Strength Characteristics Study on Si-Mn Coconut Shell Block

Rincy P, Anjana N K, Vijilesh L V, Jithin George

Abstract—The most common consuming construction material all over the world is concrete. Today construction cost is very high with using conventional materials due to unavailability of natural materials. This problem can be solved by partial replacement of concrete materials. The project aims at analyzing compressive strength and tensile strength of concrete produced using 10%, 12%, 14% and 16% Silico-Manganese as a partial replacement of cement and 5%, 10%, 15% and 20% of crushed coconut shell as partial replacement of conventional coarse aggregate. The results show that the maximum high strength is attained at the replacement of 12% of Silico-Manganese and 15% of coconut shell.

Keywords— Coconut shell, Compressive Strength, Concrete, Partial replacement, Silico-Manganese, Split tensile strength.

1 Introduction

In civil engineering aspects now-a-days the construction of buildings, industries, residential complexes etc., are more essential. There were many experimental work conducted to improve the properties of the concrete by putting new materials, whether it is natural materials or recycle materials or synthetic materials in the concrete mix [2]. The additional material can be replacing the aggregate, cement or just as additive is natural material. Cement act as a binding material to bind fine and coarse aggregate in concrete but cement industries cause an environmental pollution due to the emission of carbon dioxide gas [1]. Using of cementitious materials as a partial replacement of cement in concrete decreases the amount of cement which in turn reduces the emission of carbon dioxide.

2 Literature Review

Tangadagi studied the effect of partial replacement of Coconut Shell in varying percentages like 0%, 5%, 10%, 15%, 20%, 25% and 30% by the weight of coarse aggregate for M20 grade concrete. In this experimental study they concluded that slump and compaction factor test exhibits that, by utilizing Coconut Shell in concrete as a partial substitute to coarse aggregate, reduces the workability in marginal rate when compared to reference mix CS0. But as a practical approach, one can use Coconut Shell up to 20% as a replacement for coarse aggregate without compromising much on fresh properties of concrete. From the overall strength results obtained they concluded that the replacement of Coconut Shell can only be accepted in the range of 20% [6].

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Chirag and Abhishek Sharma (2021) reviewed that when the dose of silica fume was raised after ten percent, it showed that the silica fume and cement were immersed in their compressive qualities. The test findings indicate that the compressive strength of silica rage concrete (7 days, 14 days, and 28 days compressive strength) improves in contrast with ordinary cement. Elongation of the dose of silica has been shown to provide a higher degree of compressive quality. They came to know the tests were extended above 10%, it revealed that Silica Fume's compressive quality had plummeted and 10% is the optimal dose in Concrete.

3 Materials

3.1 Cement:

Cement is one of the most important building materials, is a binding agent that sets and hardens to adhere to building units such as stones, bricks, tiles, etc. Cement is an integral part of the urban infrastructure. It is used to make concrete as well as mortar, and to secure the infrastructure by binding the building blocks. Pozzolana Portland Cement of grade 43 was used in concrete. The experiments conducted to cement includes fineness of cement, specific gravity of cement and consistency of cement [1].

3.2 Silico-Manganese:

Silico-Manganese dust is an industrial by-product obtained from the arc- furnace while extracting manganese from its ore. It has more binding property than cement. It is a very fine pozzolanic material produced during the manufacture of manganese by electric arc furnace [2]. The manganese dust is formed when MnO gas produced in the furnace mixes with oxygen, oxidizes to MnO_2. It condenses and forms manganese which is the major part of the smoke. These smokes are collected in a bag. The smoke collected in the bag is very fine and is called as manganese dioxide dust. Silico-Manganese dust was collected from INDSIL HYDRO POWER AND MANGANESE PVT. LTD, Palakkad. Silico-Manganese dust is obtained from the production of ultra-low carbon Silico-Manganese in INDSIL.

3.3 Fine Aggregates:

These are the materials with the size less than 4.75 mm, these are generally used in preparation of concrete, as it is a parametric material. Fine aggregates are used in concrete as they are the reason for strength properties and reduce the shrinkage in concrete. The river sand manufacture sand (M-sand) is usually used in concrete. In this project M-sand is used [4].

3.4 Coarse Aggregates:

These are materials passing through 20mm and retained on 4.75mm, these are generally used in preparation of concrete, as it is a parametric material. Coarse aggregates are used in concrete as they are the reason for strength properties and reduce the shrinkage in concrete. It should be hard, strong, dense, durable and rough. Granite, crystalline lime stone or sand stone are crushed in to small pieces of varying sizes. Aggregates of rounded shape increases the workability of concrete, but reduces its strength because of poor bonding.

