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Experimental Investigation on Concrete by Partial Replacement of Coarse Aggregate by Cinder

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Abstract - *Light weight concrete has become more popular in recent years owning to the tremendous advantages it offers over the conventional concrete. The main specialties of lightweight concrete are its low density and thermal conductivity. Its advantages are that there is a reduction of dead load, faster building rates in construction and lower haulage and handling costs. We are replacing the cinder instead of coarse aggregate; it is obtained from steel industries. The surface of the cinder is usually rough and high porous due to mineral structures. Low specific gravity of cinder in compression with natural aggregates resulted in the concrete made with cinder to be lighter than normal concrete. Based on the literature, the main function for usage cinder material is to minimize the cost and it is reduced to disposal of waste material and it helps in reduction of dead load. An experimentally study has been conducted on concrete with partial replacement of conventional coarse aggregate by another light weight aggregate. The M30 concrete mix is designed using ISI method. We make concrete by replacing coarse aggregate with cinder of different percentages like0%, 20%, 40%, 60%,80% and 100% with curing of 7 and 28 days. Among all the percentages the better compressive strength obtained percentage is selected.*

Key Words: Light weight concrete, thermal conductivity, M30 concrete mix, ISI method.

1. INTRODUCTION

In recent days, due to the developments and innovations in the new construction materials, stress analysis approaches towards finding of the weight less structures to reduce the weight of the construction has lead to development of the Light Weight Aggregate Concretes (LWAC) to increase the strengths and weights. Concrete is one of the most multipurpose material used in building construction. In structural applications, the self-weight of the structure is quite important as it represents a major portion of its dead load. Replacing partially or entirely the coarser normal weight aggregate in conventional concrete can be replaced partially or fully with low density aggregates will produces lightweight concrete that can reach a reasonably good compressive resistance [1].The advantages of lightweight Aggregate concrete (LWAC) are its reduced mass and improved thermal and sound insulation properties, while maintaining adequate strength. The reduced self-weight of LWAC will reduce the gravity load as well as seismic inertial mass which leads to decreased member sizes as well as forces on foundation can be reduced. Aggregates contribute an important role in concrete volume as they contribute to 60 to 70 percent of the total volume. Thus they have an major influence on the different material properties like density, specific gravity, water absorption etc., Cinder is the material comes under the category light weight aggregate and it is a byproduct of steel, iron manufacturing companies. The surface of cinder aggregate is usually rough and highly porous due to mineral structure. The cinder material visually classified as having 100% crushed face and have been used for making building blocks for partition walls.

2. LITERATURE SURVEY

To get an overview of problem building for the present research, all the available earlier studies were browsed both in India as well as around the world. Special attention was given on how the earlier workers have used LWAC towards understanding the strengths of the concrete of their study area. A brief review of available studies related to the present strength properties of concrete materials is as follows.

2.1 Seabrooks, 1988 [2]. Demonstrates the results of the 162 trial mixtures of the second phase of a three-phase programme, using aggregates from the three sources such as, two chemical admixture systems, three levels of fly ash replacement, and three levels of silica fume replacement. It is resulted that 91 day compressive strengths of the order of 65 MPa are attainable light weight concrete, although this is the threshold level of the aggregates. Further, it is concluded that a nominal increase in strength occurs with Type F ash replacement and addition of the silica fume.

2.2 Bhaskar Desai et al., 1993, 1999, 2000 [3, 4, 5]. An effort is made to study the strength properties of LWAC in various % proportions of 0, 25, 50, 75 and 100 of cinder and calculated the properties such as compressive strength, split tensile strength, modulus of elasticity, density and shear stress. And this study concludes that, mode – II failure is procured at Double Central Notched specimen geometry. Furthermore, they made finite element analysis to disembarkat stress intensity factor and these geometry and finite elemental studies have applied in the investigations of mortar, cement paste, and plain concrete.

2.3 Siva lingaRao, et.al., 2011 [6]. Accomplished that, the best mean strength results of M20 concrette have occurred at the 60 percent replacement of conventional aggregate with cinder by volume along with cement replaced by 10percent of silica fume by weight. In addition to this it is also noted that there is a slight increase in the strength of based on the during period extension and the unit weight of the cinder concrete is varying from 1980 to 2000 Kg/m^3.furthermore, it is also noted that there is a decrease in density after extended curing periods.

