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MECHANICAL PROPERTIES OF CONCRETE WITH NANO PARTICLES

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ABSTRACT:

The use of nano particles in developing materials with desired properties has gained popularity and is being applied in many fields. More specifically, such particles can lead to improvements in the nanostructure of building materials such as cement and concrete. Concrete technology is a multidisciplinary area of research where nanotechnology potentially offers the opportunity to improve the properties of concrete to suit the specific requirements. It is also reported that addition of nano materials to concrete can lead to significant improvements in the strength and life of concrete. In order to reduce the carbon emission due to the cement manufacturing the fly ash is partially replaced in ordinary Portland cement and termed as Portland pozzolana cement (PPC) it not only reduces the environmental impact, improves the workability and long term strength of concrete. An attempt has been made to carry out an experimental investigation on concrete with nano fly ash. Fly ash was grinded in the ball grinding mill to produce nanofly ash. For 20 grade of concrete, 30%, 40% and 50% of cement was replaced with fly Ash and small percentage of Nano fly Ash. Concrete with nano fly ash was found tobe stronger than NCC and Fly Ash Concrete. The workability of concrete with nanofly ash was found to be significantly more than that of NCC.

INTRODUCTION:

Recent research has shown that a state-of-the-art process for high-performance cement adds a new dimension to classical‟ cement technology; similarly this is the time to work on “NANO TECHNOLOGY” for development of construction industry by innovations in concrete techniques and also some new materials for the concrete technology. As concrete is most usable material in construction industry it’s been requiring to improve its quality.

“Nanotechnology is defined as fabrication of devices or materials with atomic or molecular scale precision” Nanotechnology is usually associated with study of materials of micro size i.e. one billionth of a meter (a Nanometer) 10^{-9}m.

Nano-concrete is defined as “A concrete made with Portland cement particles that are less than 500 Nano-meters as the cementing agent. Currently cement particle sizes ranges from a few Nano-meters to a maximum of about100 micro meters. In the case of micro-cement the average particle size is reduced to 5 micro meters.

To modify the particle size of fly ash by transforming the micro sized fly ash into nano structured fly ash using high energy ball mill. The surface properties can be modified by ball grinding. The smooth, glassy and inert surface of the fly ash can be altered to a rough and more reactive product by this technique.

EXPERIMENTAL PROGRAM:

Experimental investigations are carried out on concrete cubes. The mix was designed for target cube strength of 20 MPa at 28 days with water-cement ratio of 0.5. grade 53 cement was partially replaced with fly ash by weight (30%, 40% and 50%). A simple method of mix proportioning using fly ash (i.e. fly ash as part replacement of cement by weight) has been adopted.

This experimental program consists of casting and testing of 63 concrete cubes of standard size of 150 mm x 150 mm x 150 mm. Number of cubes casted, their id, descriptions and their curing period are summarized below.

Cube Id	Fly ash replacement	No of cubes for		
		7 days curing	14 days curing	28 days curing
C	0%	3	3	3
F 1	30%	3	3	3
F 2	40%	3	3	3
F 3	50%	3	3	3

Table I: specimen details of partially replaced fly ash concrete

Cube Id	Fly ash replacement (weight by cement)	Nano fly ash replacement (weight by fly ash)	No of cubes for		
			7 days curing	14 days curing	28 days curing
NF 1	30%	3%	3	3	3
NF 2	40%	3%	3	3	3
NF 3	50%	3%	3	3	3

Table II: specimen details of nano concrete cubes

Results and Discussion:

Workability:

When adding cement alone as a binder the slump value become 85mm.Then while replacing binder about 30% by fly ash the slump value slightly increases. For re placement of binder as 50% by fly ash the slump value

become 90mm.At the same time adding nano silica to the above mix because of these binary components the slump value slightly increases continuously.

