

AN EXPERIMENTAL STUDY ON MUD CONCRETE USING SOIL AS A FINE AGGREGATE AND LD SLAG AS COARSE AGGREGATE

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Abstract

Aggregates are important ingredients of concrete. Sand is used abundantly after air and water. The extensive use of these natural resources is exploiting the environment every day. many alternative materials are being used, viz., slag sand, manufactured sand, quarry dust etc., as fine aggregates; Materials such as steel slag, blast furnace slag are being used as replacement for coarse aggregates. This paper reports the result of different mixes obtained by partial replacement of Natural coarse aggregates (NCA) and complete replacement of fine aggregates (FA) by alternative material such as LD slag and Natural soil respectively. This paper reports the result of different mixes obtained by partial replacement of natural coarse aggregates (CA) and complete replacement of fine aggregates (FA) by alternative material such as LD slag and Natural soil respectively. The wet compressive strength ranged from 16MPa to 20MPa for cubes made of Natural Sand and Natural Coarse Aggregates MIX-D. The wet compressive strength ranged from 18-26MPa for MIX-A; The value obtained for MIX-A was found to be 20% more compared to MIX-D. The split tensile strength ranged from 1.16-1.51MPa for MIX-A, it was concluded that, the mud concrete mix prepared with soil and LD slag gave the satisfactory result which was intended to achieve by normal conventional concrete mix MIX-D. The flexural strength ranged from 3.04-3.41MPa for MIX-A and 2.84-3.45MPa for M4, , it was concluded that, the mud concrete mix prepared with soil and LD slag gave the satisfactory result which was intended to achieve by normal conventional concrete mix. The mud concrete with Soil and LD slag cut down the cost of mix up to 43% when compared with normal conventional concrete of equivalent grade.

Keywords: MUD Concrete, LD Slag, NCA, Alternative Materials, Wet Compressive Strength.

1. INTRODUCTION

In many countries the disposal of solid waste has been the major concern over the years. Increase in the cost of construction diverting attention from using natural available materials to using solid industrial waste materials. The waste materials can also be recovered and reused with proper treatment. Hence the preservation of natural resources will go in parallel.

LD slag is a by-product, obtained during the manufacture of steel. The use of LD slag in concrete is the most promising concept. The LD slag is rich in lime content and it is cementitious material. The LD slag in its native form is uniformly graded. Hence it provides different sizes of aggregate which can be used on different occasions based on aggregate size requirement. On the other hand, steel slag possess good abrasion resistance, high mechanical strength, stiffness, and water absorption capacity. Which is why, it is being used in present study.

2. MATERIALS

A. Cement

Portland cement of 43 grade confirming to IS 12269:1987 is used in this study. The specific gravity of cement is 3.10.

B. Natural soil as a fine aggregate

IS classification was conducted on the soils procured from the different places. It was observed that, Soil used in the study was 'Clayey Sand' (SC)

Table- 1: Physical properties of soil

Sl No	Physical properties		Soil
1	Grain Size Distribution	Gravel %	2.60
2		Sand %	55.30
3		Silt %	16.00
4		Clay %	26.10
5	Specific Gravity, G_s		2.55
6	Liquid limit		27.00
7	Plastic limit		21.83
8	Plasticity Index		5.17

C. LD Slag

The slag was procured from the JSW steel plant Bellary, LD slag is by product, non-metallic material formed from the reaction of flux and non-metallic component present in the steel scrap. The LD Slag which was procured has good physical properties. Various tests have been conducted on the slag and it is seen that, the slag possesses better physical characteristics to use for concrete making process and preliminary tests conducted on LD slag is shown in the table.



Fig -1: LD Slag

Table- 2: Physical properties of LD Slag

Sl No	Physical properties	Results	Permissible limits
1	Density, kg/m ³	1840.00	-
2	Specific Gravity	2.98	2.5-3.0
3	Water absorption (%)	1.89	<2
4	Impact value (%)	17.00	<30
5	Crushing Value (%)	22.10	<45

D. Conventional Coarse aggregates

Table- 3: Physical properties of natural coarse aggregate

Sl. No	Physical properties	Results	Permissible limits
1	Density, kg/m ³	1520	-
2	Specific Gravity	2.78	2.5-3.0
3	Water absorption(%)	1.56	<2
4	Impact value (%)	18.50	<30
5	Crushing Value (%)	24.40	<45

E. Water

The potable water used for manufacture of Mud concrete in the study

Water content corresponding to each mix was carefully monitored and it was fixed based on required slump values. i.e.30% of total mass of cement and soil for MIX A.

