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Experimental Study on Lightweight Concrete Using Pumice Aggregate

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Abstract: This thesis investigates the properties, benefits, and challenges associated with the use of Pumice aggregate in green concrete. Through experimental studies, this research aims to evaluate the mechanical and durability properties of green concrete and compare them with conventional concrete. In this thesis work natural coarse aggregate is replaced from Pumice coarse aggregate by varying different percentage (50%, 80%, 100%) by weight of natural coarse aggregate. Experimental investigations, including sample preparation, compressive strength test, flexural strength test & split tensile strength test are conducted to evaluate the performance of Pumice coarse aggregate modified concrete.

Keywords: - *Pumice Coarse Aggregate, Compressive Strength Test, Flexural Strength Test, Mix Design, IS 10262-2009*

I.INTRODUCTION:

Lightweight concrete (LWC) is an important material in modern construction due to its reduced weight, which offers advantages such as lower dead load, reduced seismic forces, and improved thermal insulation. Pumice, a naturally occurring volcanic material, has been identified as a promising aggregate for LWC due to its low density and availability. This review aims to compile and analyze experimental research on the properties and performance of lightweight concrete using pumice aggregate. Light weight concrete is an amazing human invention which is used in several fields of construction in the recent times due to its lesser densities and thermal conductivities. The strength of LWC is 25 to 35 % lesser as compared to conventional concrete. Light weight concrete is a blend of light weight coarse aggregate such as shale, clay (or) slate giving it low density which range from 1440 -1840kg/m³. The main advantage of LWC is its low density, reduction of dead load, faster building rates and handling costs. Since eighteenth century, the Romans have used lightweight concrete. In Europe priority of utilization of LWAC happened around a long time back when the Roman constructed the pantheon and water systems in Rome. In light weight aggregate they are two types one is natural light weight aggregate and other one is artificial light weight aggregate. Natural lightweight aggregate includes pumice, diatomite, expanded clay aggregate and rice husk. Day by day the industrial usage is increasing and waste generated will be obtained in more quantities from the industries. To usage the industrial waste they are using cinders, palm oil shells, and fly ash. Usage of this natural and artificial light weight aggregates in making concrete results is achieving lesser densities and high thermal conductivities. Cinder absorbs water at a rate of about 1.5%. This discrepancy is assumed to be the primary cause of the decreased strength and durability of cinder-based concrete. Due to their high porosity and porous structure, pumice aggregates may be used as an alternative to aggregate in porous concrete to increase porosity without significantly lowering concrete strength. Expanded clay aggregate is one of the materials among light weight aggregate which gives the highest compressive strength.

II.PROJECT OBJECTIVE

1. To produce lightweight concrete by using pumice aggregate.
2. To know the characteristics of conventional concrete and pumice aggregate concrete.
3. To study the effect of various types of replacements (50%, 80% & 100%) of natural aggregate by pumice lightweight aggregate and conventional concrete.

III.FORMULATION OF WORK

In this stage of work natural coarse aggregate is replaced by pumice aggregate in different percentages as shown in the table below. 4 batches are prepared in different proportions including conventional concrete mix (Cement as binder, Sand as fine aggregates & Natural Coarse Aggregates). Cubes, beams & Cylinders are casted for determining compressive, flexural & Tensile strengths respectively at 7 and 28 days.

Table no. 3.1 Formulation of work

Batch Mix	Cement (%)	Sand%	Natural Coarse Aggregates (%)	Pumice Aggregates (%)
1	100	100	100	0
2	100	100	50	50
3	100	100	20	80
4	100	100	0	100

IV.EXPERIMENTAL WORK

4.1 Mix Design for M-40 Grade: Mix design as per IS 10262-2009 & IS 456-2000 the ratio of M-40 grade concrete are given below in the table

Table 4.1: Mix Proportions

Cement	Water	FA	CA	W/C Ratio
336 kg/m^3	151 kg/m^3	768 kg/m^3	889 kg/m^3	0.41
1	0.41	1.83	2.65	0.41

4.2Compressive Strength: The specimens used in the compression test of cubes having a size of 150X150X150mm. Nine specimens are used in the compression testing for each batch of mix. Calculate the compressive Strength at 7 & 28 days. As there are three specimens for each batch mix, the average of the three values is taken.

4.3 Flexural Strength Test: The specimens used in the flexural test were beams of 100X100X500mm size. Nine specimens are used in the flexural testing for each batch of mix. Calculate the bending strength for 7 & 28 days. As there are three specimens for each batch mix, the average of the three values is taken.

4.4 Split Tensile Strength: The specimens used in the tensile test of cylinder having a size of 150 mm diameter and 300 mm height.. Nine specimens are used in the tensile testing for each batch of mix. Calculate the tensile strength for 7 & 28 days. As there are three specimens for each batch mix, the average of the three values is taken

V.TEST RESULTS AND DISCUSSION

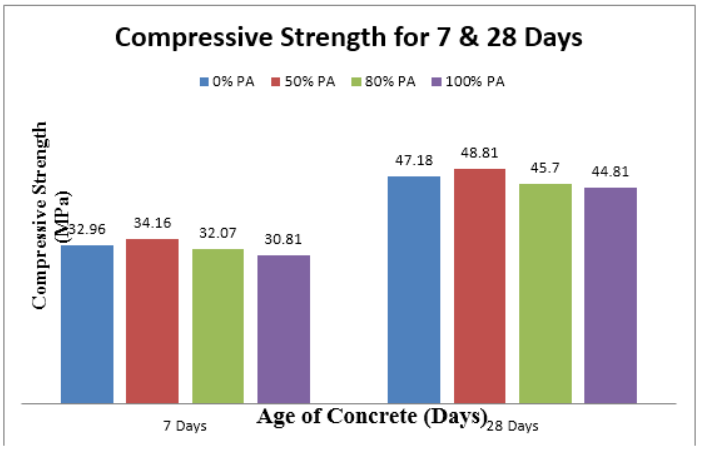
5.1 COMPRESSIVE STRENGTH TEST RESULT FOR M-40 MIX

The compressive strength test by Compression Testing machine shows an increasing trend of the compressive strength with age of the concrete specimens.