3.5 Coconut Shell:

Coconut shell is high potential material due to its high strength and modulus properties. Coconut shell powder exhibits admirable properties compared to other materials such as low cost, renewable, high specific strength to weight ratio, low density, less abrasion to machine and environmentally friendly [7]. For the purpose of this project, the Coconut shells were obtained from local house. They were crushed manually to a size such that it passes through a 20mm sieve and retained on 10mm sieve. The crushed edges were rough and spiky. The surface texture of the shell was fairly smooth on concave and rough on convex faces. Coconut shell aggregates used were in surface dry condition.

4 Methodology

Concrete were produced using 10%, 12%, 14% and 16% Silico-Manganese as a partial replacement of cement and 5%, 10%, 15% and 20% of crushed coconut shell as partial replacement of conventional coarse aggregate. The mix ratio used in this experiment is M20 grade (1:1.5:3).

Preliminary tests such as fineness test, specific gravity test, and consistency test of cement and Silico-Manganese dust and sieve analysis and specific gravity of fine aggregate, coarse aggregate and coconut shell were conducted. Also tests on fresh concrete such as slump test and compaction factor test were conducted before conducting tests on hardened concrete.

Cubes of 150mm size were used for testing the compressive strength and 150mm×300mm size cylinder were used for conducting split tensile strength test. The concrete specimens are de-moulded after 24 hours of casting and kept in water tank for curing for 28 days. These specimens are tested by compression testing machine after seven days curing or 28 days curing. Load was applied gradually until the specimens fails.

Fig. 1 below shows testing of compressive strength. Compressive strength is tested after curing and air drying. . Load was applied gradually at the rate of 140 kg/cm^2 per minute till the specimens fails. Load at the failure divided by area of specimen gives the compressive strength of concrete.

Fig. 1 Compressive strength test

Fig. 2 below shows testing of split tensile strength. Tensile strength is tested after curing and air drying. . Load was applied gradually at the rate of 1.2 MPa per minute till the specimens fails. Compressive force is applied to a concrete specimen in such a way that the specimen fails due tensile stresses induced in the specimen. The tensile strength at which failure occurs is the tensile strength of concrete [3].

Fig. 2 Split tensile strength test

5 Results and Discussion

5.1 Compressive Strength

The variation of compressive strength of concrete cube created using the combination of partial replacement of cement by Si-Mn 10% and coarse aggregate by 5%, 10%, 15% and 20% of coconut shell is shown in fig. 3. It is observed that the maximum compressive strength obtained at 15% coconut shell in concrete. For 10% Si-Mn and 15% coconut shell, the result obtained is 23.34 N/mm^2.

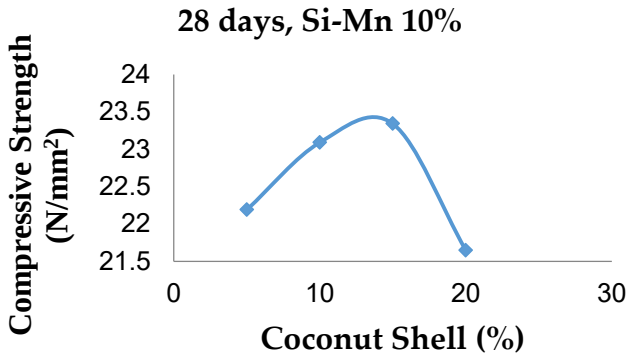

Fig. 3 Variation of compressive strength with 10% Si-Mn for 28 days

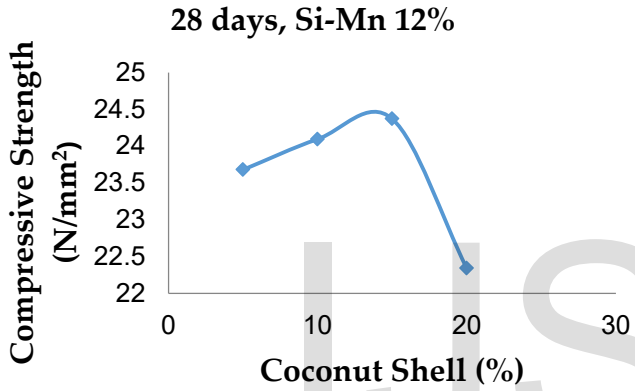

Fig. 4 Variation of compressive strength with 12% Si-Mn for 28 days

Fig. 4 shows the variation of compressive strength of concrete cube created using the combination of partial replacement of cement by Si-Mn 12% and coarse aggregate by 5%, 10%, 15% and 20% of coconut shell. It is observed that the maximum compressive strength obtained at 15% coconut shell in concrete. For 12% Si-Mn and 15% coconut shell, the result obtained is 24.8 N/mm².

