

An Experimental Investigation of Strengthening and Durability Properties of Concrete Partially Replacement of Steel Slag as Fine Aggregate

M.Gopinath¹, J.Suwethaa.², R.Jayaraj³, M.Guhan⁴, S.Pradeep⁵

Assistant Professor, Department of Civil Engineering, Muthayammal Engineering College (Autonomous) Rasipuram

.Namakkal (D.t) Tamilnadu, India¹

UG Students, Department of Civil Engineering, Muthayammal Engineering College (Autonomous) Rasipuram

.Namakkal (D.t) Tamilnadu, India²³⁴⁵

ABSTRACT: This present world is very much depends on the concrete for the construction of various infrastructural activities. Concrete has become a basic need for every structure nowadays. The increasing population of the world puts a lot of pressure on the civil engineer to develop a cost effective as well as an eco-friendly structure according to the need of human beings. Concrete is a heterogeneous mixture of binding material (cement or lime), coarse aggregates, fine aggregates (sand) and water. Fine and coarse aggregates are obtained from quarrying of large rocks which leads to a great destruction to the environment. And further the disposal of the huge amount of demolition waste was another problem. The objective of this research is to study the utilization of and ceramic waste as partial replacement of cement and coarse aggregate in concrete. The properties such as flexural strength and compressive strength of concrete incorporating and ceramic waste in partial replacement of cement and coarse aggregate were examined and compared. The flexural strength and compressive strength was determined at the age of 7 days and 28 days. Cubes for compressive strength as dimensions 150x150x150mm and for flexural beams of dimension 500x100x100mm were casted adopting weight batching and hand mixing. The mix were designated as a mix with varying percentage of ceramic waste such as 0%, 10%, 20% and 30% to evaluate various properties. The research has been conducted on M30 mix grade. The results which come out from the research work are shows that the strength developed in concrete is increased, it can be equated to higher strength concrete and it can be easily used as construction material in construction work.

KEYWORDS: Ordinary Portland Cement , Waste steel slag.

I.INTRODUCTION

A large amount of natural aggregates such as sand and water are being consumed in concrete production. To minimize these, experts have focused on the use of waste materials as potential alternatives in the construction industry. In-fact, especially in concrete construction use of waste materials such as plastic, slag, fly ash, etc., is one of the main aim of researchers to achieve sustainable construction impart about 70% - 80% of volume, where steel slag can be used as an fine aggregate. It can be a new scientific sobriety in the field of sustainable concrete. If we use waste and steel slag as fine aggregates in concrete manufacturing. Steel slag can be used as fine aggregate. This replacement has a huge saving of energy and also has an environmental benefits. Besides, it will also have influence on decreasing the concrete costs. Thus aggregates are replaced by waste steel slag for various percentages 25%, 30% and 35% to increase quality, strength and to minimize cost.

II OBJECTIVE AND SCOPE OF WORK

Adding of waste steel slag to concrete as a supplement actually decreases the construction cost and more or less maintains the concrete properties. In addition to that, when these waste materials are processed properly, have shown to be effective as construction materials and readily meet the design specifications. The aim of this project is to utilize solid waste materials in the best way in construction field without any hazardous effect on strength.