Table-5.1 below shows the increase of the compressive strength with age recorded during the test.

Table 5.1: Variation of compressive strength with age for M-40

% of PA	0%	50%	80%	100%
7 Days	32.96 MPa	34.16 MPa	32.07 MPa	30.81 MPa
28 Days	47.18 MPa	48.81 MPa	45.70 MPa	44.81 MPa



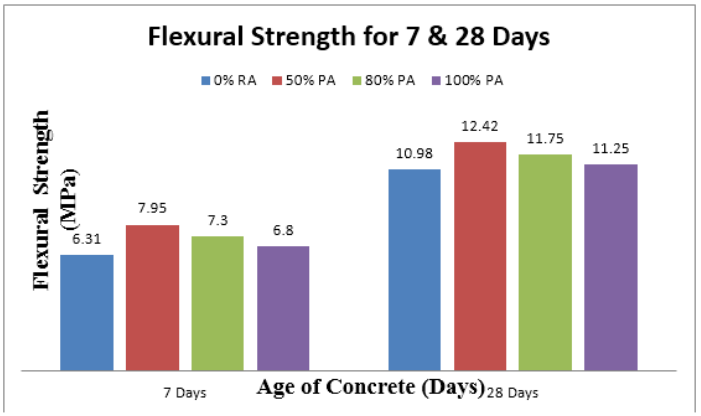
Graph 5.1: Variation in Compressive Strength with increasing % of Pumice Aggregate

5.2 FLEXURAL STRENGTH FOR M-40 MIX

Flexural strength test is performed on 3 beams of each batch mix for 7 days & 28 days. There are 4 batch mixes and each one having 9 beams. Of these 9 beams, 3 beams are tested for 7 days & 28 days each. An average of 3 values as tabulated in table 5.2, are considered for discussions

Table 5.2: Variation of flexural strength with age

% of PA	0%	50%	80%	100%
7 Days	6.31MPa	7.95 MPa	7.3 MPa	6.80MPa
28 Days	10.98MPa	12.42 MPa	11.75 MPa	11.25 MPa



Graph 5.2: Variation in Flexural Strength with increasing % of Pumice aggregate

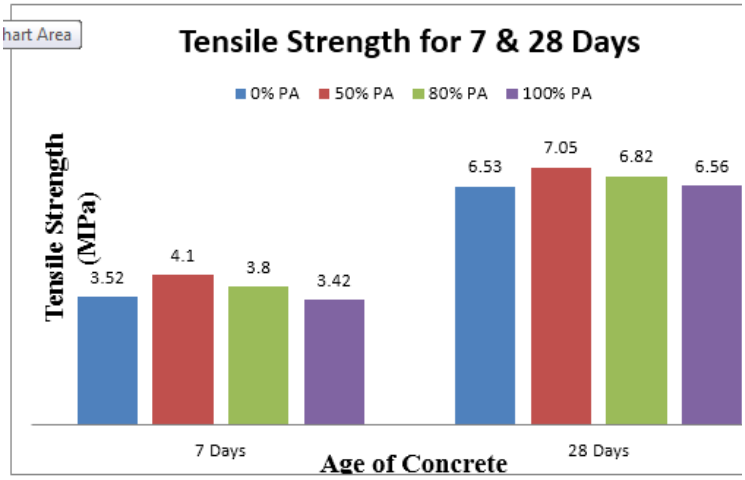
5. 3 SPLIT TENSILE STRENGTH FOR M-40 MIX

Split Tensile Strength is performed on 3 cylinders of each batch mix for 7 days & 28 days. There are 7 batch mixes and each one having 9 cylinders. Of these 9cylinders, 3 cylinders are tested for 7 days & 28 days each. An average of 3 values as tabulated in table 5.3, are considered for discussions.

Table 5.3: Variation of Split Tensile strength with age for

M-40

% of PA	0%	50%	80%	100%
7 Days	3.52 MPa	4.10 Mpa	3.80 MPa	3.42 MPa
28 Days	6.53 MPa	7.05 MPa	6.82 MPa	6.56 MPa



Graph 5.3: Variation in Tensile Strength with increasing % of Pumice aggregate

VI.CONCLUSION

After performing all the tests and analyzing their result, the following conclusions have been derived:

1. Maximum compressive strength was observed 34.16 N/mm2 & 48.81 N/mm2 (for 7 & 28 days) when Pumice aggregate replacement is about 50% for M-40 grade concrete and after that there is decrease in compressive strength of concrete with further replacement of natural coarse aggregate.
2. Maximum flexural strength was observed 7.95 N/mm2 & 12.42 N/mm2 (for 7 & 28 days) when Pumice aggregate replacement is about 50% for M-40 grade concrete and after that there is decrease in flexural strength of concrete with further replacement of natural coarse aggregate.
3. Maximum split tensile strength was observed 4.1 N/mm2 & 7.05 N/mm2 (for 7 & 28 days) when Pumice aggregate replacement is about 50 % for M-40 grade concrete and after that there is decrease in split tensile strength of concrete with further replacement of natural coarse aggregate.

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