3. EXPERIMENTAL PROGRAM

The experimental studies were carried out with the results of wet compressive strength of cubes, cylinder compressive strength; cylinder split tensile strength and beam flexural strength tests.

The observations made on these strength parameters of concrete were analyzed and paper was prepared theoretically and graphically to help for future scope of studies based on this topic.

The general steps involved in concrete casting are listed below. All the steps are discussed in detail in this section.

- ❖ Sieving
- ❖ Batching
- ❖ Mixing
- ❖ Compaction

- ❖ De moulding
- ❖ Curing

To study the behaviour of strength parameters of concrete, the tests were conducted on Cube moulds of dimension (150x150x150mm), Cylinders of dimension (150mm diameter and 300mm length) and on Beams of dimension (100x100x500mm). The cube and cylinders were tested for wet compressive strength, and split tensile strength. The testes on beams were conducted to obtain flexural strength of concrete. The curing was done for 28 days and tests were conducted at 28 days for cylinder compression, split tensile and flexure. Test was conducted for cube compressive strength at 7 days and 28 days to analyse its early strength and ultimate strength. For the convenience, proportions A0,A25,A50 etc., were considered as MIX-A similarly D0,D25,D50 were said as MIX-D.

4. COMPARISON OF TECHNICAL PARAMETERS

i) Comparison of Compressive strength for different proportion

Compressive strength of concrete at 7 days lies in the range 13.14MPa to 21.52MPa. The compressive strength at 28 days ranged from 18.79MPa to 26.11MPa.

Table- 4: Wet compressive strength of MIX-A

Sl. No	Proportion Name	% Replacement (CA)	Wet Compressive Strength @7 days	Wet Compressive Strength @28days	Water Absorption, %
1	A0	0%	13.33	18.71	2.15
2	A25	25%	12	16.21	2.21
3	A50	50%	12.89	17.83	2.25
4	A75	75%	11.15	16.11	2.30
5	A100	100%	13.21	19.83	2.38

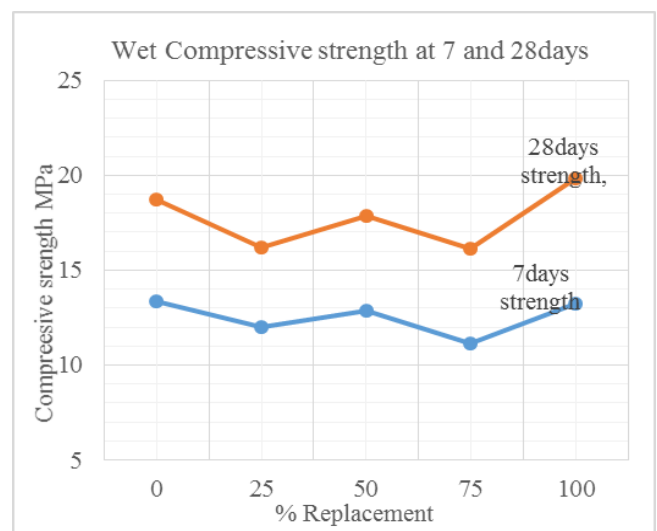


Chart- 1: Variation in WCS at 7 and 28 days for MIX-A

The WCS is 43% more in compared with normal mud concrete where soil and natural coarse aggregates (NCA) were used. On an average, 83% of total strength has been achieved in 7 days (which is >75% as per code requirement). The water absorption ranged from 2.15 to 2.38% which is well within the permissible limit; considering the use of natural sand as fine aggregate, one can interpret it as an excellent performance.

The wet cube compressive strength values for normal concrete prepared with sand as FA and LDS as NCA ranged from 13.21MPa to 18.82MPa @ 7 days testing. The compressive strength at 28 days ranges from 16.26MPa to 20.21MPa. The cube WCS value of D100 was found to be 24% higher than D0 but, difference was very small as compared to D50. The 7 day strength was found to be 85% of the 28day strength.

Table- 5: Wet compressive strength of MIX-D

Sl. No	Proportion Name	% Replacement (CA)	Wet Compressive Strength @7 days	Wet Compressive Strength @28days	Water Absorption, %
1	D0	0%	13.21	16.26	1.12
2	D25	25%	14.86	18.97	1.18
3	D50	50%	18.63	20.36	1.5
4	D75	75%	18.65	20.00	1.6
5	D100	100%	18.82	20.21	1.64

