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Recyclable Perlite Concrete using Olivine Sand

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***Abstract*— To make the perlite concrete strong enough to be used as wall panels by partial replacement of perlite aggregates by olivine sand. Compressive strength was determined for different ratios of concrete and finally a ratio was taken, in which 1.5 parts of natural perlite aggregates was replaced with olivine sand. Tests were performed on the olivine-perlite concrete cubes of standard size and it was seen that the compressive strength value obtained from the specimen was much higher compared to conventional wall panel materials. All the materials added are eco-friendly, also the emission of Co2 gas is reduced and hence does not cause much damage to the environment. Based on the results from the above tests, these blocks can be recycled and re-used for non load bearing walls. The model cube casted can be scaled up in dimension to meet the requirements of a commercial blocks and can be used for construction of wall panels in framed structures.**

***Index Terms*—Perlite concrete, Recyclable concrete, Olivine sand.**

INTRODUCTION

Generally concrete building components such as columns, beams and footings need to be large and bulky, especially for high-rise buildings, to carry the high density of concrete at about 2400 kg/m3. One way to reduce the size of the components is to develop a concrete of a lower density while keeping the compressive strength at a reasonable value. There are a number of methods to produce lightweight concrete. In one method, the fine portion of the total concrete aggregate is omitted, which is called no-fines. Another way of producing lightweight concrete is to introduce stable air bubbles inside the concrete by using chemical admixtures and mechanical foaming. This type of concrete is known as aerated, cellular, or gas concrete. The most popular way of lightweight concrete production is by using lightweight aggregate. Such aggregates, natural or artificial, are available in many parts of the world and can be used for producing concrete in a wide range of densities and suitable strength values for different fields of applications. The economical benefits of lightweight concrete are its low-heat conductivity and density. For over 30 years, the lightweight property of concrete has been desirable in constructional elements. In most studies, EPA has been used as an admixture in cement or directly in concrete as an aggregate. In concrete, EPA is used instead of fine aggregate with various replacement ratios depending on the required strength. For cement, perlite is easier to be ground than the Portland cement clinkers; therefore, this results in less of an energy requirement to produce blended cement by grinding clinker and perlite together. However, blended cement with perlite may cause strength losses at an early age compared with portland cement, and the strength has been improved by pozzolanic reactions lately. The strength of EPA based concrete is explained with the bonds between cement and perlite aggregate.

II. PERLITE CONCRETE

Perlite concrete aggregate combined with Portland cement and water produces a lightweight insulating concrete used for lightweight roof decks, floor fills, lightweight structural decks and many other applications where a lightweight permanent concrete is desired. Physical properties of perlite concrete vary according to mix designs. Perlite concrete can be made with a dry density of 320 kg/ m^3 or with the addition of sand or other aggregates up to 1440 kg/m^3 . The lower the density, the higher is the insulating value.

III. MIX DESIGN

For most uses to maintain a proper balance between insulation value and compressive strength, a 1:4This provides a K-value range of approximately 0.084 W/m °K and a compressive strength of 860 - 1375 Pa.

MIX DESIGN (Kg/m^3)							
MIX	CEMENT	PERLITE	WATER	C:P MIX DESIGN	W/C RATIO	W/P RATIO	PRE SPECIFIED DRY DENSITY
M1	191	669	229	1:3.5	1.2	0.34	860
M2	191	669	200	1:3.5	1.05	0.30	860
M3	191	764	229	1:4	1.2	0.3	955
M4	191	764	200	1:4	1.05	0.26	955
M5	191	860	229	1:4.5	1.2	0.27	1050
M6	191	860	200	1:4.5	1.05	0.23	1050

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MIX	RATIO (cement:perlite)	CEMENT (g)	PERLITE (g)	COMPRESSIVE STRENGTH (N/mm^2)	DRY WEIGHT OF CUBE (g)
M1	1:2.5	150	375	2.91	602
M2	1:3	150	450	3.08	636
M3	1:3.5	150	475	4.20	579
M4	1:4	150	600	5.98	696
M5	1:4.5	150	675	4.68	741
M6	1:6	150	900	7.85	800

IV. OLIVINE-PERLITE CONCRETE

Concrete is the most commonly used material in the world and their design consumes almost total cement production in the world. The use of large quantity of cement increases the CO_2 emission, and as a consequence of greenhouse effect. For example, The process of creating cement emits upwards of 80 percent of the cement's weight in carbon dioxide. In this project, we have added a material known as olivine sand which is obtained from the dunite rocks. Olivine sand is a natural material and hence is used as a substitute for river sand and is cheaper by about one halfth. Dunite rocks contains about considerable portion of magnesium and hence it is theoretically proved that presence of magnesium will reduce the emission of CO_2 thus making olivine sand eco-friendly.