Cube Id	Fly ash replacement (weight by cement)	Nano fly ash replacement (weight by fly ash)	Slump value (mm)	Type of slump
C	0%	-	85	TRUE
F 1	30%	-	87	TRUE
F 2	40%	-	88	TRUE
F 3	50%	-	90	TRUE
NF 1	30%	3%	89	TRUE
NF 2	40%	3%	91	TRUE
NF 3	50%	3%	93	TRUE

Table III: Test result for workability

Compressive Strength:

For conventional concrete the compressive strength at 7 days curing period is 25.33N/mm^2. For concrete with the mix proportion of F1,F2,F3,NF1,NF2,NF3 the compressive strength value at 7 days curing period are smaller than that of the conventional concrete but 28 days Strength will be higher than the conventional concrete. For Conventional Concrete 28 days Strength was 33.22 N/mm^2, the value will be increased to 38.11N/mm^2 while adding Nano Silica at 3% and Fly ash at 30%.

Cube id	Fly ash replacement (weight by cement)	Nano fly ash replacement (weight by fly ash)	Compressive strength (N/mm^2)		
			Curing for 7 days	Curing for 14 days	Curing for 28 days
C	0%	-	25.33	28.88	33.22
F 1	30%	-	21.33	27.11	34.11
F 2	40%	-	13.77	20.44	29.22
F 3	50%	-	10.66	15.11	23.88
NF 1	30%	3%	24.44	29.77	38.11

NF 2	40%	3%	19.55	24.88	32.33
NF 3	50%	3%	13.77	19.11	27

Table IV : Test result for compression

COMPARISION OF COMPRESSIVE STRENGTH VALUES OF FLY ASH AND NANO FLY ASH CONCRETE CUBES WITH NCC AT 30% REPLACEMENT OF CEMENT

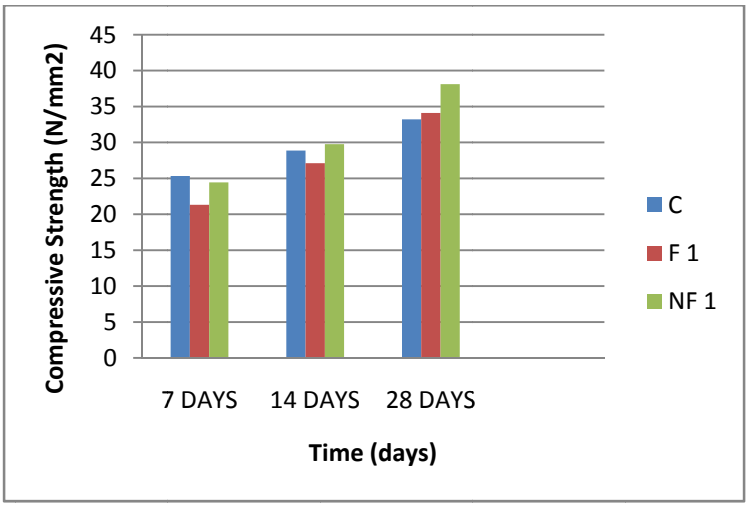

Fig 1: Compressive strength values at 30% replacement of cement

COMPARISION OF COMPRESSIVE STRENGTH VALUES OF FLY ASH AND NANO FLY ASH CONCRETE CUBES WITH NCC AT 40% REPLACEMENT OF CEMENT

