Muralidharan Raghav, Taejoon Park.
12. Durability Of Concrete Using Foundry Waste Sand: A Thesis Presented to The Faculty of The College of Business and Technology Morehead State University.

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