Experimental Study on Flexural Behaviour and Load Carrying Capacity of Self-Compacting Concrete using Alccofine

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***Abstract*:- In the present day, much research is being done globally to identify a viable cementitious material to take the role of cement. For the purpose of partially or completely substituting cement in concrete, many materials are tested in this order: fly ash, silica fume, GGBS, Metakaolin , Micro materials, Quartz powder, etc. In this paper, a novel ultrafine material named Alccofine and cement made with biobased materials might have lower CO2 emissions. Recently, it has been known as alccofine, is an efficient partial replacement for cement. Here, cement is partially replaced in self-compacting concrete by substituting 10% of alccofine The optimum percentage of alccofine content is considered for the research. Fresh and hardened properties of SCC and self-compacting concrete (SCC) were investigated for the mix and control one. The results showed that all tested properties have similar results of conventional SCC for alccofine. %. Where, slump flow diameter (SFD), compressive strengths and split tensile strength for alccofine were 550 mm, 38.66MPa and 3.6 MPa respectively achieved at 35% ratio of WS. Flexural behaviour of reinforced concrete beam using this alccofine is studied and compared with conventional SCC beam. Hence obtained similar results of conventional SCC.**

***Key Words: Alccofine,mineral admixture, Flexural stength*.**

I.INTRODUCTION

Self-Compacting Concrete (SCC) is a cutting-edge method that was developed to take the place of conventional vibrated concrete (CVC). In CVC, external vibration is necessary, and reinforcements that are crowded require extra care. It causes lapsed time and an inadequate surface polish. A thorough examination into the cause and effects of concrete degradation is necessary before placing concrete in different locations. Serious durability issues arise in places like the marine environment, underground, etc. due to carbonation, sulphate, acid, and chloride attack. These limitations can be eliminated with the use of SCC, which also has various benefits, including quick concrete placement, homogeneity, removal of vibrating equipment, reduced noise, fewer air spaces, shortened time, higher productivity, and enhanced strength and durability. The amount of powder content and the particle size are important aspects of SCC. Costs of production would rise if SCC contained more cement. Considering rapidly expanding industries, many researchers have proposed alternative supplemental cementitious materials (SCMs) or mineral admixtures to attain higher economic value. Alccofine1203 is a high range water reducer that helps concrete work more easily and have greater compressive strength. Biochar is widely considered as effective way of sequestering carbon dioxide. The possibility of using it to enhance the mechanical strength and reduce permeability of cement mortar is explored in this study.

a. ALCCOFINE 1203

Alccofine-1203 is a specifically processed product with a high glass content and high reactivity that was created through a carefully monitored granulation process. The principal component of the raw materials is low calcium silicates. Particle size distribution is managed as a result of the processing with other carefully chosen substances (PSD). The calculated blain value using PSD is approximately 12000cm2/gm, which is absolutely extremely fine. Due to its distinct chemistry and ultra-fine particle size, ALCCOFINE-1203 offers lower water content and, depending on the workability, even up to 70% replacement level for concrete performance. Additionally, ALCCOFINE 1203 may be utilised as a super workability aid to enhance flow or as a high range water reducer to enhance compressive strength.

Table -1: Chemical Composition and Physical properties

Chemical Analysis	Mass %	Physical Analysis	Range
CaO	30- 34	Bulk Density	600 -700 kg/m^3
Al_2O_3	18 -25	Surface Area	12000 cm^2/gm
Fe2O3	0.8 3.0	Particle Shape	Irregular
SO3	0.1-0.4	Particle Size,d10	<2mm
MgO	6-10	d50	<5mm

b. BIOCHAR

The ash-and-carbon-based, light-weight biochar that remains after biomass is pyrolyzed is known as biochar. The term "biochar" refers to the solid product created when biomass is thermochemically converted in an oxygen-limited environment. Here coconut shell biochar was used.

II. MATERIALS USED

2.1 Cement

Use of Ordinary Portland Cement (OPC) of Grade 53 according to IS specifications is made in this investigation. Table 2 provides cement's characteristics.

Table-2: Properties of OPC 53 grade cement

Properties	Test results	Technical reference
Specific gravity	3.12	IS4031(PART 11): 1988
Consistency (%)	30	IS4031(PART 4): 1988
Fineness of cement (%)	4.7	IS4031(PART 2): 1996
Initial setting time (minutes)	78	IS4031(PART 5): 1988

2.2 Fine Aggregate

For building, manufactured sand (M-Sand) is an alternative to river sand. M-sand is a product made from hard granite stone that has been crushed. M-Sand is less than 4.75mm in size. River sand is in short supply, hence artificial sand has been employed as an alternative for construction. M-Sand is also used since it is readily available and costs less to transport. Additionally, it is a dust-free material that pollutes very little. Table 3 lists the fine aggregate's characteristics.

