Evaluation of Strength of Concrete With Partial Replacement of Coarse Aggregate By Steel Slag And Cement By Bentonite Powder

A.R.Shambale[1], G.N.Shete[2]
Department of Civil Engineering
[1]PG Student,M.S. Bidve Engineering College, Latur, Maharashtra, India
[2]Assistant Professor,M.S. Bidve Engineering College, Latur, Maharashtra, India

Abstract-*In developing countries where concrete is widely used, the high and steadily increasing cost of concrete has made construction very expensive. This, coupled with the deleterious effect of concrete production on the environment has led to studies on various materials which could be used as partial replacement for coarse aggregate and cement. It was Accomplished to raise cement concrete by partial replaced of cement. An OPC batch, properly mix designed was prime; aiming at strength admixtures was also introduced to attain hide workability. So there is a need of alter the cement by some natural materials which having pozzolonic properties. Aggregates obtained from natural rock sand river beds, thus degrading important to seek suitable alternatives for aggregates in the future. Tests on compressive strength, split tensile strength at 7 and 28 days conducted and Flexural strength of Beam and optimum percentage of Bentoniteis find out. Replacing different percentage of Bentonite and 60% of steel slag by weight of cement and coarse aggregate for a mix of M30 grade concrete. Bentonite is an impure clay material Steel slag is an industrial by-product of steel industry. It possesses the problem of disposal as waste and is of environmental concern. The demand for aggregate in construction industry is increasing rapidly and so is the demand for concrete. Thus it is becoming them slowly. This issue of environmental degradation, and need for aggregates Demands for the usage of any other alternative source. This paper describes the optimum level of Replacement for strength and workability of concrete by.*

Keywords-Bentonite, Steel slag, Compressive Strength, Split tensile strength, Flexural strength.

I. INTRODUCTION

Concrete is the most versatile heterogeneous construction material and the impetus of infrastructural development of any nation civil engineering practice and construction works around the world depend to a very large extent on concrete. Aggregates and cement play a major role in concrete. In India there is a great shortage of natural aggregate. Apart from this waste Generation has increased considerably and finds no way for disposal. In order to overcome this, industrial slag can be used as alternate building materials.

Steel slag is an industrial by product obtained from the steel manufacturing industry. It is a non-metallic ceramic material formed from the reaction of flux such as calcium oxide with the inorganic, non-metallic components present in the steel slag.

Bentonite is clay generated frequently from the alteration of volcanic ash, consisting mostly of Montmorillonite of smectite group. It contains variety of accessory minerals in addition to montmorillonite; these minerals may include quartz, calcite, feldspar and gypsum.

Appropriate utilization of the combination of these two materials as a partial replacement for cement and coarse aggregate will bring ecological and economic benefits to the country.

II. MATERIAL PROPERTIES

A. Material Used

1) Cement:

Portland pozzolona cement of ultra tech brand was used and it was conforming to IS 1489-1991. Tests were conducted to find the properties of cement and the results are tabulated in Table 1

Table No.-1 Physical Properties of Cement

Sr. No.	Physical Properties of OPC 53 Grade Cement	Value
1	Specific Gravity	3.15
2	Standard Consistency	31%
3	Fineness Test	342kg/m2
4	Soundness Test	1.00mm
5	Initial Setting Time	150min.
6	Final Setting Time	210 min.

2) Corse Aggregate:

Coarse aggregate was crushed stone which was available locally. Maximum size chosen was 12mm. Tests are conducted to find the properties of coarse aggregate and the results are tabulated in Table 2

Table No.- 2 Physical Properties of Coarse Aggregate

Sr.No.	Tests		Coarse Aggregate (12mm down size)
1	Specific gravity		2.68
2	Bulk density	Loose	1350 kg/m3
		Compact	1600 kg/m3
3	Fineness modulus		7.13
4	Crushing value		25.36%
5	Impact value		20.35%
6	Abrasion value		30.2%

3) Fine Aggregate:

Locally available Manjra river sand was used as fine aggregate. Tests are conducted to find the properties of fine aggregate and test results are tabulated in table 3

Table No.-3 Physical Properties of Fine Aggregate

Sr.No	Tests	Values
1	Specific gravity	2.63
2	Bulk Density	1843kg/m3
3	Sieve Analysis	Zone II

4) Steel Slag:

Steel slag, a by-product of steel making, is produced during the separation of the molten steel from impurities in steelmaking furnaces. The slag occurs as a molten liquid melt and is a complex solution of silicates and oxides that solidify upon cooling. Tests are conducted to find the properties of Steel slag and the results are tabulated in Table no 4.

