Compressive Strength of Concrete with Construction and Demolition Waste and m-SAND using Additives

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***Abstract*: Construction and Demolition wastes(C&D wastes) are generated in all cities of the world due to rapid urbanization. Disposing C & D waste these days is a costly affair, and raises environmental issues. Hence an attempt is made to reuse the demolished concrete as a partial replacement of natural coarse aggregates. Also due to ban of sand mining by local authorities, the cost of natural fine aggregate is very high and itself becoming a scarce material. Hence crushed stone aggregates called manufactured sand (m sand) is used, totally replacing natural fine aggregates. This concept is found to be cost effective, minimizes disposal of C & D wastes, and leads towards Green Building Concepts.**

Compression test on M40 concrete cubes of size 150mmx150mmx150mm are conducted at end of 7 days and 28days. Mix design for M40 concrete is made in accordance to IS: 10262-2019 with water cement ratio of 0.45 using 53 Grade Ordinary Portland cement. Superplasticizer (LIQUIFIX) is used to enhance workability. Nano Silica (NS)(1.5% by weight of cement),Wollastonite powder(WP)(10%by weight of cement) and Basalt fibres(BF)(1% by weight of cement) are added as additives.

It is observed, that compressive strength of 7 days and 28 days cured samples is 25% more with the addition of all three additives compared to samples without additives. Hence the loss of compressive strength obtained by using demolished concrete as aggregates and m sand in concrete is regained with the addition of additives.

***Index Terms*— Construction & Demolition waste, Concrete, m Sand, Nano Silica, Basalt fibres, Wollastonite powder.**

I. INTRODUCTION

Globally, Construction & demolition waste is generated every year of the order 2.2 Billion tons per annum and in India it is 10 to 12 million tons per annum, as per the statistics available. Disposing this waste is a very costly affair, and disposing by filling in open grounds, will lead to health problems of the public and raises environmental issues. Hence an attempt is made to reutilize the demolished concrete in concrete, to evaluate its compressive strength, after 7 days and 28 days curing. After assessing the compressive strength at end of 7 day and 28 days, the outcome of the work will enable its applicability of its use in structural elements. Research works carried out by various authors involve Compressive Strength Tests, Flexural Tests, Split Tensile Tests, and Durability Tests, indicate the following facts: Forood Torabian Isfahani et al.[1], mentions that there was a remarkable improvement of compressive strength of 41%, by using Nano silica. Rutuja Mininath Sarade et al.[2], concludes that by adding Nano silica , it reduces carbon dioxide emission and also 20% increase in compressive strength is observed. Renu Mathur et al.[3] in their work states that with the addition of Wollastonite powder, an 28% to 35% increase in compressive strength and an 36% to 42% increase in flexural strength, were observed. Also, reduction in water absorption, drying shrinkage, abrasion loss of concrete, enhancement of durability against sulphate attack and alternate freezing & thawing were observed. Kandula Mohan Krishna Reddy et al.[4] observed an 24% increase in compressive strength , and 14% increase in flexural strength with addition of Wollastonite powder. Tehmina Ayub et al.[5] in his work indicates that with the addition of Basalt fibres the compressive strength, tensile splitting strength and the flexural strength of concrete increased significantly. Nayan Rathod et al.[6] concludes that use of Basalt fibres in concrete has multifold benefits. The benefits of using Basalt fibres are: it is non corrosive, the flexural and compressive strengths increases, and has good thermal resistivity.

II. METHODOLOGY

As per the IS 10262:2019, for M40 Grade concrete, the proportions by weight of cement/Fine aggregate/coarse aggregate 1:2.56:3.26 is followed, six concrete cubes are cast for Normal Concrete, another six cubes are cast with demolished concrete(50% replacement for natural coarse aggregates), and with m sand (100% replacement for natural fine aggregate), and another six cubes with demolished concrete and m sand with additives Nano silica(1.5% by weight of cement, Basalt fibres (1% by weight of cement and Wollastonite powder(10% by weight of cement) as additives are cast. The percentages of additives are the optimum percentage obtained by experimental tests on compressive strength of cubes tried individually with each additive. Tables 2 to 4 gives the details of optimal percentages of Nano Silica, Basalt fibres and Wollastonite powder.

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After 7 days and 28 days of curing the cubes are tested for compressive strength. Table.1 to 4 & Fig.1 to 4 shows the comparison of the experimental results obtained for compressive strength.

