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Study On Flexural Behavior of Light Weight Green Concrete Beams

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ABSTRACT

The increasing quantity of waste materials and industrial by- products is a major concern in the world today. The disposal of these by-products is becoming a big issue, because of the expense of disposal. Foundry Sand is a form of fine aggregate that is often used in hand and machine-made moulds. There is a strong desire to discover an alternative method of disposing of Foundry sand(FS) while also limiting the use of natural resources. So Fine aggregate is partially substituted with foundry sand in this experimental work in order to produce green concrete (GC) Light weight concrete is one of the initiatives attempted to lower the self -weight of concrete. The study focused on the strength characteristics of concrete when pumice aggregate was used as a partial replacement for coarse aggregate. Various strength tests are conducted by partially replacing coarse aggregate with pumice stone by 20%,25%,30%,35% and 40%. Light weight green concrete(LWGC) is made by partially replacing fine aggregate by foundry sand(20%) and coarse aggregate with 25% pumice stone. The findings suggest that Foundry Sand(FS) can effectively replace fine aggregate and pumice stone(PS) can effectively replace coarse aggregate to produce Light weight green concrete.

Keywords:-*Pumice, Stone, Foundry, Sand, Green Concrete, Lightweight.*

INTRODUCTION

Concrete has been one of the most used building materials for hundreds of years. It is getting more important and favoured in comparison with wood and steel because of its adaptability. River sand consumption is high due to rapid infrastructure construction, the demand for it is equally strong in emerging countries. Supplanting waterway sand, either to some extent or totally, is being reviewed as an answer for this issue. The usage of UFS has received little attention, and it remains an unknown area in terms of its use as a supplement for river sand. UFS from the ferrous and non-ferrous metal casting industry is usually abandoned as waste or dumped in open baron areas. In contrast, numerous countries are experiencing a shortage of river sand to fulfil rising construction demands. UFS causes public inconvenience through air and water pollution. It is critical to discover a strategy for reusing foundry sand and reducing sand extraction from river beds. So in this Experimental work, Fine aggregate is partially replaced with Foundry Sand. Concrete is a relatively fragile material when subjected to standard stresses and impact loads. Light weight concrete is one of the initiatives attempted to lower the self weight of concrete. Lightweight aggregates are used to make lightweight concrete, which reduces the self weight and density of the concrete. Lightweight concrete has a density ranging from 1440 kg/m3 to 1840 kg/m3. Pumice stone is an extremely well known material as a light

weight rock, and it has been used as a development material in the common business for a really long time. Oneself load of the substantial is diminished when coarse total is utilized instead of pumice, bringing about lower self-structures. In earthquake-prone zones must be carefully considered. This is required since some of these components, such as beams and walls, offer the largest load because they are dead loads, contributing to the building's weight. This huge weight intensifies the earthquake's impact by forcing the building to fall. As a result, building weight must be lowered to make it more earthquake- resistant. Lightweight aggregate concrete based on pumice stone can be utilised in earthquake-resistant buildings, those with thermal resistance as the key criterion.

MATERIAL PROPERTY

Table 1:-*Material property*

Item	Property	Value
OPC 53	Consistency	34%
	Fineness	6.15%
	Specific gravity	3.15
Fine Aggregate	Specific gravity	2.6
	Fineness modulus	3.58
	Bulk density	1.5g/cc
Coarse aggregate	Bulk density	1.53g/cc
	Fineness modulus	3.51
	Specific gravity	2.807
Foundry Sand	Bulk density	1.342kg/L
	Fineness modulus	1.83
	Specific gravity	2.29
Pumice stone	Water absorption	43.38%
	Specific gravity	1.58
	Bulk density	0.49g/cc

TEST PROCEDURE

Fresh Concrete Properties

The test is performed with a metal form molded like a tapered frustum known as a downturn cone, which is open at the two finishes and has connected handles. The inside breadth of the device is ordinarily 100 millimeters at the top and 200 millimeters at the base, with a level of 300 millimeters. The cone is positioned on a hard, nonabsorbent surface. In three phases, this cone is burdened up with new concrete. A 16 mm-measurement, 600 mm-long slug nosed metal pole is utilized to pack each layer multiple times. The substantial is hit off flush with the highest point of the shape toward the finish of the third step. To avoid weight of concrete Materials utilised in the construction of building disturbing the concrete cone, the mould is carefully hoisted vertically upwards. The Slump values for normal concrete mix, Green concrete mix, Light weight green concrete mix at different percentages are determined. Green concrete is prepared by replacing Fine aggregate by 20% Foundry sand in

M25 mix.Light Weight Green concrete Mix is prepared by replacing fine aggregate by 20% Foundry sand and Coarse aggregate partially replaced with pumice stone in the order of 20%,25%,30%,35% and 40%.

