



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

IJIRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 11, Issue 7, July 2022

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 8.118

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6381 907 438

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An Experimental Work on Strength Properties of M30 Grade Concrete by Partial Replacement of Cement and Fine Aggregate with Non-Conventional Construction Materials

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ABSTRACT:The major problem, world is facing today is the environmental pollution. In the construction industry, mainly the production of Portland cement will causes the emission of pollutants results in environmental pollution. In the present study, egg shell powder (ESP) are partially replaced in cement and varied from to 2.5% to 15% (2.5%, 5%, 7.5%, 10%, 12.5% and 15%) and steel slag (SS) is added to fine aggregates with partial replacement varying from 5% to 30% (5%, 10%, 15%, 20%, 25% and 30%). These two wastes are recycled as an incomplete replacement of cement and fine aggregate and various properties like workability. From the experimental results, it is found that 7 and 28 days strength of concrete using the partially replacement of cement & Fine aggregates with egg shell powder and steel slag in concrete. The compressive strength is 40.06%, split tensile strength is 3.34% and flexural strength is 4.06% for the duration of 28 days have been achieved when compared with the conventional type of concrete.

KEYWORDS:Egg shell powder, strength, steel slag.

I. INTRODUCTION

Concrete is a composite material composed of fine and coarse aggregate both together with fluid cement that hardens over time. It is the main part of any construction work which is composed of gravels or crushed stones, sand hydrated cement etc. it has been used over a century in all construction works. Now a day's construction sector is expanding rapidly on a large scale involving new techniques. The consumption of natural resources in construction is phenomenal and high cost. To overcome the use of natural resources and to utilize the waste materials like egg shell powder, Iron slag, steel slag etc., in concrete.

The use of waste materials is workable as alternative to the traditional material in concrete has increased popularity in current years, which is due to the over-exploitation of the natural material. Waste utilization in concrete has two advantages, discarding of waste in green manner and improving strength and durability properties of concrete. In the most recent decade, major development in green concrete has been led to the use of discarded items in concrete, Egg shell powder, Steel slag, coconut shell, recycled asphalt, recycled aggregate, synthetic fibres, quarry dust, wood waste, textile, disposed tires, plastic, glass powder, Copper slag, human hair, and many more. The utilization of waste items in concrete makes it cost-effective as well as takes care of a disposal issues.

Improvement in technology throughout the world has shown that treated or unprocessed industrial by-products can be used in concrete, which gives an sustainable solution. This alternative solution, not just benefits in recycle of the waste material, but in addition makes a cleaner and greener condition. The objective of materials management is to ensure that construction materials are accessible at their place of utilization when required. Construction management framework ensures that materials are of required quality and readily available at construction site location. Thus, reintegrating wastes into fresh concrete matrix remains will increase sustainability drive at the construction sites. Moreover, using these materials aid the development of lightweight concrete, which is used for adaptability and economical significance.

In the present work, the two nonconventional materials are used and partially replaced with cement and fine aggregates. Eggshell is rich in calcium and almost same synthesis of limestone, utilization of egg shell waste in cement rather than common lime to suppliant cement it will have advantage of limiting the utilization of cement, saving normal lime and helps to reduce the carbon dioxide emission from cement factories. Steel Slag is by-product of pig iron and steel. It contains of chemical composition like calcium, magnesium and aluminum silicates. The use of steel slag

concrete increases the tensile strength of concrete by 1.4 to 2.4 times the strength of normal concrete, depending on the used ratio.

II.LITERATURE SURVEY

Concrete is a versatile engineering material made with cement aggregates and admixtures in some cases to develop in the construction field. The consumption of natural aggregates is very high. Therefore, extreme use of concrete leads to scarcity of natural aggregates. Because of this reason, use waste materials like egg shell powder and steel slag in concrete are implemented in this work. The following section gives a brief background and some of the important patient studies that were carried out to the considered work. This provides an overview of the research activities relevant to this research work through references.

Harjot Singh & Khushpreet Singh (2019), an investigation was conducted to study the properties of concrete containing egg shell powder and iron slag in a concrete mix. Egg shell powder is used in research as the partial replacement of cement and iron slag is used as the partial replacement of the fine aggregates. Different ratios of egg shell powder and iron slag combination were developed by replacing 2.5-7.5% of egg shell powder for cement and 20-40% of iron slag for fine aggregates respectively by weight. Various tests were conducted on M30 grade of concrete to know the compressive strength, flexure strength and split tensile strength. The results obtained were further compared with the usual concrete, thereby we can get to know about the change in the property of concrete containing egg shell powder and iron slag.