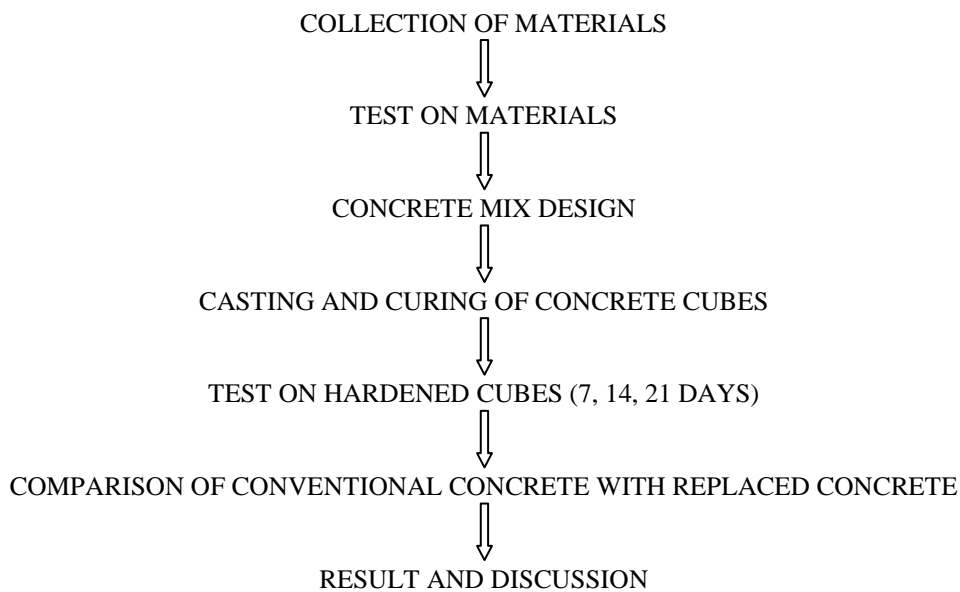
2.1 OBJECTIVE

1. To study the partial replacement of fine aggregate with waste steel slag.
2. To compare the strength of replaced concrete with the conventional concrete. To evaluate the effect of using steel slag in concrete.

2.2 SCOPE OF THE WORK

The main scope of this project work is to arrive the mix proportion of M30 concrete made up of replacing some percentage of fine aggregate with steel slag. Flexural strength for various trial mixes of slag and fine aggregate proportioned concrete element is to be found out.

III. METHODOLOGY



IV. EXPERIMENTAL MATERIALS

Steel slag aggregate are hard having considerable value of specific gravity, light weight than normal aggregate and rough surface on one side and smooth surface on other side. Replacement of steel slag is not only cost effective but also environment-friendly. The waste steel slag are into mixed with concrete as partial replacement of fine aggregate. The usage of waste steel slag would lead to reduce the environmental pollution. The properties are Steel slag concrete mixes have very high stabilities and satisfactory flows and excellent stripping resistance. Steel slag used as surface course has good wear and skid resistance. Steel slag mixes have good heat retention and compatibility. When in contact with moisture, steel slag has a potentially expansive nature up to 10% attributed to the hydration of the free Cao and magnesium hydrates.

S.NO	PROPERTIES	VALUES
1	Specific Gravity	3.40
2	Water absorption(%)	2.5%
3	Unit Weight (kg/m3)	1750

Table 1 Typical physical properties of steel slag

Other materials such as cement, sand and steel slag are also tested. Cement is a binding material and it is tested for its physical properties such as specific gravity (3.15 average specific gravity), consistency (0.29), and initial and final



setting time. The fine aggregate should pass through a IS sieve of size 4.75mm and the sand should be free from impurities. The fine aggregates are also tested for its physical properties such as Specific gravity – 2.66 and average water absorption – 0.7. The steel slag are also tested for its physical properties such as Specific gravity – 3.40 and water absorption – 2.5. The coarse aggregates showed the following test results on their physical properties, Specific gravity – 2.73, which must pass through 20mm sieve and retained in 12mm sieve will be used for casting all specimens.

V. CONCRETE MIX DESIGN

The concrete mix has been designed based on Indian standard code IS: 456-2000. The cement content must be adequate for mild exposure condition as per IS:456-2000. Degree of workability should be around 0.09 and degree of quality control must be good for concrete.

Table 2. Mix preparation

	Cement	Water	F.A (Kg/m ³)	C.A (Kg/m ³)
By Weight (Kg/m ³)	330	150	789.7	1206.9
By ratio	1	0.45	2.4	3.65

VI. RESULT AND CONCLUSION

6.1 Compressive strength: The compressive strength of concrete of six mixes was determined at the age of 7 days, 14 days and 28 days the results are given table 4 and its variation is presented . It is evident from the results that 30% steel slag attains higher compressive strength than other mixes. It is noticed that 30SS mix produced 22.8, 29.8, and 38.5Mpa higher compressive strength than the control concrete at the age of 7, 14, and 28 days respectively.