Table no 4. Physical properties of Coarse aggregate

Sr.No	Tests	Values
1	Specific gravity	2.97
2	Fineness modulus	5.32
3	Water absorption	0.64%
4	Crushing value	29%
5	Impact value	18.5%
6	Abrasion value	28%

Table4.1.-Chemical Composition of steel slag

Constituent	Composition (%)
Aluminum oxide	1-3
Calcium oxide	40-52
Iron oxide	10-14
Magnesium oxide	5-10
Manganese oxide	5-8
Silica	30-35

5). Bentonite Powder:

Bentonite is an absorbent aluminum phyllosilicate, impure clay consisting mostly of montmorillonite. Bentonite isavailable in powder and solution form, which can replace cement up to 40% of cement used in the concrete. Bentonitepresents strong colloidal properties and its volume increases several times when coming into contact with water, creating a gelatinous and viscous fluid. The ionic surface of Bentonite has the useful property in making a stickycoating on sandgrains.Bentonite acts as natural pozzolan in ordinary Portland cement. A pozzolan is siliceous or aluminous material which itself possesses equivalent to zero percent cementing properties, but in thepresence of moisture it chemically reacts with calcium hydroxide at ordinary temperature to form compounds possessing cementitious properties. When water is added in a mixture of OPC and pozzolan, its silica component reacts with liberated calcium hydroxide in hydrated cement paste. Tests are conducted to find the properties of Bentonite powder and the results are tabulated in Table no.5.

Table no.5.Physical properties of Bentonite powder

Sr.No.	Tests	Value
1	Specific Gravity	2.41
2	Fineness	3.4
3	Size passing	90μm sieve
4	Water Absorption	1 %

3.2.6. Water:

The water available in laboratory which satisfies the potable water standards was used casting of concrete specimen and its subsequent curing.

III. EXPERIMENTAL INVESTIGATION

2.1. Mix Proportioning

The grade of concrete M30 is used further proportion of 1:1.29:1.97 respectively. Characteristic compressive strength required at the end of 28 days is 30 N/mm2.

Water	Cement	Fine Agg.	Coarse Agg.
200	500	644	985
0.40	1	1.29	1.97
20	50	64	98

2.2. Slump Cone Test

To determine consistency of concrete, Slump test was conducted with a particular w/c is fixed according to the slump of 72mm from graph plotted. The constant w/c for different proportions of cement with Bentonite powder and coarse aggregate with steel slag.

2.3. Casting of Specimen

As the aggregate of size less than 12 mm, cubes mould of 150x150x150 mm is used. Cylindrical mould of size 150 mm diameter and 300 mm height and beam mould of size 700x150x150mm are used for casting specimen.

Sr. No.	Material Composition		Average compressive strength in N/mm2	
	Bentonite powder	Steel slag	7 Days	28 Days
1	0%	0%	26.11	35.88
2	10%	60%	29.46	37.86
3	20%	60%	30.48	40.83

2.4. Production of Concrete

Cube Moulds, Cylindrical mould and beam mould of were used. They were lubricated with engine oil in order to reduce friction and to enhance removal of cubes from the moulds. They were then filled with concrete in three layers and each layer was tamped 25 times. The moulds containing the cubes were left for 24 hours under a roomtemperature for the cubes to set before removing the mould. The cubes were removed after 24 hours and were taken to curing tank.

2.5. Curing of Cubes

The method use for curing in this work is the total immersion of the cubes in water for specific age of 7 and 28 days from the day of casting.