3. MATERIALS AND THEIR PROPERTIES

The materials which are used for the experimental procedure are as follows;

1) Cement- Cement is the most important ingredient which determines the fresh & hardened properties of concrete. Ordinary Portland cement of 43 grade (sp gravity-3.15)confirming to IS 12269-1987 is used in this experimental program.

2) Fine aggregates - The aggregates which are passing through 4.75mm size IS sieve and contains only that much of coarse grained materials as permitted by the specifications are generalized as fine aggregates. Fine aggregates confirming to zone II passing through 4.75mm IS sieve (sp gravity-2.52) is used in this experimental program.

3) Coarse aggregates: The aggregates which are retained on4.75mm size IS sieve and contains only finer materials are generalized as coarse aggregates. Coarse aggregates Passing through 12mm sieve and retained on 10mm sieve (spgravity-2.63) are used in this experimental program.

4) CINDER: Cinder is a naturally occurring light weight rock(sp gravity-1.512) of igneous origin. It is a pyroclastic material which is similar to that of pumice and has many cavities.

4. METHODOLOGY

The raw materials are firstly cleaned such that it should be free from impurities and then they are subjected to the basic tests. Based on the appropriate water cement ratio the mix designs are obtained for M30 grade concrete as per the codal provisions. For the obtained mix design the lightweight aggregates such as CINDER are partially replaced in place of conventional aggregates with various percentages. The fresh concrete, slump test is carried for each proportion. For each proportioned percentage the cubes and cylinders are casted in order to determine hardened properties of concrete. The above specimens are kept for curing for 28days and then the test results are determined. The above process is carried for the M30 grade of conventional concrete. After testing the light weight aggregate concrete the proportion at which optimum strength obtained is determined. Further the optimum light weight aggregate concrete is compared with that of conventional grade concrete, so that the amount of strength gained with respect to normal conventional concrete is determined.

5. EXPERIMENTAL ANALYSIS:

The fresh and hardened properties of concrete are determined by various tests as follows;

A) Test on fresh concreter:

1)slump test

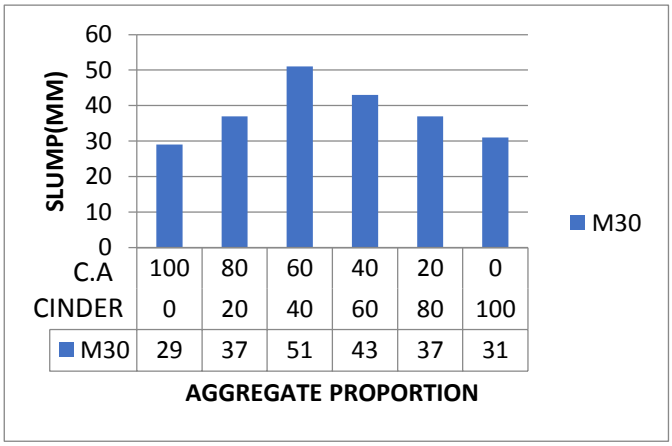
B) Test on hardened concrete:

1) Compression strength test.

2) Split tensile test.

SLUMP TEST

The slump test is carried out in order to determine the workability of concrete. Slump test is carried out for various proportions of light weight concrete and the test results shown in graph 1 as follows

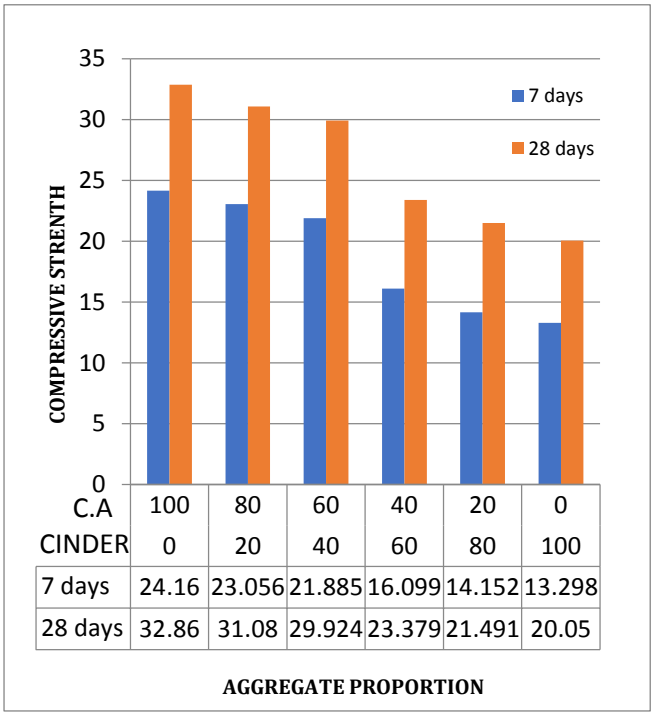


Graph1: comparison of aggregate proportion (%) verses slump (mm) for M30 grade concrete mixes.