PROCEDURE

Expanded perlite aggregates passing through 2.38mm sieve and retained on 2.00mm sieve is taken and is mixed with ordinary portland cement. Olivine sand is also sieved and particles retained on 75 μ sieve is taken. Different kinds of trial mixes for cement-perlite concrete was done in order to find out which ratio showed the best compressive strength. Based on various trial mixes practiced, two different ratios is taken in which 1.5 parts of perlite is replaced with olivine sand. All the materials is mixed and casted into cube of size 100mmx100mmx100mm size and various kinds of tests was performed on the cube specimens.

OBSERVATION

The perlite concrete was found to be having a large number of air voids but with the addition of olivine sand, the sizes of the pores was much reduced. One of the biggest advantage of using light weight concrete for construction is that less number of reinforcements, foundation excavation etc is required when compared to conventional concrete structures. Also after the addition of olivine sand in perlite concrete, the compressive strength of the concrete had increased. Since the olivine-perlite concrete had become strong, it could also be used in wall panels for framed structures as the load is not exerted over the wall panels in framed structures.

RECYCLING

At last, the olivine-perlite concrete could be completely recycled and with the addition of extra cement, they could again be mixed and used for compound walls, parapet walls etc. Also, the compressive strength value obtained was about 65% of the cube before recycling.

DENSITY OF O-P CONCRETE

The density of the concrete was found out for the following two mix ratios.
Density of concrete is found out using the formula,

$$\text{Density} = \frac{\text{mass}}{\text{volume}}$$

For 1:1.5:2.5,

$$= \frac{980}{0.1x0.1x0.1}$$

$$= 980 \text{ kg/m}^3$$

For 1:2:4,

$$= \frac{1150}{0.1x0.1x0.1}$$

$$= 1150 \text{ kg/m}^3$$

Therefore, the density of the olivine-perlite concrete ranged from 980kg/m^3 to 1150 kg/m^3.

COMPRESSIVE STRENGTH TEST

Compressive strength was determined for the selected ratios and they were compared with the results of ordinary

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cement-concrete. The values obtained were found to be almost equal to those.

SL.NO	RATIO	WEIGHT (g)	COMPRESSIVE STRENGTH (kN/mm²)		
			7	14	28
1	1:1.5:2.5	980	13.5	15.3	18.90
2	1:2:4	1350	16.5	19.1	26.60
3	Recycled Cube of 1:2:4	1723	16.29 (7day)		

SIEVE ANALYSIS TEST

A sieve analysis or gradation test is a procedure used to assess the gradation of a granular material. The size distribution is often of critical importance to the way the material performs in use.
Type of sieve used: Wire mesh cloth

SLUMP CONE TEST

The concrete slump test measures the consistency of fresh concrete before it sets. The slumped concrete takes various shapes, and according to the profile of slumped concrete, the slump is termed as true slump, shear slump or collapse slump.
The value of slump observed = 1.8cm

COMPACTION FACTOR

Compacting factor of fresh concrete is done to determine the workability of fresh concrete by compacting factor test as per IS: 1199 – 1959.
Empty weight of the cylinder (W) = 8.5 kg
Weight of the partially compacted concrete (W_1) = 10.56 kg
Weight of the fully compacted concrete (W_2) = 12.32 kg

$$\text{Compacting factor} = \frac{(\text{Weight of partially compacted concrete})}{(\text{Weight of fully compacted concrete})}$$

$$= \frac{10.56}{12.32}$$
$$= 0.86$$

IV. CONCLUSION

Perlite concrete which was primarily used for manufacture of heat transfer pipes, thermal insulation etc had been enhanced in all its aspect in order to make it efficient to be used for wall panels.

- Perlite concrete consisted of lot of air voids which was sealed after the addition of olivine sand and also imparted water retention capacity to the concrete.
- Various tests were performed on the test specimen and the values were noted down.
- From the test results, it was noted that the desired strength for perlite concrete to be used as wall panels was achieved.
- The cube which we had casted was completely broken and again recycled. It had 65% of compressive strength as the one before recycling.

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