H. Eramma & Madhukaran (2019), in the present study, egg shell powder (ESP) are varied up to 10% and steel slag (SS) is added to optimum egg shell powder content cement concrete from 20% to 40% (20%, 30% and 40%). These two wastes are recycled as an incomplete replacement of cement and fine aggregate and various properties like workability. From the experimental results, it is found that 28 days strength of concrete using the partially replacement of egg shell powder and steel slag in concrete.

T.K.Arun Kumar&Priyanka (2017), an experimental investigation will be conducted to study the properties of concrete containing copper slag as a partial replacement of fine aggregates in the concrete mix design. Various durability tests will be conducted on such concrete of M30 grade and M40 grade to know the compressive strength, split tensile strength, flexural strength by varying proportions of copper slag (CS) with fine aggregates by 0%, 5%, 10%, 15%, 20%,25%,30% and Egg shell powder (ESP) as cement by 0%, 5%, 10%, 15%, 20%, 25%,30% by weight. The obtained results will be compared with the conventional concrete, there by knowing the changes in the properties of concrete containing copper slag as a partial replacement of fine aggregates.

Jay Gohil, an experimental investigation will be conducted to study the properties of concrete containing copper slag as a partial replacement of fine aggregates in the concrete mix design. Various strength tests will be conducted on such concrete of M20 grade and M25 grade to know the compressive strength, split tensile strength, flexural strength by varying proportions of copper slag (CS) with fine aggregates by (0% CS + 0% ESP), (10% CS), (10% ESP), (20% ESP), (30% ESP), (40% ESP), (50% ESP), (10% ESP), (10% CS + 10% ESP), (20% CS + 10% ESP), (10% CS + 20% ESP), (30% CS + 20% ESP), (20% CS + 30% ESP), by weight. The obtained results will be compared with the conventional concrete, there by knowing the changes in the properties of concrete containing copper slag as a partial replacement of fine aggregates.

Dhana Lakshmi M, in the present study, these two wastes are used as a partial replacement of cement and various properties like work-ability, compressive strength, and density were determined. Egg shell powder are varied up-to 12.5% (0%, 2.5%, 5%, 7.5%, 10% and12.5%) and fly ash is added to optimum egg shell powder content cement concrete from 0% to 30% (0%, 5%, 10%, 15%, 20%, 25% and 30%).

Pradeep Sharma & Mukesh Kumar, this research was carried out to determine the optimum percentage of eggshell powder as partial cement Replacement and Copper Slag as partial replacement of Fine aggregate. The construction industries are searching for 'alternative products that can reduce the Construction cost. Over 5% of global CO₂emissions can be attributed to Portland cement production. Demand for cement continues to grow. Different ESP concretes were developed by replacing 4-16% of ESP for cement. Concrete plays the key role and a large quantity of concrete is being utilized in every construction practices. The egg shell usually which are disposed, is used as an



alternate for the cement since the shell is made up of calcium. An egg shell are used in different combinations to find the feasibility of using the egg shells as an alternate to cement. aim of this project is to prevent the pollution of environment by the improper disposal of the Eggshell waste, The Copper Slag is replaced with sand in percentage (10%-40%). The optimum proportion of replacement was found by conducting the following tests. Compressive strength test, Flexural strength test and Split Tensile Strength Test.

III.METHODOLOGY

In this experimental study, M30 grade concrete is designed as per the IS code. The materials are collected i.e. cement, fine aggregate, coarse aggregate, egg shell powder and steel slag with the control concrete i.e. 0%, 2.5%, 5%, 7.5%, 10%, 12.5%, 15% of cement is partially replaced with the egg shell powder and 0%, 5%,10%, 15%,20%,25%,30% of fine aggregate is partially replaced with steel slag. The mould is casted for both conventional concrete and replaced concrete with egg shell powder and steel slag. Casted specimenis cured in water for 7 and 28 days respectively. After curing, the compression strength test, split tensile strength test and flexural strength test is conducted at 7 and 28 days. These cubes are tested for each designation andaverage of three results will be taken.