From the above slump values it is observed that the slump goes on increasing up to 40% replacement of cinder and 60% replacement of coarse aggregate. Further the values of the slump goes on decreasing till the last proportion, therefore from the graph it is analysed that the slump is highest for the 40% cinder and 60% coarse aggregate replacement proportion.

COMPRESSION STRENGTH TEST

The cubes of 150x150x150mm are casted by varying the proportions of leca and cinder for both M30 grade concrete mixes. The results obtained are tabulated for the curing period of 7 days, 28 days as shown below in graph 2



C.A	100	80	60	40	20	0
CINDER	0	20	40	60	80	100
7 days	24.16	23.056	21.885	16.099	14.152	13.298
28 days	32.86	31.08	29.924	23.379	21.491	20.05

Graph 2: comparison of aggregate proportion (%) verses compressive strength for M30 grade concrete mixes

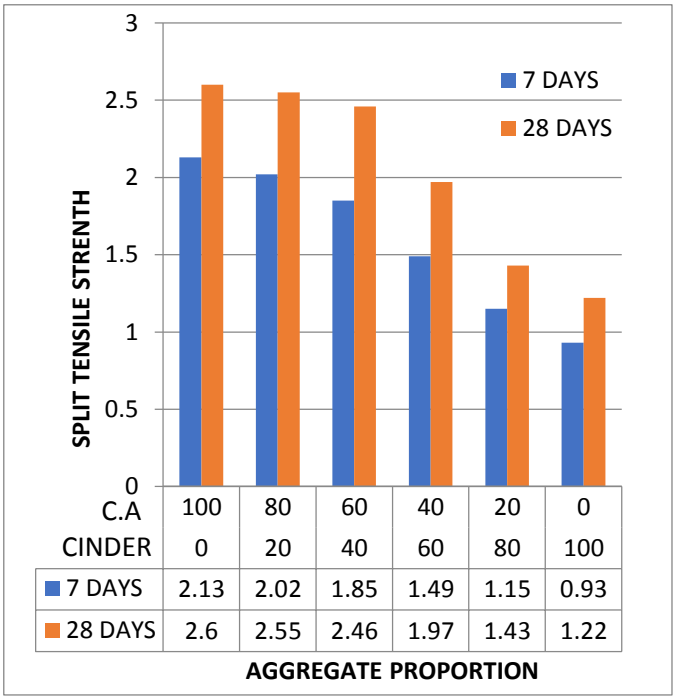
The compression test results which are obtained are plotted in graph 2, with compressive strength along y axis and the aggregate proportions along x axis.

With 0% replacement of cinder and 100% replacement of coarse aggregate, compressive strength for M30 is 32.86 for 28 days curing period and 7 days curing period compressive strength is 24.16.Variation in the strength is observed consecutively in same extent as the aggregate proportions are varied. From the above compression test values it has been observed that the strength goes on decreasing from the first proportion to the last in a gradual sense.

SPLIT TENSILE TEST:

The cylinders of 300X150mm are casted by varying the proportions of coarse aggregate and cinder for M30 grade concrete mixes. The results obtained are shown graphically for the curing period of 28 days and 7 days as shown below

Split tensile test is carried out for the M30 grade by varying the aggregate proportions. From the obtained results; the graph is plotted with split tensile strength along y axis and aggregate proportions along x axis.