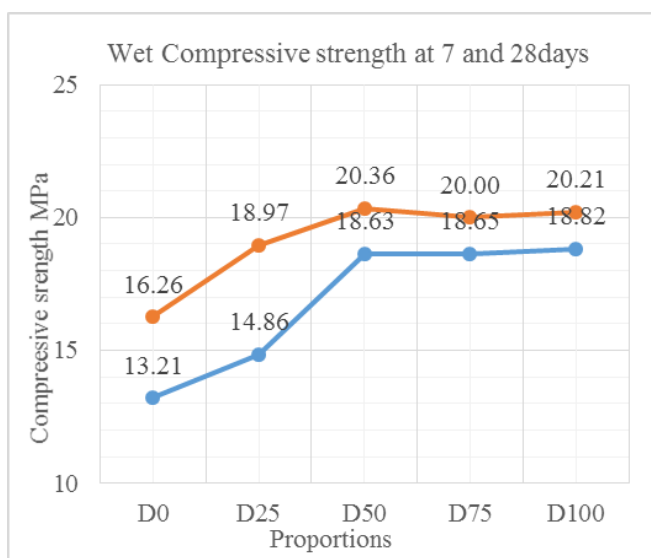


Chart- 3: Variation in Cylinder compressive strength at 7 and 28 days for MIX-A and MIX-D

ii) Comparison of Cylinder Compressive Strength for different proportions

Table- 6: Cylinder compressive strength of MIX-A & MIX-D

Type of proportion	Wet Compressive strength of Cylinder, MPa	Type of proportion	Wet Compressive strength of Cylinder, MPa
A0	16.39	D0	13
A50	18.39	D50	16.7
A100	20.62	D100	17.4

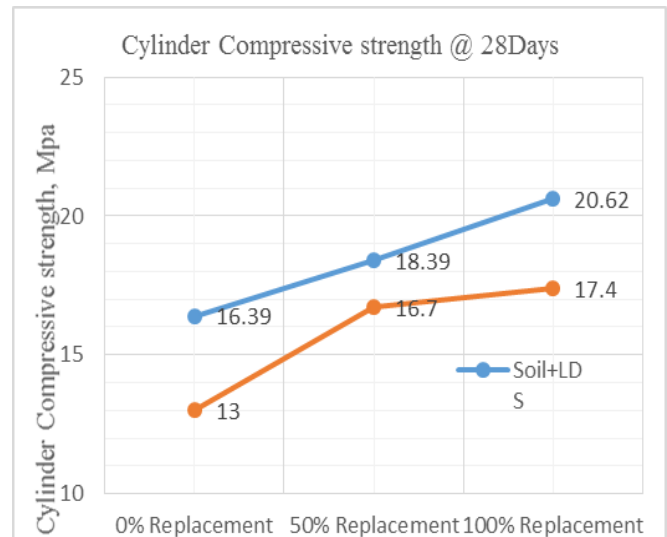


Chart- 3: Variation in Cylinder compressive strength at 7 and 28 days for MIX-A and MIX-D

The wet compressive strength of cylinder (CCS) ranged from 16.39 - 20.62MPa; Proportion A100 consisting of 100% LDS showed the highest cylinder compressive strength of 20.62MPa. As per available literatures, the Compressive strength of cylinder for concrete @ 28 days is equal to 0.75 - 0.87 times the strength of cube; here, the CCS values were found to be 0.87 times the cube compressive strength. All the values are within permissible limits.

From the above discussion, one can interpret that, the compressive strength of cylinder is good for mix proportion prepared with soil A as FA and LDS as NCA. As the strength relation b/w cylinder and cube is also well under permissible limit, one can consider this mix proportion for future performance studies.

iii) Comparison of Split Tensile Strength for different proportions

Table- 7: Split tensile strength of MIX-A & MIX-D

Type of proportion	Split Tensile Strength of Cylinder, MPa	Type of proportion	Split Tensile Strength of Cylinder, MPa
A0	16.39	D0	13
A50	18.39	D50	16.7
A100	20.62	D100	17.4

The Split Tensile Strength ranged from 1.16MPa to 1.51MPa; Proportion A100 consisting of 100% LDS showed the highest split tensile strength 1.50 MPa; As per available literatures, the split tensile strength for conventional concrete is up to 10% of cylinder compressive strength values for 28 days.

