

The Effect of Egg shell & Steel Slag as an alternative cement & fine aggregate replacement material in Concrete after 28 days Strength

Nupur Dewangan* , Mr .Shrikant Mishra **

*Student of M.tech Structural Engg.

** Asst.Prof. ,Dept of Civil Engg.SSGI,Bhilai.

ABSTRACT

In the present study an investigation is made on properties of concrete by partial replacement of cement with egg shell and fine aggregate with steel slag. Egg shell powder concrete are varied up to 0 to 20% and steel slag is added to optimum egg shell powder content cement concrete from 0 to 20%.These two waste are recycled as an incomplete replacement of cement and fine aggregate and then characteristics compressive strength after 28 days is analyzed and then it is compared with conventional normal concrete strength.

Keywords- Egg shell powder, steel slag , slump test and compressive strength test, split tensile strength test.

INTRODUCTION

Concrete is one of the world's most construction material due to its versatility, durability and economy. A major component of concrete is cement and it is one of the three primary producers of carbon dioxide, a major greenhouse gas. 900kg of CO₂ are emitted for every ton of concrete. The entire construction industry is in search of a suitable and effective the waste product that would considerably minimize the use of cement and ultimately reduces the construction cost. Also waste byproducts from agriculture and industry like fly ash, egg shell, copper slag, rice husk ,quarry dust etc are creating environmental and health concern problem.

EGG SHELL:- In the present study these egg shell powder is used as a partial replacement of cement and various properties like workability, compressive strength, split tensile strength and flexural strength were determined. It consists mostly of calcium carbonate , a common form of calcium .The rest is made up of protein and other minerals.

STEEL SLAG :- Steel slag ,a by-product of steel making ,is produced during the separation of the molten steel from impurities in steel making furnaces .The slag occurs as a molten liquid melt and is a complex solution of silicate and oxides.

PROPERTIES OF EGG SHELL

Chemical composition of Egg shell :-

The difference in mineralogical composition in Egg shell compared to Portland cement is shown in the table below.

| Mineral | Egg Shell | Portland Cement |
|--------------------------------|-----------|-----------------|
| CaO | 51.25% | 55-66% |
| SiO ₂ | 0.14% | 20-24% |
| Al ₂ O ₃ | 0.09% | 0-8% |
| MgO | 0.56% | 5% |

Advantages of Egg Shell

- Egg shell increasing the compressive and flexural strength of concrete.
- The amount of egg shell if increase then the workability of concrete is decrease.
- The compressive strength of concrete using eggshell powder as a substitute for cement is reduced by 10%.
- Egg shell cost is very low.
- Eggshells powder is an accelerator.

Properties of Steel slag:- The typical chemical composition of steel slag are below table.

| Element | Percent by Weight |
|--------------------------------|--|
| CaO | 40 – 52 |
| SiO ₂ | 10-19 |
| FeO | 10-40 (70 - 80% FeO, 20 - 30% Fe ₂ O ₃) |
| MnO | 5-8 |
| MgO | 5-10 |
| Al ₂ O ₃ | 1-3 |

Steel slag is byproduct of steel production. The main component of steel slag is lime and silica.

Advantages of steel slag

- Steel slag of greater hardness, better adhesion and greater stability.
- Steel slag increasing strength over long period time.
- Steel slag has been completely calcined and does not generate CO₂.
- Steel slag reduces wear.
- Steel slag is high chemical durability.

LITERATURE REVIEW

(a) Afolayan J. O :- This research presents the experimental results of the effect of eggshell ash as a partial replacement of cement in concrete. The properties of concrete investigated include the compressive strength, workability and the setting time. The cement in the concrete mix were partially replaced with egg ash at varying percentages which includes 0%, 5%, 10%, 15%, 20%, 25% and 30% using a mix ratio of 1:2:4 and a constant water cement ratio of 0.55. The specimen produced for the various percentages of eggshell ash were cured for 7, 14, 21 and 28 days before carrying out the compressive strength test. The average compressive strength at 28days of curing for 5%, 10%, 15%, 20%, 25% and 30% are 31N/mm² , 30N/mm² , 27N/mm² , 24N/mm² , 19N/mm² and 15N/mm² respectively. The result shows that increase in the percentage of Egg shell ash leads to decrease in the compressive strength. However at 15% replacement the compressive strength is 27N/mm², which satisfied the require strength for grade 25 concrete in BS 8110.

(b) Dhanalakshmi M1 - The carbon dioxide produced by cement industries causes environmental pollution and global warming. In 1000Kg of cement manufacturing processes approximately 900Kg of CO₂ is emitted. In order to reduce the impact of cement production on atmosphere, wastes by products are used as admixture in this study, so that environmental pollution and natural resources consumption is reduced. 75million tones of fly ash which are rich in silica are disposed to landfill as a waste annually in India. Egg shell powder which is rich in calcium is thrown away as a waste. In the present study, these two wastes are used as a partial replacement of cement and various properties like workability, compressive strength, and density were determined. Egg shell powder are varied upto 12.5% (0%, 2.5%, 5%, 7.5%, 10% and 12.5%) 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%).