III. EXPERIMENTAL RESULTS

Table.1 Seven day and Twenty eight day compressive strength test results with all the additives

Types of concrete cubes	Concrete with demolished concrete(50%) as CA and m sand (100%) as FA, without any additives	With nano silica (optimum %)	With wollastonite (optimum%)	With basalt fibres (optimum%)	With all the three additives (optimum%)
Seven day compressive strength	22.76MPa	27.14MPa	25.8MPa	26.61MPa	28.6MPa
Twenty eight day compressive strength	34.83Mpa	41.86MPa	40.6MPa	42.14MPa	43.7MPa

Table.2 Seven day and Twenty eight day compressive strength test results to compute optimum percentage of nano silica

Types of concrete cubes	Concrete with demolished concrete(50%) as CA and m sand (100%) as FA, without any additives	With nano silica (1%)	With nano silica (1.5%)	With nano silica (2%)	Optimum % of Nano silica = 1.5%
Seven day compressive strength	22.76MPa	24.14MPa	27.14MPa	25.11MPa	27.14MPa
Twenty eight day compressive strength	34.83Mpa	37.14MPa	41.86MPa	39.61MPa	41.86MPa

Table.3 Seven day and Twenty eight day compressive strength test results to compute optimum percentage of wollastonite powder

Types of concrete cubes	Concrete with demolished concrete(50%) as CA and m sand (100%) as FA, without any additives	With wollastonite (10%)	With wollastonite (15%)	With wollastonite (20%)	Optimum %of wollastonite =10%
Seven day compressive strength	22.76MPa	25.8MPa	24.6MPa	23.6MPa	25.8MPa
Twenty eight day compressive strength	34.83Mpa	40.6MPa	38.8MPa	37.6MPa	40.6MPa

Table.4 Seven days and Twenty eight days compressive strength test results to compute optimum percentage of basalt fibres

Types of concrete cubes	Concrete with demolished concrete(50%) as CA and m sand (100%) as FA, without any additives	With basalt fibres (1%)	With basalt fibres (2%)	With basalt fibres (3%)	Optimum % of basalt fibres = 1%
Seven day compressive strength	22.76MPa	26.61MPa	25.2MPa	24.31MPa	26.61MPa
Twenty eight day compressive strength	34.83Mpa	42.14MPa	41.2MPa	38.8MPa	42.14MPa

