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ENHANCEMENT OF THERMAL RESISTIVITY AND COMPRESSIVE STRENGTH OF CONCRETE BY USING PERLITE

K. V. Pratap[1], P. Padmarao[2], M.Sahithi[3], CH.Subbareddy[4], A.Achaiah[5], D. John Saida[6]

[1]Assistant professor, Department of Civil engineering,
Narasaraopeta Engineering College (Autonomous), Narasaraopet, Guntur, A.P (INDIA)
[2]Assistant professor, Department of Civil engineering, Vignan's University,
Vadlamudi, Guntur, A.P (INDIA)
[3,4,5,6]IV year B.Tech students, Department of Civil engineering,
Narasaraopeta Engineering College (Autonomous), Narasaraopet, Guntur, A.P (INDIA)

ABSTRACT

Concrete is the main material used in construction industry, but has low thermal insulating property which can barely with stand up to 300°C. By adding admixtures to concrete this lagging property can be enhanced so that concrete can sustain even at high temperatures. Among many types of admixtures Perlite is a material with very low thermal conductivity and can be blended with concrete to make perlite powder concrete. Very few studies have been conducted on perlite powder in concrete. In the present study , main aim is to increase the thermal insulation of concrete by replacing perlite powder in certain percentages(2.5%, 5%, 7.5%) to cement and are subjected to different temperatures(300°C , 600°C and 900°C).

Keywords: *compressive strength, elevatedtemperature, perlite powder (PP), silica fume (SF), thermal insulation.*

1. Introduction

Blended concrete is now getting popular as it is economical and possesses more strength than normal concrete. Perlite is an amorphous volcanic glass obtained from obsidian lava with high water content. Perlite is a pozzolanic material formed naturally by hydration of obsidian and expands when heated. As the curing period increases Perlite gains more strength and for initial strength silica fume is also used in a constant of 10% replacement which makes the concrete as ternary blended concrete.

The chemical composition of perlite is as follows:

70-75% silicon dioxide (SiO_2), 12-15% aluminum oxide (Al_2O_3), 3-4% sodium oxide (Na_2O), 3-5% potassium oxide (K_2O), 0.5-2% iron oxide (Fe_2O_3), 0.2-0.7% magnesium oxide (MgO) , 0.5-1.5% calcium oxide (CaO) and 3-5% loss on ignition(combined water).

Perlite expands nearly 15-17 times the original size of it when heated up to 900-1100°C. When perlite is blended along with concrete it offers very high thermal insulation to the concrete and also perlite is a waste material which is a volcanic glass which is relatively cheaper and makes the mix economical. Today's competitive world is growing so fast and construction works are also getting developed by using admixtures and blended concrete, durability of the structures are being increased considerably. There are number of important buildings and there is a chance of getting fire accidents. Fire accidents sometimes completely destroy the building and strength of the concrete relatively decreases and it will be hard for the building to survive. In such cases when perlite powder is used in concrete which can sustain up to high temperatures and some rehabilitation of the structure can make the building ready for reuse which is so economical.

2. **Materials**

2.1Cement: Ordinary Portland Cement (OPC) of 53 grade is used in this experiment. Properties of cement are as follows:

TABLE: Properties of cement.

S.NO	PROPERTY		VALUE
1.	Fineness of cement		5%
2.	Soundness of cement		2mm
3.	Specific gravity of cement		3.15
4.	Setting time	Initial	39 min
		Final	200 min

2.2Coarse Aggregate: Coarse aggregate is collected from the nearby stone crusher. Preliminary tests on aggregates were performed according to IS: 383-1970 and the properties are as follows:

TABLE: Properties of coarse aggregate.

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S.NO	PROPERTY	VALUE
1.	Specific gravity	2.72
2.	Fineness modulus	5.78

2.3Fine Aggregate: Fine aggregate is the locally available river sand which comes under zone III as per IS: 383-1970. Properties of fine aggregate are as follows:

TABLE: Properties of fine aggregate.

S.NO	PROPERTY	VALUE
1.	Specific gravity	2.43
2.	Fineness modulus	4.475

2.4Perlite Powder: Perlite powder is purchased from Astra chemicals.

2.5Silica fume: Silica fume or micro silica is a byproduct of silicon metal.

TABLE: Properties of silica fume.

S.NO	PROPERTY	VALUE
1.	Specific gravity	2
2.	Specific surface	600-630
3.	Bulk density	18 cm^2/g

3. **Experimental study**

In this experimental study, cement is replaced with different percentages of perlite as 2.5%, 5% and 7.5% in M30 mix. Perlite powder is replaced in small amount as perlite possess high water absorption and after reviewing all the literature papers 5% of the perlite powder in concrete gives optimum value and the strength of concrete containing more than 5% gradually decreases as the perlite content increases. Hence the percentage 2.5% which is below 5% and 7.5% which is above 5% is selected to study the property of perlite powder concrete.

A constant replacement of 10% of silica fume is taken to attain the initial strength as perlite shows strength with long curing period. Cubes are casted for conventional concrete mix and by replacing with the perlite powder percentages and are tested for compressive strength at 7days and 28 days. At 28 days curing, conventional mix cubes and cubes with replacement are subjected to elevated temperatures at 300°C, 600°C and 900°C for one hour and are taken for compressive strength test. Compressive strength results are noted and are compared to the strength of conventional concrete and cubes with replacement at room temperature and perlite powder concrete strength results are compared to the conventional concrete.