2.6. Compressive Strength Test

The compressive strength of concrete is one of the most important properties of concrete. Comparative strength if M30 grade of concrete for the partially replacement of cement and coarse aggregate by crushed was found. In this test 150x150x150mm concrete cubes were cast, by using 30 N/mm2 concrete. The mixing was done by cubes were remolded and placed under water and cured for 28 days. Then the cubes were tested for their crushing strength at 7 and 28 days.

2.7. Split Tensile Strength Test

The test is carried out in a cylindrical specimen of 150mm diameter and 300mm length. The cylindrical specimen is placed horizontally between the loading surface of a compression testing machine and the load is applied until failure of cylinder, along the vertical diameter.

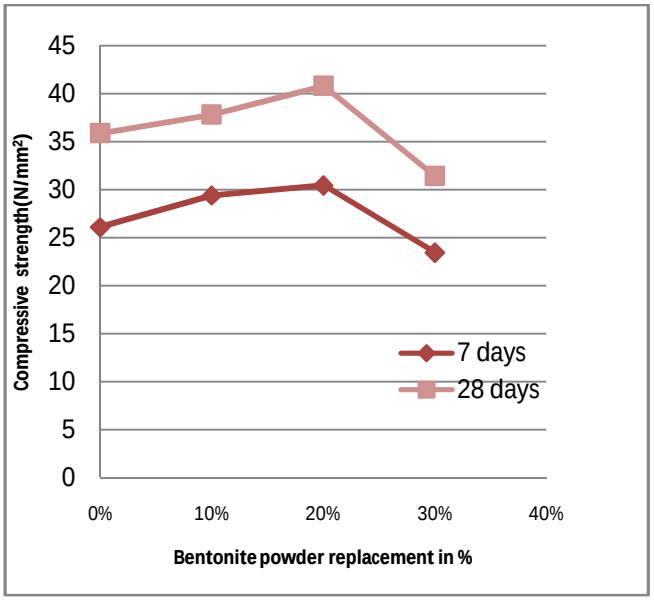
2.8. Flexural Strength Test

Flexural strength is a measurement that indicates a material's resistance to deforming when it is placed under a load. The values needed to calculate flexural strength are measured by experimentation, with rectangular samples of the material placed under load in a Two-point testing setup.

I. Test on Hardened Concrete:
1) The Compressive Strength.
2) The Split Tensile Strength.
3) The Flexural Strength.

IV. RESULT AND DISCUSSIONS

3.1 The Compressive Strength on Cubes: Average Compressive strength of concrete for Different of percentage Bentonite powder and 60% of Steel slag constant for 7 and 28 days curing.

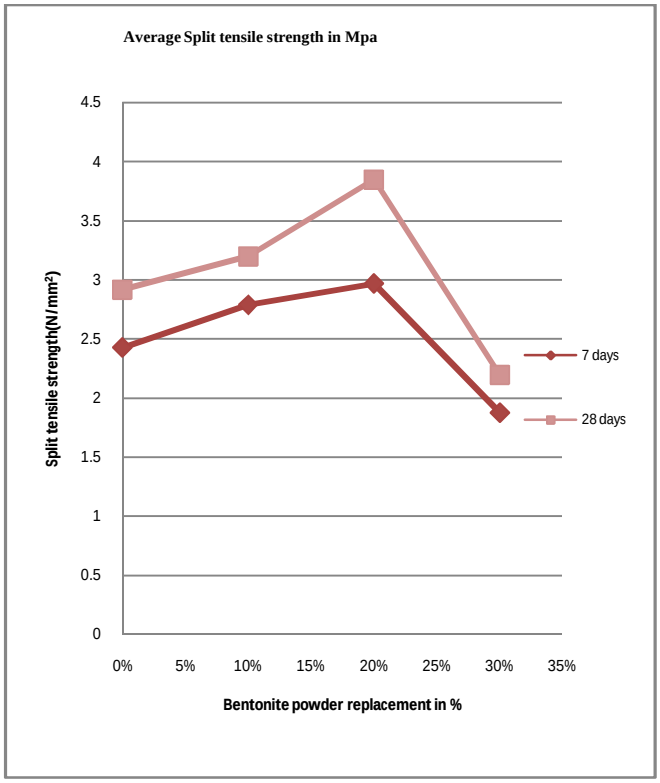


Graph 1: Average Compressive strength in Mpa.