Table 3.compressive strength of concrete

S.NO	MIX ID	COMPRESSIVE STRENGTH (Mpa)		
		7 days	14days	28 days
1	CC	17.5	24.2	30.4
2	10SS	19.6	26.8	32.8
3	20SS	21.20	27.5	34.6
4	30SS	22.8	29.8	38.5
5	40SS	21.50	28.2	35.8
6	50SS	20.4	27.20	33.6

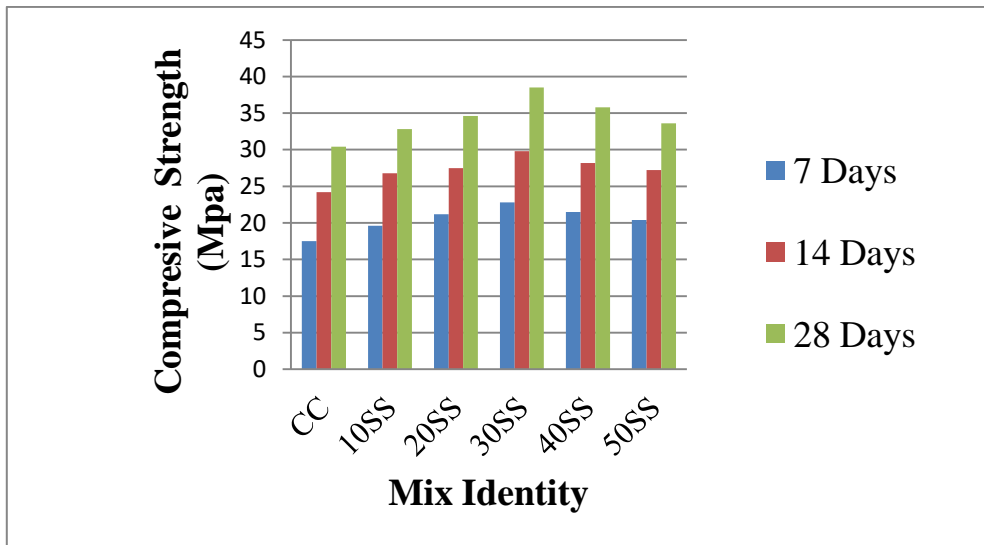


Figure 1. Compressive strength of concrete

6.2 SPLIT TENSILE STRENGTH

The split tensile strength of concrete of six mixes was determined at the age of 7 days and 28 days and the results are given in Table 7.2 and its variation is presented in Figure 7.2. It is evident from the results that 30% steel slag gives higher split tensile strength than other mixes similar to compressive strength. It is noticed that 30SS mix produced 2.05, 2.86, and 3.15Mpa higher split tensile strength than the control concrete at the age of 7, 14, and 28 days respectively.

Table 4. Tensile strength of concrete

S.NO	MIX ID	SPLIT TENSILE STRENGTH		
		7 days	14 days	18 days
1	CC	1.52	2.02	2.65
2	10SS	1.78	2.25	2.82
3	20SS	1.85	2.48	2.96
4	30SS	2.05	2.86	3.15
5	40SS	1.92	2.72	3.02
6	50SS	1.80	2.36	2.84