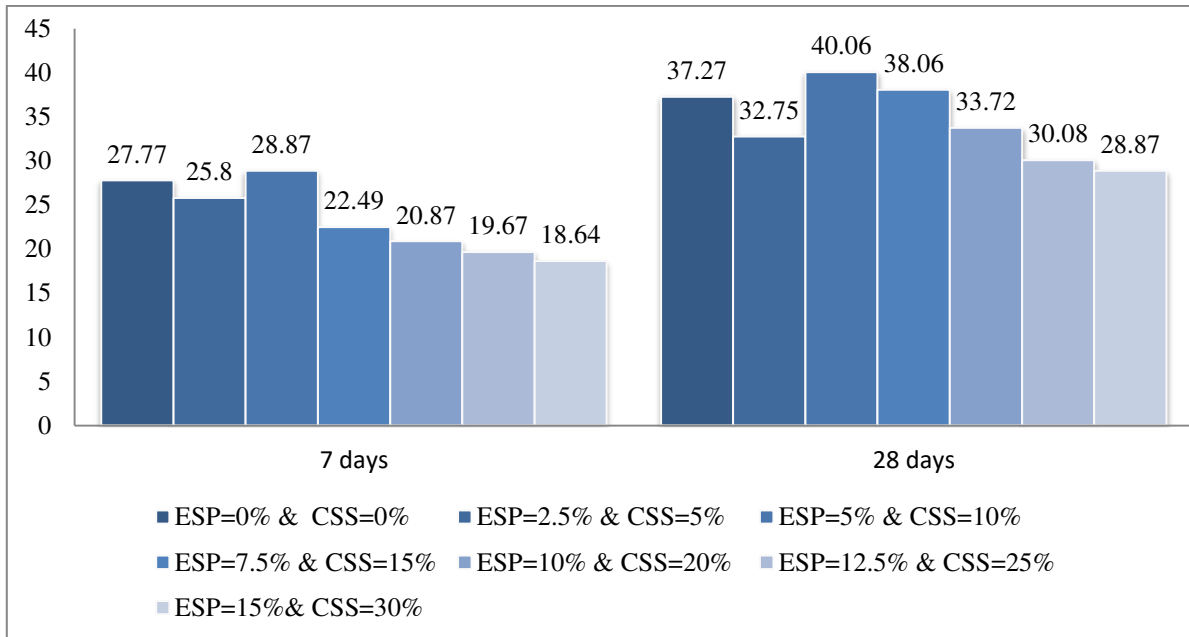
IV.EXPERIMENTAL RESULTS

The properties and the quantity of proportions remain same for all the mixes but the percentageof admixtures changes for every mixes. The strengths of self-curing concrete is compared to thestrengths of normalconcrete

1) COMPRESSIVE STENGTH RESULTS FOR DIFFERENT PERCENTAGE OF ESP AND CSS FORM 30 GRADE

1.1 Test results of M₃₀ grade concrete for 7 and 28 days

SL.NO	Grade	Percentage Replacement of ESP and CSS	7	28
			Compressive strength in Mpa	
1	M ₃₀	ESP=0%+ CSS=0%	27.77	37.27
2	M ₃₀	ESP=2.5%+ CSS=5%	25.80	32.75
3	M ₃₀	ESP=5%+CSS=10%	28.87	40.06
4.	M ₃₀	ESP=7.5%+ CSS=15%	22.49	38.06
5	M ₃₀	ESP=10%+ CSS=20%	20.87	33.72
6	M ₃₀	ESP=12.5%+ CSS=25%	19.67	30.08
7	M ₃₀	ESP=15%+CSS=30%	18.64	28.87



OBSERVATIONS:

The above graph indicates that the compressive strength for 7 and 28 days with varying of 2.5%,5%,7.5%, 10%,12.5%,15% of ESP of the weight of cement and varying of 5%, 10%,15%, 20%, 25% and 30% of CSS of the weight of fine aggregates. The optimum value compressive strength is obtained at 5% replacement of ESP in cement and 10% replacement of CSS fine aggregates.

2) SPLIT TENSILE STRENGTH RESULTS FOR DIFFERENT PERCENTAGE OF ESP AND CSS FOR M30 GRADE

2.1 Test results of M₃₀ grade concrete for 7 and 28 days

SL.NO	Grade	Percentage Replacement of ESP and CSS	7	28
			Split tensile strength in Mpa	
1	M ₃₀	ESP=0%+ CSS=0%	2.37	3.24
2	M ₃₀	ESP=2.5%+ CSS=5%	2.15	3.2
3	M ₃₀	ESP=5%+CSS=10%	2.6	3.34
4.	M ₃₀	ESP=7.5%+ CSS=15%	2.45	2.59
5	M ₃₀	ESP=10%+ CSS=20%	2.44	2.59
6	M ₃₀	ESP=12.5%+ CSS=25%	2.16	2.32
7	M ₃₀	ESP=15%+CSS=30%	2.15	2.32