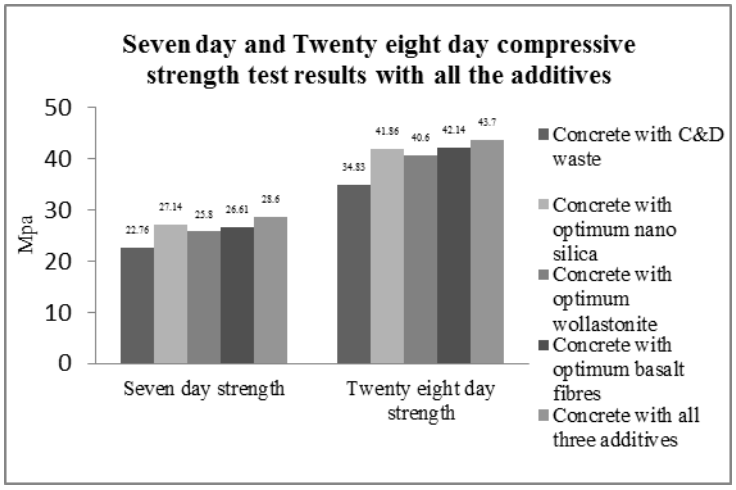

Fig. 1 Comparative strength at optimum dosages of additive mixes

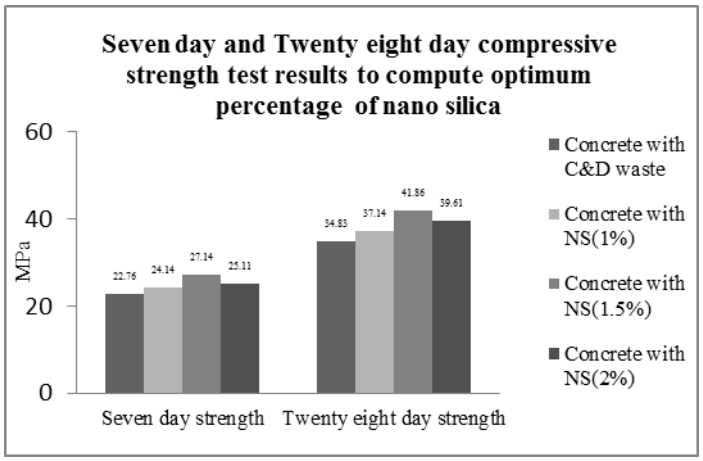

Fig. 2 Comparative strength for different dosages of nano silica

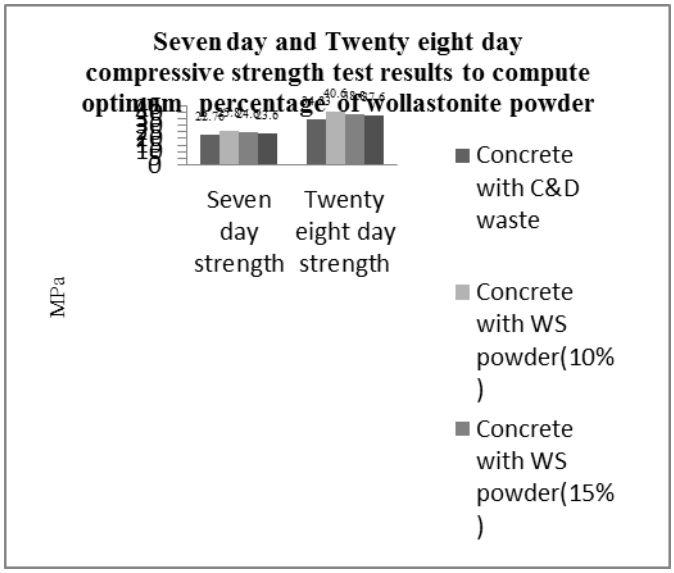

Fig. 3 Comparative strength for different dosages of wollastonite powder

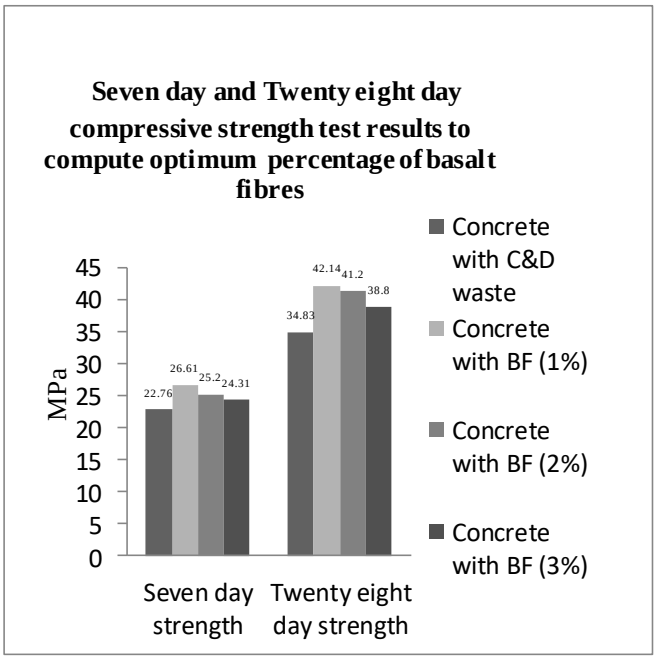

Fig. 4 Comparative strength for different dosages of basalt fibres

IV. CONCLUSIONS

The following are the conclusions of the work undertaken,and tabulated in Tables 1 to 4, and shown in Figures 1 to 4.

1. The 7 day compressive strength without addition of any of the additives is found to be 22.76 Mpa.
2. The addition of the optimum percentages of the additives, increased the 7 day compressive strength to 28.6 Mpa.
3. The 28 day compressive strength without addition of any of the additives is found to be 34.83 Mpa.
4. The addition of the optimum percentages of the additives, increased the 28day compressive strength to 43.7 Mpa.
5. Hence, with addition of additives -Nano Silica, Basalt Fibres, and Wollastonite powder, the compressive strength at 7 days and 28 days helps to achieve the desired target compressive strength. The results proves that combination of additives can be added to concrete with C&D Wastes to regain the compressive strength which is lost due to use of C&D wastes.

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