Evaluating the Effect of Bentonite, Steel Slag and Sodium Silicate on Strength and Durability of Concrete

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Abstract:- **Concrete is the third largest material consumed by human beings after food and water as per WHO. Concrete consists of cement, coarse aggregate, fine aggregate and water. During cement production carbon di oxide released in the environment that is becoming a big issue in pollution control. So there is a need of alter the cement by some natural materials which having Pozzolonic properties.**

Aggregates obtained from natural rocks and riverbeds, 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 optimum percentage of Bentonite is find out.

Replacing different percentage of Bentonite and 20% of steel slag by weight of cement and fine aggregate for a mix of M40 grade concrete. Bentonite is a 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 fine 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 fine aggregates demands for the usage of any other alternative source.

This paper describes the optimum level of replacement for strength and workability. The strength admixture sodium silicate was introduced to increase the strength and reduce the porosity caused by bentonite. It was seen from the result the Bentonite resulted in poor early stage and good later stage compressive strength when compared to conventional .

1. INTRODUCTION

GENERAL

Concrete is one of the most widely used construction material in the world . It can be cast in diverse shapes . concrete is a composite material formed by the combination of cement, sand, coarse aggregate and water in a particular proportion in such a way that the concrete produced meets the needs as regards its workability, strength, durability and economy.It is found to be versatile and hence gained importance in building materials.

The cost effectiveness in construction will be achieved only if we thinking from every corner of construction materials and also there is a demand for natural aggregate. Hence alternative materials must replace the constructional material in concrete to meet the future problems. In this project, an attempt has made to overcome this problem by the limited use of Bentonite powder in place of cement and limited use of steel slag in place of fine aggregate .The sodium silicate admixture were used to increase the performance of concrete.

2. MATERIAL USED

A. CEMENT

In this project, 43 grade cement is used for the experimental study.

PROPERTIES OF CEMENT

PROPERTIES	VALUE
Normal consistency	34%
Specific Gravity	3.15
Initial Setting Time	30 min
Final setting time	600 min

B.COARSE AGGREGATE

Two size of coarse is used; one 16 mm passing through 12.5mm retained and other 25 mm passing through 20 mm retained. As per IS: 2386 – 1963 recommendation the following properties of coarse aggregate were determined.

PROPERTIES OF COARSE AGGREGATE

PROPERTIES	VALUE
Fineness modulus	4
Specific gravity	2.73
Size	Passing through 20 mm and retaining in 10 mm sieve
Water absorption ratio	0.50%

C. FINE AGGREGATE

By conducting sieve analysis, and compared with grading table from IS 383 – 1970, Table 3.3, it was found that the sand used belong to the zone 3.

PROPERTIES OF FINE AGGREGATE

PROPERTIES	VALUE
Fineness modulus	3.24
Specific gravity	2.41
Size	Passing through 4.75 mm sieve

D. BENTONITE

Bentonite presents strong colloidal properties and its volume increases several times when coming into contact with water, creating a gelatinous and viscous fluid.
PROPERTIESOF BENTONITE

PROPERTIES	VALUE
Fineness modulus	2.54
Specific gravity	2.2

E. 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 silicates and oxides that solidify upon cooling.
PROPERTIES OF STEEL SLAG

PROPERTIES	VALUE
Fineness modulus	2.4
Specific gravity	2.95

F. SODIUM SILICATE

Sodium silicate is other wise called as liquid glass. It is agglomerated that produce the bonding strengthin the final product. A binder can be a liquid or solid that forms a bridge, filim or matrix filler or that causes a chemical reaction in concrete.PROPERTIES OF SODIUM SILICATE

PROPERTIES	VALUE
Density at 25 c g/cm³	1.15
Specific gravity	2.1

3. MIX PROPORTION

The mix design for obtaining the amount of cement, fine aggregate and coarse aggregate are calculated based upon the code IS 10262: 2009 to achieve a compressive strength of M25 grade. The maximum size was 20mm; water content is 186 kg/m3, water/cement ratio of 0.432, slump of 68mm and compaction factor of 0.905 was observed and shown in Tables.

A. MIX DESIGN PROPORTION FOR CUBE

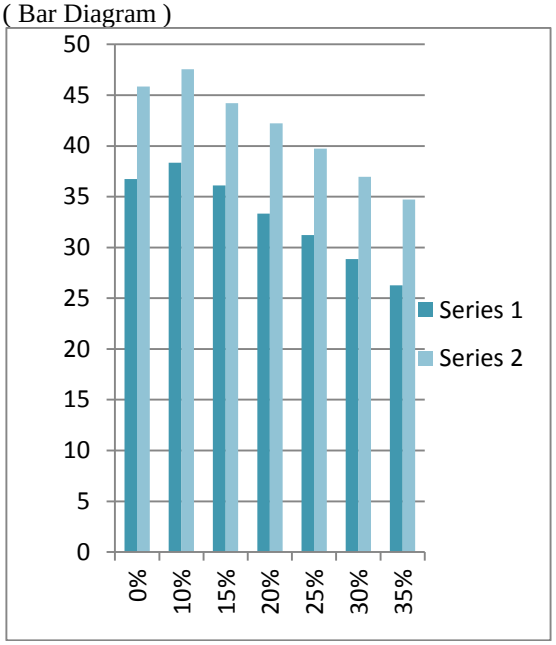
% OF BENTONITE ADDED	AMOUNT OF BENTONITE (KG)	AMOUNT OF CEMENT (KG)	%OF SLAG (KG)	AMOUNT OF SLAG (KG)	AMOUNT OF FA (KG)	AMOUNT OF CA (KG)	AMOUNT OF SODIUM SILICATE (KG)	AMOUNT OF WATER (KG)
0	0	1.225			2.220	4.597		6.6
10%	0.122	1.103	20%	0.444	1.776	4.597	0.18	6.6
15%	0.182	1.039	20%	0.444	1.776	4.597	0.18	6.6
20%	0.245	0.980	20%	0.444	1.776	4.597	0.18	6.6
25%	0.304	0.917	20%	0.444	1.776	4.597	0.18	6.6
30%	0.367	0.857	20%	0.444	1.776	4.597	0.18	6.6
35%	0.427	0.796	20%	0.444	1.776	4.597	0.18	6.6