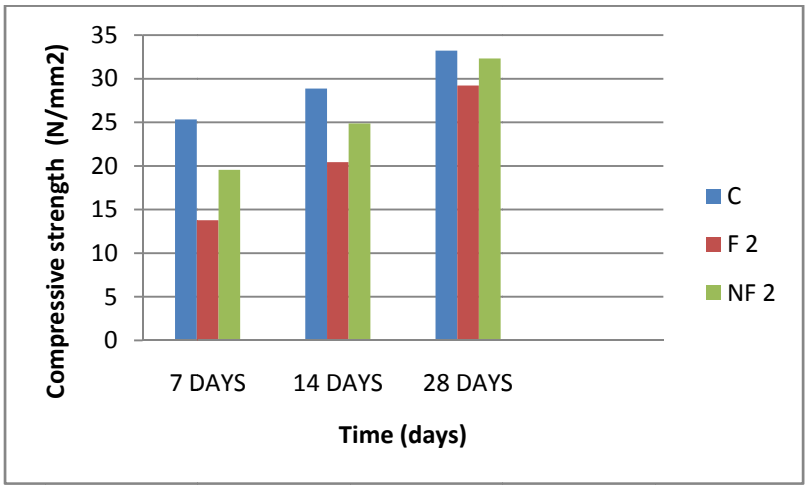

Fig2: Compressive strength values at 40% replacement of cement

COMPARISION OF COMPRESSIVE STRENGTH VALUES OF FLY ASH AND NANO FLY ASH CONCRETE CUBES WITH NCC AT 50% REPLACEMENT OF CEMENT

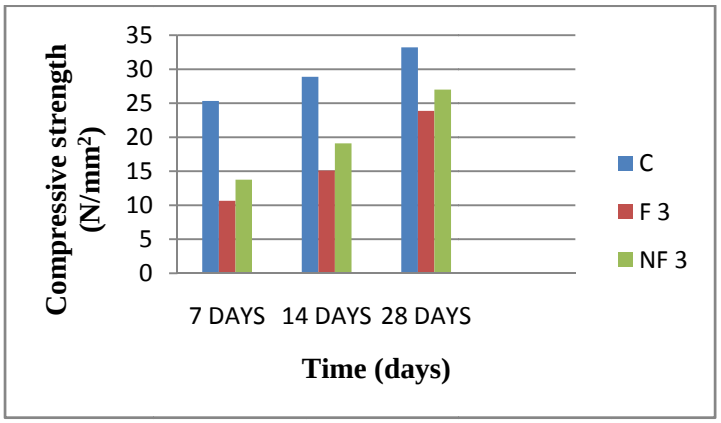

Fig 3:Compressive strength values at 50% replacement of cement

COMPARISION OF COMPRESSIVE STRENGTH VALUES OF NCC, FLY ASH AND NANO FLY ASH CONCRETE CUBES AT 28 DAYS CURING

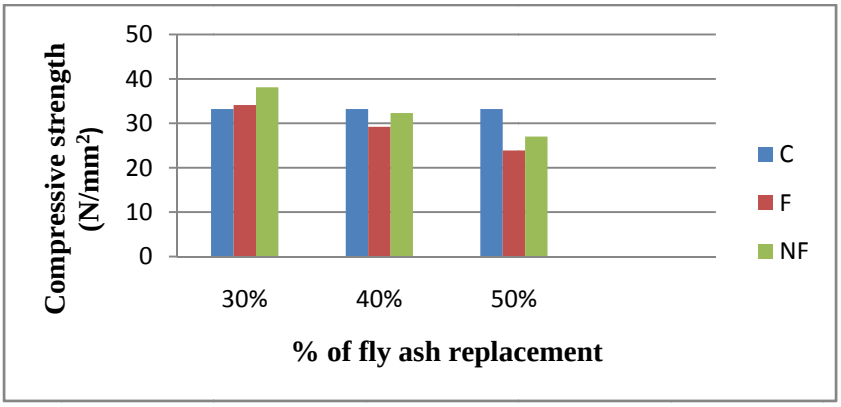

Fig 4: Compressive strength values of fly ash and nano fly ash concrete cubes at 28 days curing

CONCLUSIONS:

The following conclusions are derived based on the present research.

- Since the nano sized particles are most active, the strength of concrete with nano materials was found to be higher than that of Normal Cement Concrete.
- The workability of the concrete with nano fly ash was found to be higher than that of Normal Cement Concrete.
- The workability of concrete increases with the increase in fly ash in concrete. Fly ash use improves the workability of the mix and thus allows a decrease in the amount of water used.
- The compressive strength increases with the increase in fly ash in concrete upto 30% replacement. Therefore it is an optimum percentage of replacement.
- As the fly ash contents increases in 53 grade OPC there is reduction in the strength of concrete. This is expected, as the secondary hydration due to pozzolanic action is slower at initial stage for fly ash concrete. The reduction is more at earlier ages as compared to later ages.

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