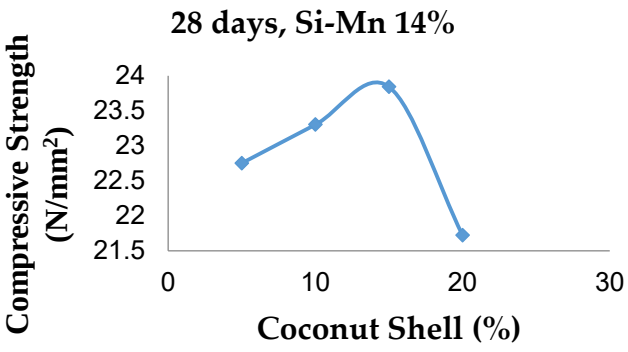

Fig. 5 Variation of compressive strength with 14% Si-Mn for 28 days

The variation of compressive strength of concrete cube created using the combination of partial replacement of cement by Si-Mn 14% and coarse aggregate by 5%, 10%, 15% and 20% of coconut shell is shown in fig. 5. It is observed that the maximum compressive strength obtained at 15% coconut shell in concrete. For 14% Si-Mn and 15% coconut shell, the result obtained is 23.85 N/mm².

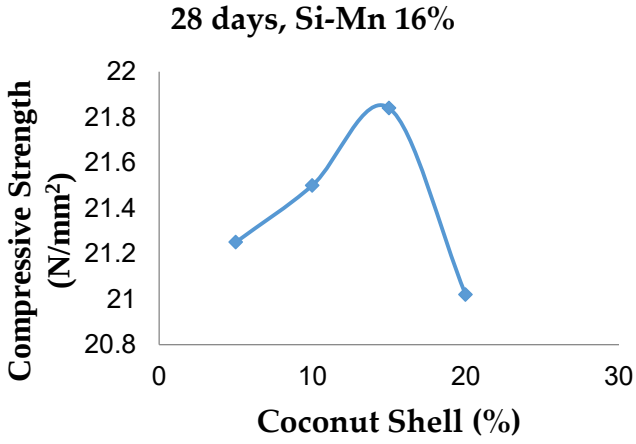

Fig. 6 Variation of compressive strength with 16% Si-Mn for 28 days

The variation of compressive strength of concrete cube created using the combination of partial replacement of cement by Si-Mn 16% and coarse aggregate by 5%, 10%, 15% and 20% of coconut shell is shown in fig. 6. It is observed that the maximum compressive strength obtained at 15% coconut shell in concrete. For 16% Si-Mn and 15% coconut shell, the result obtained is 21.84N/mm².

5.2 Split Tensile Strength

The variation of tensile strength of concrete cube created using the combination of partial replacement of cement by Si-Mn 10% and coarse aggregate by 5%, 10%, 15% and 20% of coconut shell is shown in fig. 7.

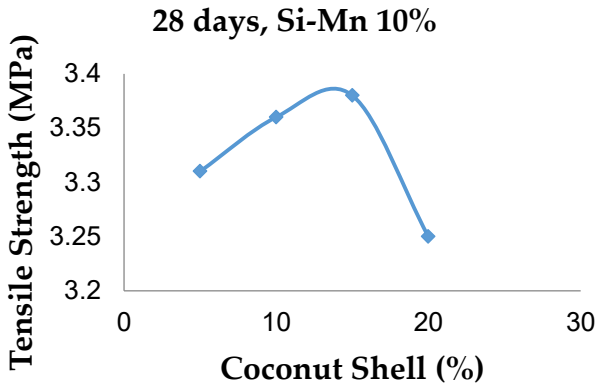

Fig. 7 Variation of tensile strength with 10% Si-Mn for 28 days

It is observed that the maximum tensile strength obtained at 15% coconut shell in concrete. For 10% Si-Mn and 15% coconut shell, the result obtained is 3.37 MPa.