4. RESULT

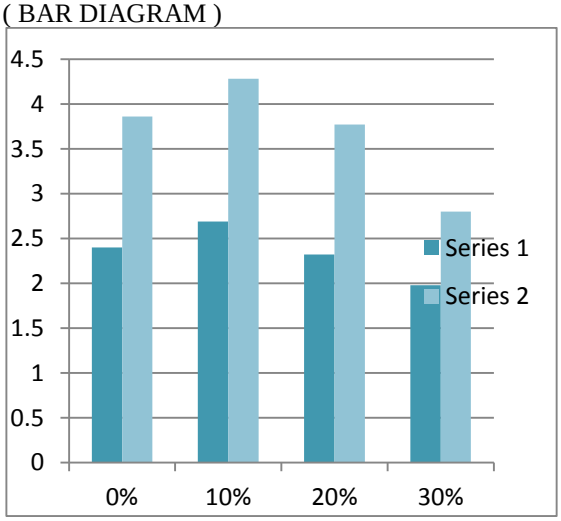
COMPRESSIVE STRENGTH FOR 7 AND 28 DAYS

S. NO	PERCENTAGE OF BENTONITE	PERCENTAGE OF SLAG	PERCENTAGE OF SODIUM SILICATE	7 DAYS AVERAGE COMPRESSIVE STRENGTH(Mpa)	28 DAYS AVERAGE COMPRESSIVE STRENGTH (Mpa)
1	0%	0%	0%	36.73	45.85
2	10%	20%	3%	38.35	47.55
3	15%	20%	3%	36.12	44.22
4	20%	20%	3%	33.33	42.23
5	25%	20%	3%	31.23	39.74
6	30%	20%	3%	28.87	36.97

Comparison of compressive strength results for 7 and 28 days
(Bar Diagram)



COMPARISON OF FLEXURAL STRENGTH RESULTS FOR 7 AND 28 DAYS
(BAR DIAGRAM)



5. DISCUSSION

A. COMPRESSIVE STRENGTH

When bentonite powder was mixed with M40 grade concrete, the cube compressive strength was found to increase by 38.35 Mpa for 7 days, when the bentonite powder mix proportion is between 0% to 30% by weight of cement and 45.55 Mpa for 28 days, when the Bentonite powder mix proportion is between 0% to 30% by weight of cement.

Beyond 10% mix percentage of bentonite powder, result is the gradual decrease in strength of concrete and that above the strength of ordinary concrete.

B.FLEXURAL STRENGTH

The flexural member also found to take more loads than ordinary concrete. When bentonite powder was mixed with M40 grade concrete, the beam flexural strength was found to increase by 2.69 Mpa for 7 days, when the bentonite powder mix proportion 0% to 30% by weight of cement and 4.28 Mpa for 28 days, when the bentonit powder mix proportion is between 0% to 30% by weight of cement.

Beyond 10% mix percentage of bentonite powder, result in the gradual decrease in strength of concrete and that above the strength of ordinary concrete.

6. CONCLUSION

A. GENERAL

After conducting all the tests on the specimen. It has been observed that up to 10% replacement of cement with Bentonite proved to be good in Compression, as well as in flexure, whereas the concrete properties with equal proportion of Bentonite and conventional cement confirmed to be inefficient.

B. SUMMARY

"CONSTRUCTION MUST BE SUSTAINABLE"

The building industry have been living for long decades enjoying the various natural resources as raw materials directly and now, we are suffering a depletion of ozone layer due to the production of cement.

Therefore, to cope up with this situation we can further employ other materials as resources for construction. It will enhances the safety of environment as well as efficient usage of landscape .

- This experimental study has proved to be better method or way in providing strong and durable concrete. It also giving solution to disposal problem of steel slag.
- From this study concluding we conclude that Cement can replaced by bentonite partially without affecting strength characteristics.
- Based on the Compression Strength test, 10 %replacement of cement by bentonite and 60 % replacement of sand by coarse aggregate gives higher compressive strength than conventional concrete.
- Concrete with good strength can be producing Electric Arc Furnace slag from cast iron foundry as an alternative material for aggregate.
- The mechanical properties of steel slag concrete May it will show better results than Conventional aggregate. so it can replace coarse aggregate without impact the strength properties.
- Hence, it can be concluded on the whole that, by utilizing these types of Industrial by-product as major constituent of concrete by effective proportioning, we can reduce the environmental impact.

7. REFERANCES

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