3.2 The Split tensile on Cylinder: Average Split tensile strength of concrete for Different percentage of Bentonite powder and 60% of Steel slag constant for 7and 28 days curing.

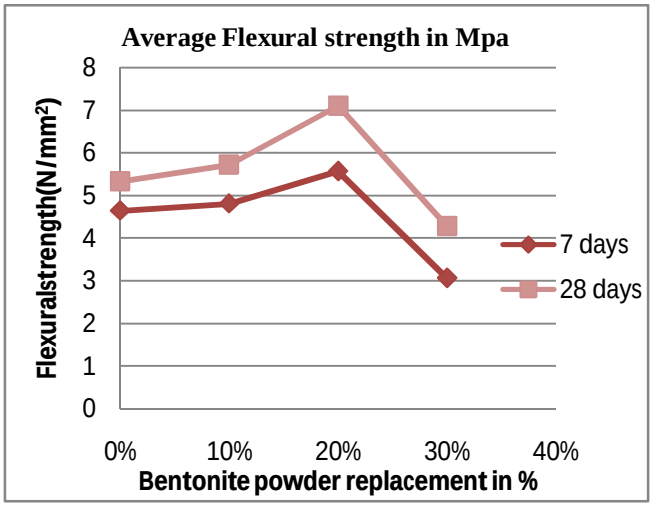
Sr. No.	Material Composition		Average Split tensile strength in N/mm2	
	Bentonite powder	Steel slag	7 Days	28 Days
1	0%	0%	2.43	2.92
2	10%	60%	2.79	3.20
3	20%	60%	2.97	3.85
4	30%	60%	1.88	2.20

Sr. No.	Material Composition		Average Flexural strength in N/mm2	
	Bentonite powder	Steel slag	7 Days	28 Days
1	0%	0%	4.65	5.34
2	10%	60%	4.82	5.73
3	20%	60%	5.58	7.11
4	30%	60%	3.07	4.29



Graph 2: Average Split tensile strength in Mpa.

3.3 The Flexural Strength on Beams: Average Flexural Strength of concrete for Different percentage of Bentonite powder and 60% of Steel slag constant for7 and 28 days curing.



Graph 3: Average Flexural strength in Mpa.

V. CONCLUSIONS

Based on the results and observation made in this experimental research study. The following conclusions are drawn.

1] The experimental study has proved to be better method in providing strong and durable concrete it also gives solution to disposal problem of steel slag.

2] After conducting all the tests on the specimen, it has been observed that up to 20% replacement of cement with bentonite provide to be good in compression, as well as Split tensile, where as the concrete properties with equal proportion of bentonite and conventional cement and confirmed to be inefficient.

3] From this we conclude that cement can replace by bentonite partially without affecting strength characteristics.

4] The compressive strength, split tensile strength and flexural strength of the cubes, cylinders and beams increases when the 10% and 20% ofcement is replaced by Bentonite and 60% of Coarse aggregate is replaced by steel slag. When the 30% cement replaced by Bentonite with 60% of Steel slag, reduction in compressive strength, split tensile strength and flexural strength is observed.

5] 14.23&13.85% increment in the compressive strength is found at 20% replacement of cement by Bentonite and 60% of coarse aggregate by steel slag at7 and 28 days respectively when compared to normal concrete. And the strength decreases by 10.11% &12.37% when the cement is replaced by 30% of Bentonite and coarse aggregate is replaced by 60% of steel slag, by using Aggregate cement ratio (A/C) is 3.25 and Water cement ratio (W/C) is 0.40.

6] 15.63%&10.52% and 13.33&12.86% increment in the split tensile strength and flexural strength is found at 20% replacement of cement by Bentonite and 60% of coarse aggregate by steel slag at 7 & 28 days respectively when compared to normal concrete. And the strength decreases by 10.68%&8.26% and 19.32%&9.84% when the cement is replaced by 30% of Bentonite and coarse aggregate is replaced by 60% of steel slag, by using Aggregate cement ratio (A/C) is 3.25 and Water cement ratio (W/C) is 0.40.

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