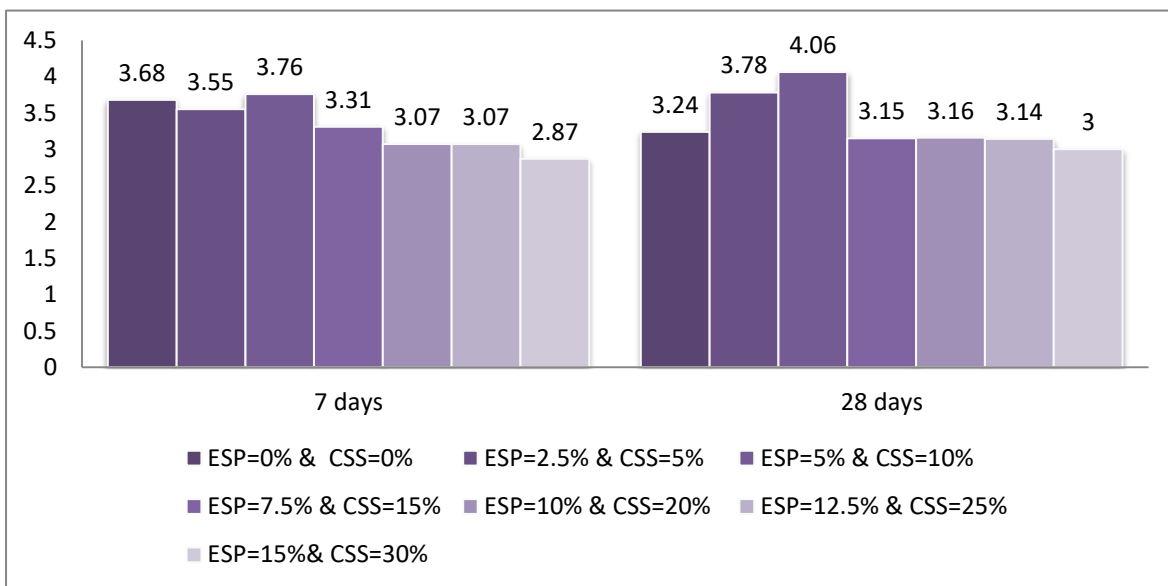
OBSERVATION:

The above graph indicates that the compressive strength for 7 and 28 days with 2.5%,5%,7.5%, 10%,12.5%,15% of ESP of the weight of cement and 5%, 10%,15%, 20%, 25% and 30% of CSS of the weight of fine aggregates. The optimum value of split tensile is obtained at 5% replacement of ESP in cement and 10% replacement of CSS in fine aggregates.

3) FLEXURAL STRENGTH RESULTS FOR DIFFERENT PERCENT AGE OF ESP AND CSS FOR M30 GRADE

3.1 Test results of M₃₀ grade concrete for 7 and 28 days

SL.NO	Grade	Percentage Replacement of ESP and CSS	7	28
			Flexural strength in Mpa	
1	M ₃₀	ESP=0%+ CSS=0%	3.68	4.0
2	M ₃₀	ESP=2.5%+ CSS=5%	3.55	3.78
3	M ₃₀	ESP=5%+CSS=10%	3.76	4.06
4.	M ₃₀	ESP=7.5%+ CSS=15%	3.31	3.51
5	M ₃₀	ESP=10%+ CSS=20%	3.07	3.51
6	M ₃₀	ESP=12.5%+ CSS=25%	3.07	3.16
7	M ₃₀	ESP=15%+CSS=30%	2.87	3.00





OBSERVATION:

The above graph indicates that the compressive strength for 7 and 28 days with 2.5%,5%,7.5%, 10%,12.5%,15% of ESP of the weight of cement and 5%, 10%,15%, 20%, 25% and 30% of CSS of the weight of fine aggregates. The optimum value flexural strength is obtained at 5% replacement of ESP in cement and 10% replacement of CSS in fine aggregates.

V. CONCLUSION

- The Compressive strength of concrete M30 grade mix is obtained by increase with increase in percentage of ESP & CSS as compared to conventional/normal concrete. It is noticed that the maximum results is obtained for ESP=5% & CSS=10% replacement in cement and fine aggregates.
- Split tensile strength and flexural strength of concrete M30 grade mix is obtained by increase with increase in percentage of ESP & CSS as compared to conventional/normal concrete. It is noticed that the maximum results is obtained for ESP=5% & CSS=10% replacement in cement and fine aggregates.

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