Table-3: Properties of Fine Aggregate

Properties	Test results
Specific gravity	2.52
Finess modulus	3.84
Free surface moisture	Nil

2.3 Coarse Aggregate

Aggregates with a particle size range of more than 4.75 mm, but typically between 10 and 40 mm in size. Concrete benefits from coarse aggregate's strength, toughness, and hardness qualities as well as its resistance to abrasion. The experimental study's coarse aggregate was 12.5mm in size and conformed to IS 383:1970. Table 4 lists the characteristics of coarse aggregate.

Table-4: Properties of Coarse Aggregate

Properties	Test results	Technical reference
Specific gravity	2.69	IS2386(PART 3): Clause 2.4.2
Free surface moisture	Nil	IS383(PART 3): 1970
Fineness modulus	4.25	IS383(PART 3): 1970 table 2

2.4 Alccofine 1203

One of the newest micro-fine materials, Alccofine 1203, is produced in India and has a particle size that is smaller than that of cement, fly ash, silica fume, etc. Due to its efficient particle size distribution, Alccofine 1203 has special characteristics that can affect the performance of concrete in both its fresh and hardened states. The early strength of concrete made with alccofine 1203 is found to be similar to or greater than that of silica fume. Because alccofine starts the initial chain of events when cement hydrates, this is the reason. Additionally, the alccofine 1203 eats the calcium hydroxide byproduct that is generated during the hydration of cement, increasing the concrete's late-age strength. As a result, it produces additional C-S-H gel that is comparable to that of other pozzolans. Alcofine's calculated particle size distribution (PSD) is roughly 12000 cm2/g. According to the need, it can be replaced with cement up to a 70% replacement level. Table 5 lists the alccofine 1203's properties.

Fig- 1 : Alccofine 1203

Table-5: Properties of Alccofine 1203

Properties	Test results
Specific gravity	2.9
Bulk density (kg/m³)	700-900
Fineness (cm²/g)	>1200

2.5 Biochar

One of the waste byproducts that has lately received attention is biochar, which could be used in cementitious and asphaltic composites for infrastructure purposes. It is a carbon-rich solid residue created when municipal solid waste (MSW) or biomass are thermochemically converted in an oxygen-limited atmosphere. This process is known as pyrolysis and is both energy- and environmentally-friendly. Pyrolysis typically produces less sulphur and nitrogen oxide than standard MSW incineration, which can result in cleaner energy . While being mixed in the reactor, MSW is first prepared by source collection separation, which includes sorting and shredding, and then heated externally using combustion gas from pyrolysis. The colour, weight, size, and mechanical strength of the biomass change simultaneously with the chemical and physical state change during this process, and syngas, bio-oil, and char develop. The feedstock disintegrates by up to 80% in weight at temperatures about 350°C, and the remaining feedstock then becomes charcoal.

Fig-2: Biochar

2.6 *Admixture*

Admixtures are defined in ACI 116R as "a material other than water, aggregates, hydraulic cement, and fiber reinforcement, used as an ingredient of concrete or mortar, and added to the batch right away before or during its mixing". Chemical admixtures are used to upgrade the quality of concrete during mixing, transporting, placement and curing. MASTERRHEOBUILD 1126ND is an admixture of a new generation based on modified naphthalene formaldehyde ether. The product has been primarily developed for applications in high performance concrete where the highest durability and performance is required. MASTERRHEOBUILD 1126ND is free of chloride & low alkali. It is compatible with all types of cements. MASTERRHEOBUILD 1126ND has a different chemical structure from the traditional super plasticisers. It consists of a naphthalene formaldehyde polymer with long side chains. At the beginning of the mixing process, it initiates the same electrostatic dispersion mechanism as the traditional super plasticisers, but the side chains linked to the polymer backbone generates a steric hindrance which greatly stabilizes the cement particles' ability to separate and disperse. Steric hindrance provides a physical barrier (alongside the electrostatic barrier) between the cement grains. With this process, flowable concrete with greatly reduced water content is obtained.

Table-7: Performance Data

Aspect	Dark brown liquid
Relative density	1.24 ± 0.02 at 25˚c
pH	≥ 6
Chloride iron content	< 0.2 %

III. SPECIMEN DETAILS

Beam of size 150 mm x 200 mm x 1250 mm was used for the study. A total of 2 specimen was casted. Mould of casting beam specimen . The specimen was tested by the optimum content of alccofine with optimum content of 10 % in self-compacting concrete. The beams were designed as balanced section, according to IS 456: 2000 and the details.