Hardened concrete properties

Hardened properties were studied using compression strength test,split tensile strength test and flexural strength test. Hardened properties of concrete were studied using cubical specimens with size 15x15x15 cm for compressive strength, cylindrical specimen with size 30 cm height and 15 cm diameter for determining split tensile strength and prism of size 10x10x50 cm3were prepared for flexural strength studies. Green concrete is prepared by replacing fine aggregate with 20% foundry sand in M25 mix. Light Weight Green concrete Mix is prepared by replacing fine aggregate by 20% Foundry sand and Coarse aggregate partially replaced with pumice stone in the order of 20%,25%,30%,35% and 40%.

Fig.1:-*Compressive Strength Test*

Fig.2:-*Split Tensile Strength Test*

Fig.3:-*Flexural Strength Test*

Durability

Durability study of different mix were carried out using tests such as alkaline attack, acid attack, water absorption of concrete and salinity resistance. Durability test was carried out on a 100 mm x 100 mm x 100 mm LWGC cube. For the purpose of evaluating the concrete's durability, three cubes were each cast and test under compression loading. Cubes were cured in 5% solution of NaCl, HCl and NaOH for salinity test., acid resistance test and alkaline test respectively for 28 days and later tested its compression load.

RESULT AND DISCUSSION

Fresh concrete properties

Table 2*:-Fresh concrete test results*

Type of concrete	**Slump value(mm)**
Normal Concrete	80
20%FS	85
20%FS +20PS	80
20%FS +25%PS	78
20%FS +30%PS	78
20%FS +35%PS	75
20%FS +40%PS	75

Hardened Properties Test

Table 3:-*Mechanical Properties Test Results*

Test	PS0 FS0	PS20 FS20	PS25 FS20	PS30 FS20	PS35 FS20
Compressivestrength (MPa)	26.04	24.7	26.14	23.58	22.96
Split tensile strength (MPa)	3.55	3.45	3.76	3.34	3.31
Flexural strength (MPa)	6.2	5.83	6.83	6.09	5.33

Table 4:-*Weight reduction in concrete*

Specimen	**Replacement Proportion**	**Mass Of Concrete(Kg)**	**Density Of Concrete (kg/m^3)**
Cube	PS25FS20	6	1778
Cylinder	PS25FS20	9.2	1735
Beam	PS25FS20	8.8	1760

The mechanical strength properties shows that there is an increase in compressive strength, flexural strength and tensile strength upto a certain limit. After that the strength is decreasing. But the weight of concrete is decreasing and its density falls in the range of condition for light weight concrete(density ranges between 1440 to 1840 kg/m^3) Replacement of coarse aggregate with 25% pumice stone and Fine aggregate with 20% foundry sand possesss maximum strength.

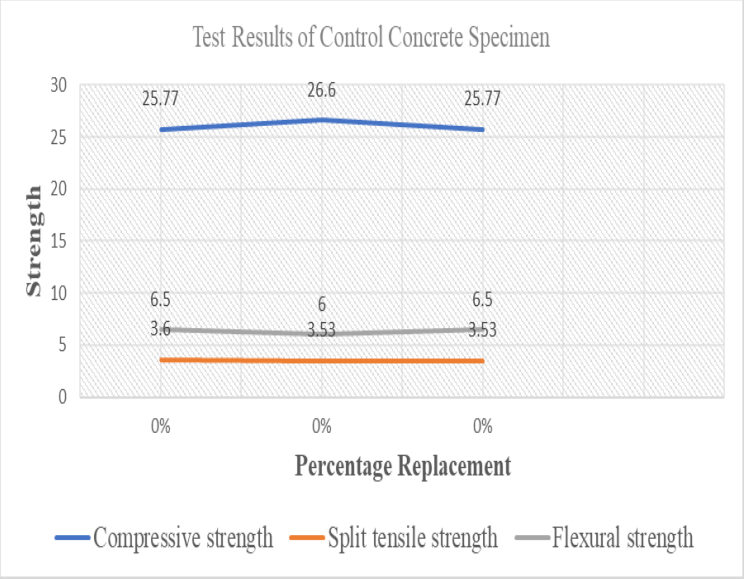

Fig 5:-*Test results of control concrete specimens*

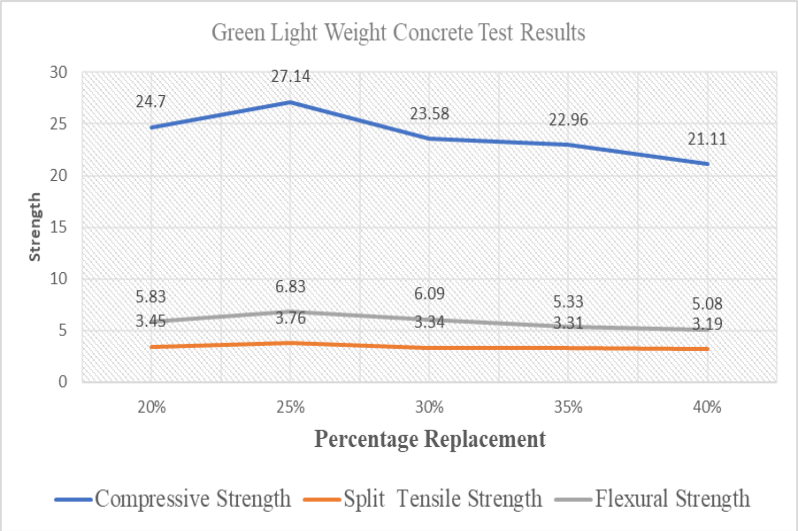

Fig 6:-*Test Results of Light weight Green Concrete Specimens*

Durability

Acid, Alkaline, Saline resistance

Table 5*:-Durability results*

SN	Mean compressive strength(N/mm^2)		Percentage loss in mass	
	CC	LWGC	CC	LWGC
Acid resistance	24.53	25.07	7.88	4.83
Alkaline resistance	25.14	24.11	8.3	10.71
Salinity resistance	25.11	25.19	4.13	6.04