4. **Results**

Compressive strength of the cubes at 7 days after subjected to elevated temperatures is given in the table below:

TABLE: 7 days compressive strength when subjected to temperature.

Percentage replacement	Compressive strength (N/mm^2) at			
	Room temperature	300°C	600°C	900°C
0%	24.8	26	21.2	5.7
2.5%	25.9	26.8	24.8	6.2
5%	28.2	29.7	27.6	7.5
7.5%	25.1	25.9	23.3	5.8

Compressive strength of the cubes at 28 days after subjected to elevated temperatures is given in the table below:

TABLE: 28 days compressive strength when subjected to temperature.

Percentage replacement	Compressive strength (N/mm^2) at			
	Room temperature	300°C	600°C	900°C
0%	38.7	40.2	34.1	9.2
2.5%	40.6	41.3	39.8	10.1
5%	45.3	45.8	44.1	10.3
7.5%	40.1	41.1	39.6	9.8

4.1 Graphs:

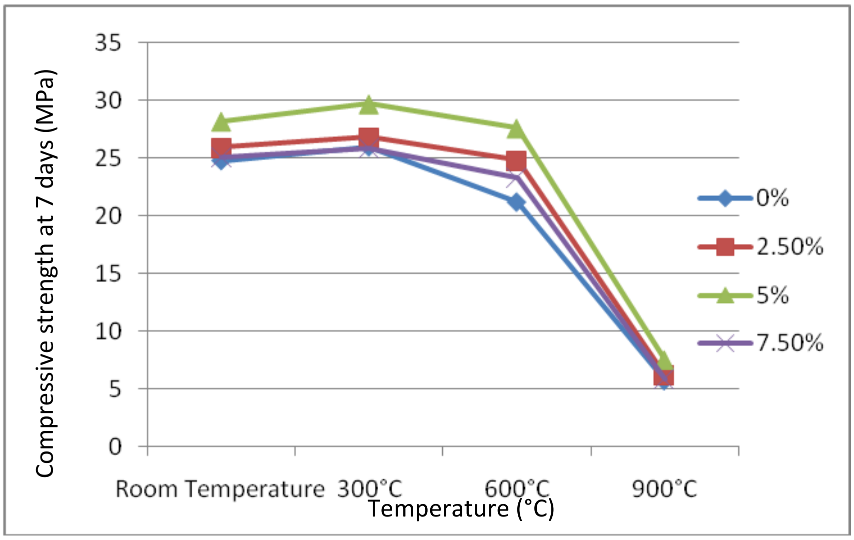

Fig 1: Graphical representation of compressive strength values at 7 days

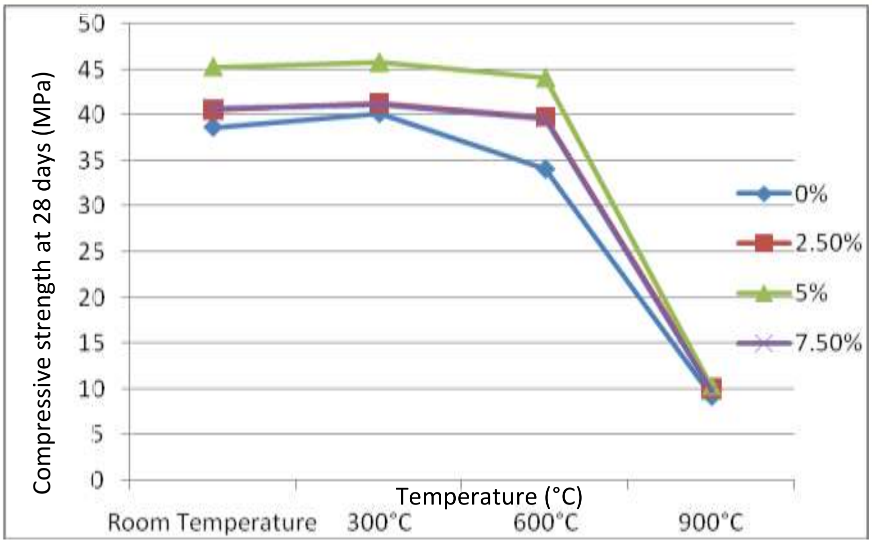

Fig 2: Graphical representation of compressive strength values at 28 days

5. Conclusions

- On 7th and 28th day, the specimen at 300°C has maximum compressive strength obtained for the mix containing 5% PP and 10% SF shows 29.7 MPa and 45.8 MPa respectively.
- Surface cracks observed at temperature 600ºC and it gets more pronounced to further temperature and change of color also seen at this temperature.
- Increasing the target temperature lowers the strength of the concrete in all mixes.
- However, increase in the temperature suppresses the concrete strength, blends of SF and PP makes the concrete more resistant to heat.
- The blends of SF and PP show excellent compressive strength than the conventional concrete.
- From all the mixes, mixof 5% PP and 10% SF proven to be better at elevated temperatures than the others.

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