1. PREPARATION OF SPECIMEN

The required quantities of cement, fine aggregate, coarse aggregate, super plasticisers, mineral admixture and water were taken for control specimens, in addition to this, alccofine were mixed with the ingredients. Concrete was prepared by machine mixing. Initially cement and fine aggregate were mixed in dry state until it is of even colour throughout and free from streaks followed and then measured quantity of coarse aggregate was spread out. The whole mass was mixed by machine in an angle of 45%. Three quarter of the total quantity of water was added while the materials were turned in towards the centre with spades. The remaining water was added slowly when the whole mixture was turning over and over again until a uniform colour and consistency was obtained throughout.The mould was made ready by applying oil in all contact surfaces. The control specimens of normal concrete cover of 25 mm were prepared by placing the reinforcements in the mould with suitable cover blocks. Concrete was spread on the mould and uniformly spread the mix on the mould. The other specimen was cast by adding alccofine 10% to the concrete Proper surface finishing was provided. The specimen was removed from the mould after 24 hours and kept for curing. After 28 days of curing, specimens were ready for testing

2. TEST RIG AND INSTRUMENTATION

The experimental investigation of this project includes six (6) beams. Three (3) beams cast as control specimens with Fe 415 steel using normal M30 mix and three (3) beams cast as the 35 percentages of walnut shell as volume of coarse aggregate in concrete. All beams have a total length of 1250 mm, width of 150 mm and depth of 200 mm each. The longitudinal reinforcement was calculated using IS 456-2000 to obtain flexural failure and was same for all beams. The main lower reinforcement is 2#8 mm diameter and 8mm diameter stirrups.

The steel cover used was 25 mm. All beams were cast using M30 concrete mix. The beams were cured using jute bags with room temperature for 28 days. The compressive strength of the concrete mix was measured after 28 days using standard cubes. The mean compressive strength for the mix was 35 MPa.

The flexural strength of the specimens was tested using a 30-ton loading frame. A dial gauge was attached at the bottom of the beam to determine the deflection at the centre of the beam. For testing of the specimen, the supports were provided at a distance of 130 mm from the edges of the beam. The effective span of the beam was taken as 990 mm in the case of 1250 mm beam. A proving ring of 500 kN was connected at the top of the beam to determine the load applied.

The flexural strength of the beam was tested as a two-point loading system using a hydraulic jack of 50 ton attached to the loading frame. The behaviour of beam was keenly observed from beginning to the failure. The loading was stopped when the beam was just on the verge of collapse. The first crack propagation and its development were observed carefully. The values of load applied and deflection were noted directly and further the plot of load v/s deflection was performed which was taken as the output. The load in KN was applied with uniformly increasing the value of the load and the deflection under the different applied loads was noted. The applied load was increased up to the breaking point or till the failure of the mate

IV. RESULTS

4.1 LOAD DEFLECTION BEHAVIOUR

Due to increase in the load, the beam starts to deflect, up to certain level the load v/s deflection graph will be linear that is load will be directly proportional to deflection. Due to further increase in the load, the load value will not be proportional to deflection, since the deflection values increases as the strength of the materials goes on increasing material loses elasticity and undergoes plastic deformation. The deflection and the corresponding load, of RC beams reinforced with walnut shell as coarse aggregate were compared with normal RC beams of SCC.

The load values and corresponding deflection of control specimens and other specimens are given in table 7. Flexural cracks and shear cracks were formed in the mid-span and quarter span respectively of all the tested beams. No shear failure of the beam was observed till the failure. The maximum load values and maximum verticaldeflection at midspan is given in table 7 and observed that the maximum load was carried by the scc beams with alccofine.

Figure 4.1 indicates the load-deflection curves of control beams and RC beams reinforced with alccofine. It can be observed that the alccofine beams and control beams shows similar inelastic behavior. The curves for all the beams showed similar response in the initial stage of loading till the formation of first crack. But with the increase in load, a variation was observed for alccofinemix.

Deflection (mm)	Control specimen Load (kN)	Test specimen Load (kN)
0	0	0
0.5	11.26	14.724
1	20.71	23.313
1.5	36.77	39.878
2	53.0333	60.73
2.5	88.0332	100.02
3	109.484	120.85
3.5	134.74	139.87
4	151.194	160.73
4.5	156.88	168.09
5	162.646	170.53

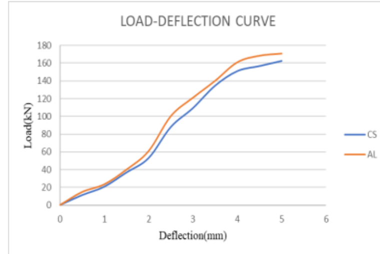

Fig 4.1 Load - Deflection Graph

V. CONCLUSIONS

The main findings of this investigation are described below.

- SCC beams with 10% alccofine had more load carrying capacity compared toCS. Also the initial crack load was increased for alccofine.
- All the specimens showed a linear relationship between load and deflection until the formation of cracks
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- All the specimens showed a linear relationship between load and deflection until the formation of cracks
- The beam failures flexurally

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