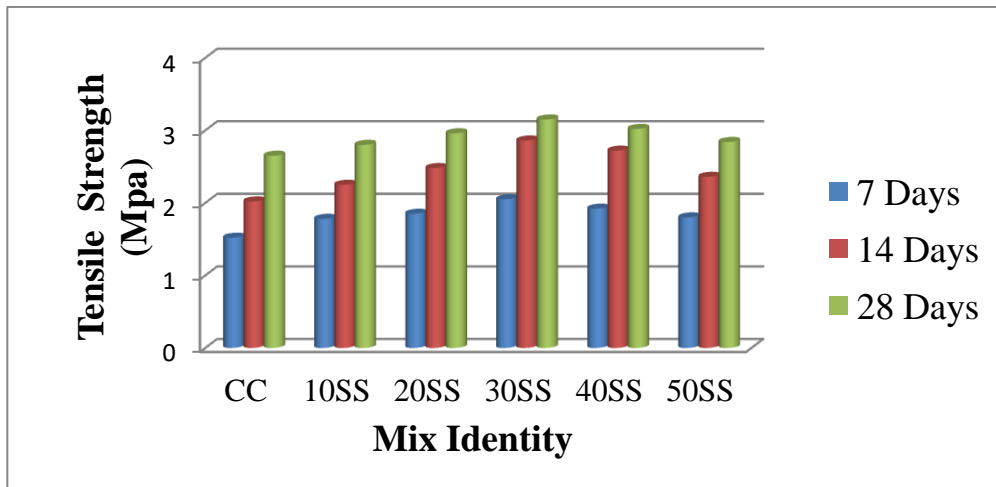


Figure 2. Split tensile strength of concrete

6.3 WATER ABSORPTION TEST

Table 5 Water Absorption of Concrete

S. N O	MIX ID	INITIAL WEIGHT (Kg)	Overn Dry weight	Weight after Immersion	% of Water absorption
1	CC	8.30	8.25	8.58	4.0
2	10 SS	8.35	8.30	8.52	2.65
3	20 SS	8.32	8.27	8.48	2.53
4	30 SS	8.34	8.29	8.53	2.89
5	40 SS	8.30	8.26	8.47	2.54
6	50 SS	8.32	8.27	8.49	2.66

The water absorption of concrete of six mixes was determined and the results are given in Table 7.3 and its variation is presented in Figure 7.3. It is noticed that 30SS mix produced 2.89% it is high when compared other mix of concrete except conventional mix.

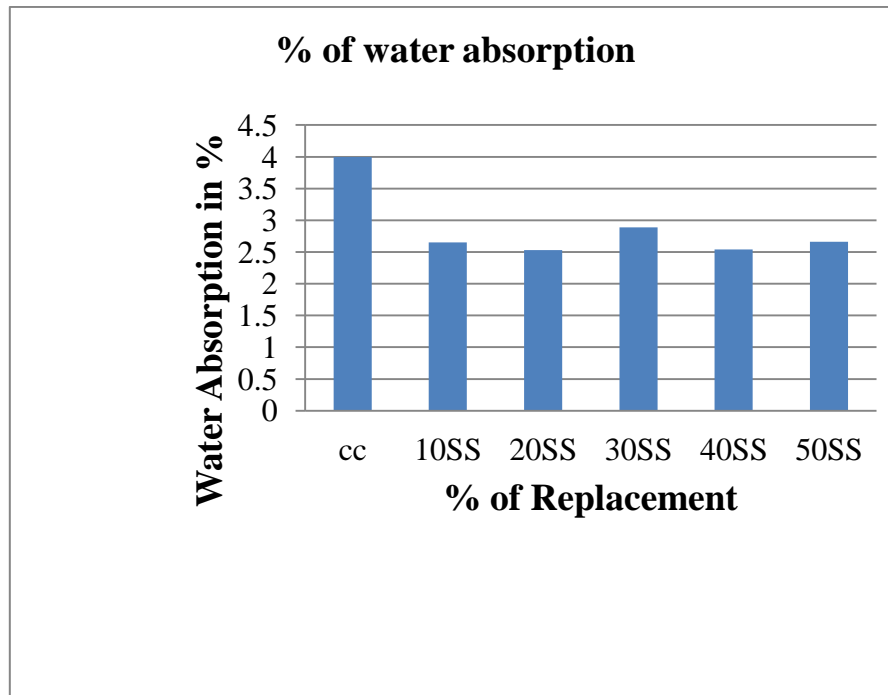


Figure 3. Water Absorption of concrete

VII. CONCLUSION

In this present work, an attempt has been made to study the strength performance of the steel slag concrete. The material properties of ingredients were studied and found that all the properties are well with the prescribed standards. The control concrete mix design was made for M 30 grade concrete. The compressive, split tensile strength and water absorption of concrete was found. Based on strength properties of steel slag concrete, the following conclusion is drawn.

- i. Among all steel slag mixes, the 30% steel slag concrete mix has highest compressive strength of 38.5MPa at the age of 28 days.
- ii. The similar trend has been noticed in split tensile strength, and flexural strength of steel slag concrete. The split tensile strength of 30SS is 3.15MPa which is greater than other mix concrete.
- iii. Therefore, the optimum content of steel slag is found as 30% in conventional concrete.

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