(c) Nisar Ahmed Gabol -In this research, eggshell powder (ESP) was used as a partial substitute for cement in concrete to decrease the usage of cement in concrete production. The main objective of the study was to determine the workability and reinforcing properties including compression, tensile and flexural strength of concrete using various percentages (0, 2.5, 5, 7.5 & 10) of ESP by weight instead of cement. A total of 120 concrete samples were cast (60 cubic meters, 30 cylinders and 30 prisms) with a target strength of 28 N/mm². The compressive strength of a cube sample (100 × 100 × 100 mm) was tested after 3, 7, and 28 days, while tensile strength were also measured for 3 days, 7 days and 28 days using a cylindrical specimen (200 × 100 mm). The bending strength of the specimen (100 x 100 x 500 mm), cast during 3, 7, and 28 days of curing. The test results showed that during the. With ESP 7.5%, tensile strength increased by 9.6%, and a maximum strength of 8% was obtained using ESP 7.5% during 28-day cure. As the percentage of ESP increases, the workability of fresh concrete decreases. ESP is used in concrete to enhance the power of a concert.

(d) T.KARUN KUMAR1 , N.PRIYANKA2- 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.

(e) S. Arun Kumar, G.Vasudhevan :- The M40 concrete with high volume steel slag sand replacement for fine aggregate are examined in the present study. The effect of the amount of steel slag was evaluated adapting 10%, 20%, 30%, 40%, 50% cement replacement. Quality is determined from the experimental test values. For the best proportion of steel slag sand is partially replaced for fine aggregate in various percentages of 10%, 20%, 30%, 40%, 50%. The material properties were carried out experimentally. according to material properties compressive strength, flexural strength, split tensile strength and modulus of elasticity were found experimentally. The results are found to be increasing with the increase in the percentage of steel slag, and it is concluded that the steel slag can be partially utilized in concrete.

(f) Dr. S. B. Shinde, Riyaz Khan :-Steel Slag is produced locally in great amounts, creates problems for the environment when disposed .To overcome this problem slag is the sound choice in favour of ecology when used as fine aggregate in rapid concrete sector. This work includes the determination of different properties of locally available steel slag & utilization of steel slag in concrete by replacing it partially and fully by fine aggregate keeping the other parameters constant. Shear strength is considered for investigation on M20 grade of concrete with constant 0.5 w/c ratio. Steel slag replacement of 0,20, 40, 60, 80 & 100% are used. The best results are obtained for replacement ratio of 60%. Therefore, the use of steel slag in concrete would enhance of the strength of concrete.

CONCLUSION

- (1) The eggshell powder high percentage combination of Silica (SiO₂), Iron (Fe₂O₃) Aluminum (Al₂O₃) and Calcium (CaO) 52%.
- (2) The compressive strength of concrete using eggshell powder as a substitute for cement is reduced by 10 - 15%.

- (3) The use of eggshell in the concrete industry able to reduce the amount waste disposed to the environment.
- (4) Addition of ESP to cement concrete leads to reduction in workability.
- (5) Eggshells powder is an accelerator. The higher the content of the ESP, the greater the accelerating effect.
- (6) Compressive strength was higher than control concrete for 5 % ESP replacement at 7 and 28 days of curing ages. ESP replacements greater than 15 % had lower strength than control concrete. Addition of steel slag improved compressive strength of ESP concrete.
- (7) The tensile strength of concrete from eggshells decreases with the addition of egg shells powder. This can be added if concrete is used with steel slag.
- (8) Eggshell powder concrete can improve the compressive strength as well as the tensile and flexural strength of concrete.
- (9) Cost of Construction has been reduced by adding Egg shells powder.
- (10) The concrete becomes environment friendly, due to use of waste industrial material.
- (11) The results that, irrespective of ESP percentage replacement there was good relationship between compressive strength and split tensile strength.
- (12) Better mechanical and physical properties of concrete can be obtained with the replacement of cement with Egg shell powder in mix.
- (13) The best proportion of steel slag sand is partially replaced for fine aggregate in various percentages of 10%, 20%, 30%, 40%, 50%
- (14) The test results, it is observed that 40% replacement level of fine aggregate with steel slag gives equal strength as conventional concrete.
- (15) The Compressive strength, flexural strength and splitting tensile strength for steel slag aggregates concrete were similar to conventional concrete.
- (16) Steel slag easily available in industrial site.
- (17) The compressive strength of conventional concrete cubes is 21.85MPa at 7days, whereas compressive strength of partially replacement cement by an amount of 10% ESP and FA by 30% of SS at 7 days found be 28.88MPa. Also ,it is found that the compressive strength of partially replacement concrete cubes have 7.03% higher strength than the conventional concrete respectively.
- (18) The egg shell varied up to 10% and steel slag is added to 20 to 40% ,the compressive strength is 71% ,split tensile strength is 15.66% have been achieved than the conventional types of concrete.

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