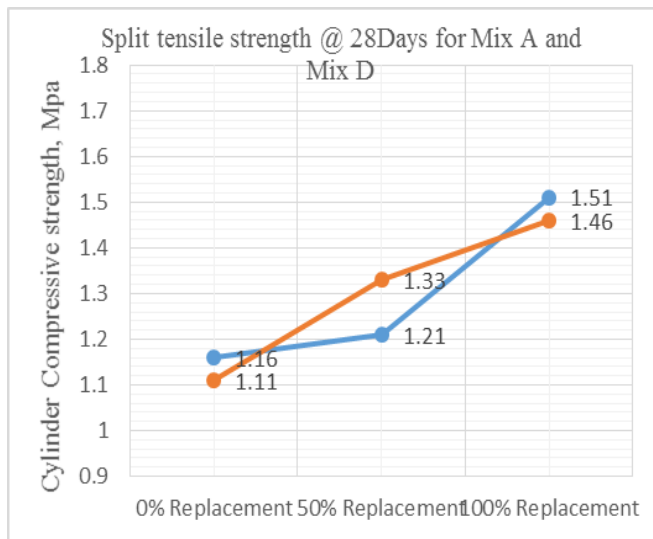


Chart- 4: Variation in Split tensile strength at 7 and 28 days for MIX-A and MIX-D

The Split tensile strength value obtained for different proportion of mud concrete is 7.3% for Mix A, which is reasonable, considering the fact that in proportion Mix D which is conventional concrete mix with natural sand as fine aggregate. Whereas the other proportion contain natural soil as fine aggregate. Considering this fact one can say the performance of natural Soil s Fine Aggregate in Mud Concrete as Good, hence one can say seriously considering this combination in performance studies.

iv) Comparison of Flexural strength for different proportions

Table- 8: Flexural strength of MIX-A & MIX-D

Type of proportion	Flexural strength of Cylinder, MPa	Type of proportion	Flexural strength of Cylinder, MPa
A0	3.04	D0	2.84
A50	3.19	D50	3.06
A100	3.41	D100	3.45

The Flexural strength for Mix A ranged from 3.04 to 3.41MPa. The FS increased up to 13% between A0 and A100. Mix D produced the highest flexural value of 3.45MPa for D100 proportion.

From discussion it is observed that the concrete with Natural Sand as FA and LDS as CA has maximum flexural strength; Mud concrete with Soil as FA and LDS as CA have almost similar value as that of M4. AsD0 but, difference was very small as compared to D50. The 7 day strength was found to be 85% of the 28day strength.

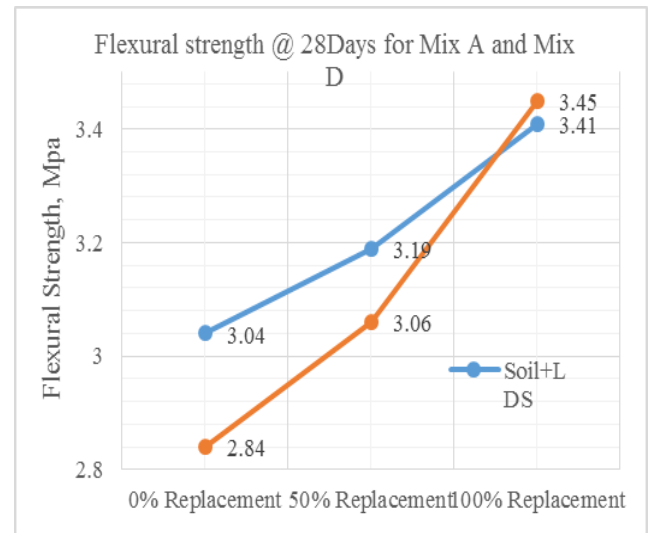


Chart- 5: Variation in Flexural strength at 7 and 28 days for MIX-A and MIX-D

CONCLUSION

- [1]. The mud concrete prepared with soil showed extremely good results when compared to normal conventional concrete.
- [2]. Water absorption increases with the increase in the percentage of LD slag.
- [3]. Using locally available soil and LD slag in concrete makes it environmental friendly, which can be labelled as Green construction material right away.
- [4]. The transportation charges of materials are also cut down if the locally available soil meets the basic requirement to be a fine aggregate in mud concrete. LD slag available in bulk makes it easier to adopt in rigid pavement construction projects.
- [5]. The wet compressive strength ranged from 16MPa to 20MPa for cubes made of Natural Sand and Natural Coarse Aggregates MIX-D. The wet compressive strength ranged from 18-26MPa for MIX-A; The value obtained for MIX-A was found to be 20% more compared to MIX-D.
- [6]. The split tensile strength ranged from 1.16-1.51MPa for MIX-A, it was concluded that, the mud concrete mix prepared with soil and LD slag gave the satisfactory result which was intended to achieve by normal conventional concrete mix MIX-D.
- [7]. The flexural strength ranged from 3.04-3.41MPa for MIX-A and 2.84-3.45MPa for M4, , it was concluded that, the mud concrete mix prepared with soil and LD slag gave the satisfactory result which was intended to achieve by normal conventional concrete mix.

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