C.A	100	80	60	40	20	0
CINDER	0	20	40	60	80	100
7 DAYS	2.13	2.02	1.85	1.49	1.15	0.93
28 DAYS	2.6	2.55	2.46	1.97	1.43	1.22

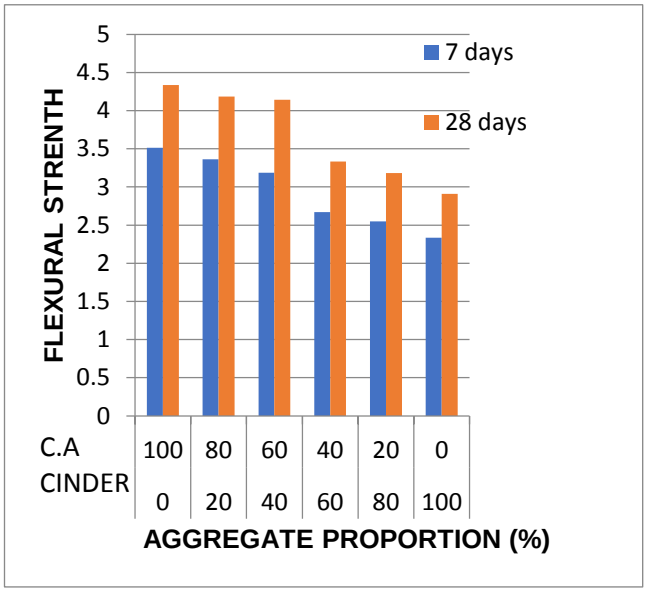
Graph 3: comparison of aggregate proportion (%) verses split tensile strength for M30 grade concrete mixes.

The graph shows the results of split tensile strength for 7days and 28 days of curing period with respect to the variation in the aggregate proportion for M_{30} grade of concrete. It can be observed that, strength value increases with respect to increase in curing period. That is with 0% cinder and 100% coarse aggregates the value of split tensile strength for 7 days of curing period is 2.13 N/mm^2, and for 28 days of curing period it is found to be 2.6 N/mm^2. It is also observed that, the split tensile strength is found to be varying in a detrimental way with the variation in the aggregate proportion. That is, with 20% replacement of cinder and 80% of coarse aggregate, the value of split tensile strength for 28 days of curing is found to be 2.55 N/mm^2.whereas with 40% replacement of cinder and 60% of coarse aggregate the value of split tensile strength is found to be 2.46 N/mm^2.This may be due to the reason that, the specific gravity of cinder is less than that of the coarse aggregate.

FLEXURAL STRENGTH TEST:

Experiments were also conducted to study the behavior of cinder as coarse aggregate subjected to flexural strength test for M30 grade concrete for 7 and 28 days curing period

Split tensile test is carried out for the M30 grade by varying the aggregate proportions. From the obtained results; the graph is plotted with split tensile strength along y axis and aggregate proportions along x axis.



Graph 3: comparison of aggregate proportion (%) verses flexural strength for M30 grade concrete mixes.

It is observed from the graph 6.4. that, for 0% replacement of cinder and 100% of coarse aggregate the flexural strength value for 7 days of curing period is 3.513N/mm^2, and for 28 days it is 4.334N/mm^2.Similarly for 20% cinder and 80 % coarse aggregate the flexural strength value for 7 days of curing period is 3.361N/mm^2 and for 28 days it is 4.185N/mm^2.This shows that decrease in flexural strength is observed till the last proportion that is 100% cinder and 0% coarse aggregate. It is observed that, the values of flexural strength are found to be increased with respect to increase in the curing period. This may be due to the reason that, as the curing period of concrete increases, the strength also increases. From the graph it is also observed that as the value of flexural strength decreases with the variation of aggregate proportion in a gradual sense, this may be due to the reason that the coarse aggregate is strong enough and have high specific gravity when compared to cinder. Hence with the increase in the cinder content and decrease in the coarse aggregate content will result in decrease in the value of flexural strength of concrete. Results are observed in case of M_{30} grade concrete also and the same is presented in graph

6. CONCLUSIONS

From the limited experimental study of the following conclusions are seem to be valid:

1. The slump value is found to increase gradually until the(40%,60%) cinder and coarse aggregate proportions, and thereafter the slump goes on decreasing gradually. Therefore with 40%replacement of cinder and 60% of coarse aggregate the better workability are obtained for the both concrete mixes.

2. From the study it is concluded that the cube compressive strength is decreased continuously with the increase in percentage of cinder and also the percentage of decrease in cube compressive strength is increased continuously with increasing cinder. However even with 40% replacement of conventional aggregate by cinder aggregate optimum target mean strength of concrete is achieved.

3. From the study it is concluded that the cylinder compressive strength is decreased continuously with the increase in percentage of cinder and also the percentage of decrease in cylinder compressive strength is increased continuously with increasing cinder.

4. From the study it is concluded that the split tensile strength is decreased continuously with increase in percentage of cinder and also the percentage of decrease in split tensile strength is increased continuously with increasing cinder.

5. From the study it may be concluded that the young's modulus have decreased continuously with the increase in percentage of cinder

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