LWGC specimens has high acid and salinity resistance comparedto alkali resistance.

Water Absorption

Table 6:-*Water absorption results*

Mix Designation	Dry mass (kg)	Wet mass(kg)	Mean Water Absorption %
CC	2.34	2.5	6.4
	2.33	2.51	
	2.34	2.48	
LWGC	1.7	1.85	7.86
	1.73	1.88	
	1.73	1.87	

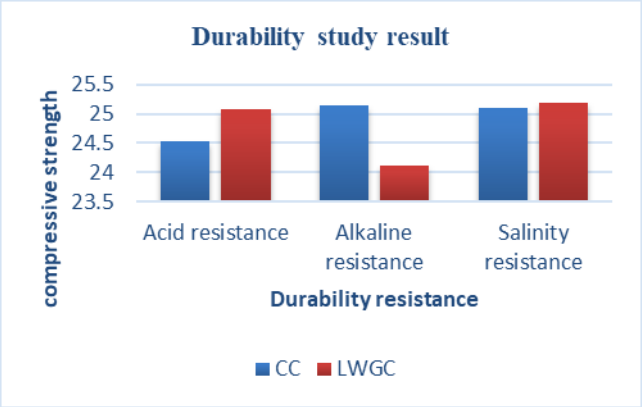

Fig.7:-*Durability study test results*

Flexural Study on Reinforced Beam

Flexural Behaviour of LWGC Beam

'Third-point loading' and/or 'Center-point loading' are the two common procedures used to assess the flexural strength of any material. The former test needs the application of a set of two equal loads at each 1/3rd point along the entire span of material, whereas the latter demands the application of a full load at the material's centre. Flexural strength is the mechanical measure of a material's maximal load carrying capability without permanent deformation. In simple terms, it is the degree to which an object or material resists breaking when bent.

Table 7:-*Flexural study on beam results*

Specimens	Load at the onsetof crack(kN)	Failure load (kN)
1	50	100
2	55	100
3	50	100
Average	51.6	100

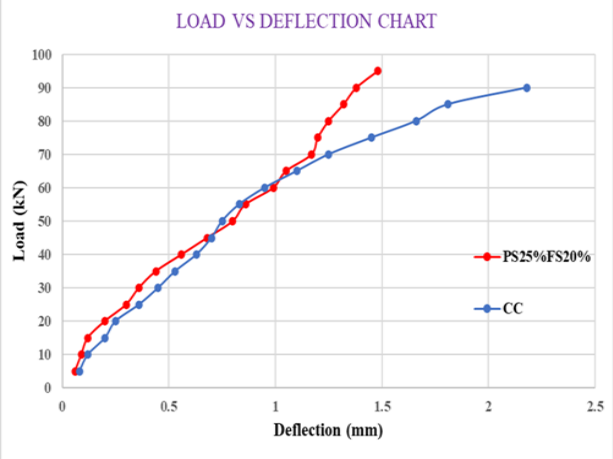

Fig.8:-*Load deflection graph*

CONCLUSIONS

1) Bulk density of pumice stone is obtained as o.49g/cc. So coarse aggregate can be partially replaced with pumice stone.
2) It is found that 20% replacement of fine aggregate with foundry sand increased the Compressive strength, Split Tensile Strength and Flexural Strength upto 29.86N/mm2 ,3.86N/mm2 and 7.16N/mm2 respectively. Thus Green concrete can be used in many structural elements.
3) Optimum percentage replacement of coarse aggregate bypumice is obtained as 25%.
4) Compressive strength, Split Tensile Strength and Flexural Strength of Light Weight Green Concrete specimens (20%FS+25%PS) has increased upto 27.14N/mm2, 3.76N/mm^2 and 6.83N/mm^2 respectively.
5) The Flexure strength on CC and LWGC beams are studied.The CC beams are able to carry a load of 95KN applied centrally. LWGC beams are able to carry a load of 100KN applied centallyon the beam.less crack patterns are formed for LWGC Beams as compared to CC Beam.
6) LWGC specimens has high acid and salinity resistance compared to alkali resistance.Also LWGC specimens have high water absorption compared to CC specimens.

7.1 Future Scope

1. Furthur study on Light weight green concrete can be focused onhow to improve the strength parameters of LWGC specimens.
2. In this study,durability exposure is limited to 28 days.studies can be conducted by increasing exposure period to study the performance characteristics of LWGC specimens.

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