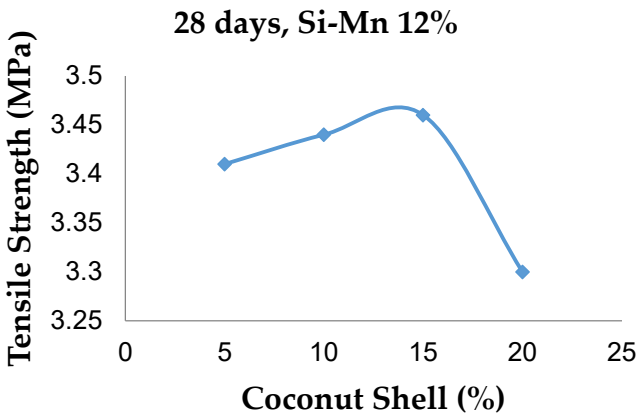

Fig. 8 Variation of tensile strength with 12% Si-Mn for 28 days

Fig. 8 shows the variation of tensile strength of concrete cube created using the combination of partial replacement of cement by Si-Mn 12% and coarse aggregate by 5%, 10%, 15% and 20% of coconut shell. It is observed that the maximum tensile strength obtained at 15% coconut shell in concrete. For 12% Si-Mn and 15% coconut shell, the result obtained is 3.48 MPa.

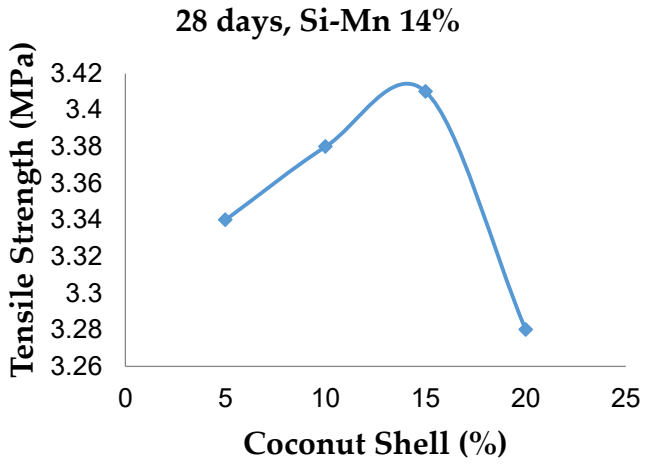

Fig. 9 Variation of tensile strength with 14% Si-Mn for 28 days

Fig. 9 shows the variation of tensile strength of concrete cube created using the combination of partial replacement of cement by Si-Mn 14% and coarse aggregate by 5%, 10%, 15% and 20% of coconut shell. It is observed that the maximum tensile strength obtained at 15% coconut shell in concrete. For 14% Si-Mn and 15% coconut shell, the result obtained is 3.41 MPa.

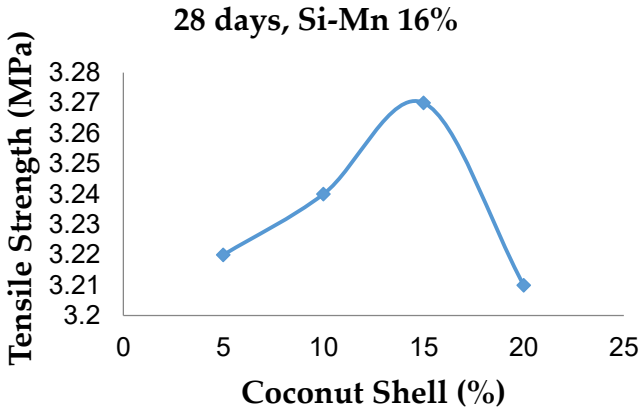

Fig. 10 Variation of tensile strength with 16% Si-Mn for 28 days

Fig. 10 shows the variation of tensile strength of concrete cube created using the combination of partial replacement of cement by Si-Mn 16% and coarse aggregate by 5%, 10%, 15% and 20% of coconut shell. It is observed that the maximum tensile strength obtained at 15% coconut shell in concrete. For 16% Si-Mn and 15% coconut shell, the result obtained is 3.29 MPa.

6 Conclusion

The maximum compressive strength and tensile strength of variant mix found to be 24.8 N/mm² and 3.48 MPa respectively. So it is concluded that the optimum percentage replacement of Silico-Manganese found to be 12% and the optimum percentage replacement of coconut shell is 15%. Thus, from this experiment, it is understood that the partial replacement of cement and coarse aggregate by Silico-Manganese and coconut shell can improve the performance of concrete. It is also useful to draw down the waste products in a useful way.

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