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Effect of Nano particles on the properties of concrete

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Abstract: The cement industry is responsible for 6% of all CO_2 emission, because the production of one tonne of Portland cement emits approximately one tonne of CO_2 into the atmosphere. In order to overcome the greenhouse effect caused by the manufacturing of the ordinary Portland cement an immediate need arise to find a suitable substitute for ordinary Portland cement. The usage of supplementary materials such as fly ash, silica fume, slag cement, rice husk ash etc has been increased in the construction industry due pozzolanic activities. In this study agricultural waste such as Rice hush ash as used as partial replacement of cement and the size of particles was analysed and observed as nanoparticles which were in a range of 70-90nm. In this investigation, the properties of concrete modified with Nano rice husk ash and fly ash in M35 grade is determined. In the first sample cement is replaced by 3% Nano rice husk ash and 20% fly ash. And in the second normal concrete sample fly ash replaces 20% of the cement. The compressive, split tensile, flexural strength was measured to know the mechanical properties of two types of concrete after curing period of 7 days, 28 days and 56 days. Results showed concrete modified with nano RHA-fly ash shows better results than fly ash concrete.
Keywords: Nano particles, concrete.

I Introduction

With the advancement of nanotechnology, nonmaterial have been developed that can be applied to concrete mix designs to study the physical, chemical and enhanced mechanical properties of concrete. These efforts included the utilisation of supplementary cementations materials such as fly ash, silicafume, granulated blast furnace slag, rice-husk ash and metakaolin as alternative binders to Portland cement.

Here Nano rice husk ash is used as a partial replacement of cement. Rice plant is one of the plants that absorbs silica from the soil and assimilates it into its structure during the growth . Thus the outer covering of the grain of rice plant with a high concentration of silica, generally more than 80-85%. Rice husk is produced in millions of tonnes per year as a waste material in agricultural and industrial processes. The non-crystalline silica and high specific surface area of the RHA are responsible for its high pozzolanic reactivity. RHA has been used in lime pozzolan mixes and could be a suitable partly replacement for Portland cement.

Some of the common properties of Nano-particles are:

- Well-dispersed nano-particles increase the viscosity of the liquid phase helping to suspend the cement grains and aggregates, improving the segregation resistance and workability of the system.
- Nano-particles fill the voids between cement grains, resulting in the immobilization of “free” water (“filler” effect).
- Well-dispersed nano-particles act as centers of crystallization of cement hydrates, therefore accelerating the hydration.

- Nano-particles favour the formation of small-sized uniform clusters of C-S-H.
- Nano particles participates in the pozzolanic reactions, resulting in the consumption of Ca(OH)2 and formation of an "additional" C-S-H.
- Nano-particles improve the structure of the aggregates' contact zone, resulting in a better bond between aggregates and cement paste.
- Crack arrest and interlocking effects between the slip planes provided by nano-particles improve the toughness, shear, tensile and flexural strength of cement based materials.

This research involved partial replacement of cement by RHA and thereby making concrete more affordable to the common man and also to find a solution to the disposal problems created by rice husk.

II Literature Review

The nano- Fe2O3 particles blended concrete had significantly higher compressive strength compare to that of the concrete without nano-Fe2O3 particles[1].RHA blended concrete can decrease the total porosity of concrete, modify the pore structure of the cement, mortar, and concrete, and significantly reduce the permeability which allows the influence of harmful ions leading to the deterioration of the concrete matrix[2]. The addition of nano particle greatly enhances the hardening process of fly ash-cement pastes and the early-age compressive strength of fly ash-cement mortars[3].The RHA contains mostly silica (90-95%) besides minor amount of calcium, potassium, phosphorus, magnesium, sodium and sulphur along with trace amount of aluminium, manganese and iron[4]. Habeeb and Fayyadh investigated the influence of RHA average particle size on the properties of concrete and found out that at early ages the strength was comparable, while at the age of 28 days, finer RHA exhibited higher strength than the sample with coarser RHA[5].Nano particles can improve durability and mechanical properties of concrete. The contribution of nano-TiO_2 on improvement of mechanical properties and durability of concrete was more than the other nano particles[6]. The concrete with 10% and 20% replacement of cement with fly ash shows good compressive strength for 28 days than normal concrete[7]. Rukzon, Chindaprasirt and Mahachai further studied the effect of grinding on the chemical and physical properties of rice husk ash and the effect of RHA fineness on properties of mortar and found that pozzolans with finer particles had greater pozzolanic reaction[8]. RHA is also utilized as a replacement of cement and silica fume or as a mineral admixture in manufacturing of low cost concrete blocks[9].The addition of rice husk ash to Portland cement does not only improve the early strength of concrete, but also forms a calcium silicate hydrate (CSH) gel around the cement particles which is highly dense and less porous, and may increase the strength of concrete against cracking[10].The use of Fe_2O_3 nano- particles up to maximum replacement level of 2.0% produces concrete with improved split tensile strength and flexural strength[11].Nano material added in small percentage generally in the range of 1 to 4% improves strength, permeability and shrinkage of concrete. Nano Sio2 has large specific surface area so it is more sticker and has good water penetration resistance as compared to normal concrete[12].

III Experimental Investigation

3.1 Compression test

Cubical moulds of size 150x150x150mm are taken. It is made of non-absorbent material and substantial enough to hold their form during the moulding of test specimens. Sample is kept for water curing after demoulding. This sample is tested after 7, 28 and 56 days of curing.

3.2 Split tensile test:

Cylindrical moulds are taken. It is made of non-absorbent material and substantial enough to hold their form during the moulding of test specimens. Standard cylindrical moulds have dimension 150x300mm. Sample is kept for water curing after demoulding. This sample is tested after 7, 28 and 56 days of curing.

3.3 Flexural Strength test:

For flexural test prism moulds of dimension of 100x100x500mm are taken. It is made of non-absorbent material and substantial enough to hold their form during the moulding of test specimens. Sample is kept for water curing after demoulding. This sample is tested after 7,28 and 56 days of curing.

IV Results and Discussions

4.1 Compression Test:

To determine the compressive strength, three cubes (150mm x 150mm x 150mm) were casted for each mix and the samples were tested after 7,28 and 56 days of curing.

The Compression test results are the 7th, 28th and 56th day are given in the Table 4.1, 4.2 and 4.3 respectively.

Table 4.1: Compressive Strength Test (7th day test)

S.No	Grade of concrete	Type of sample	Sample name	Load(KN)	Compressive Strength(N/mm2)	Average Strength(N/mm2)
1	M35	Nano RHA concrete	A	650	28.89	28.22
			B	620	27.56	
			C	635	28.22	
2	M35	Normal Concrete	A	687	30.53	30.81
			B	703	31.24	
			C	690	30.67	

Table 4.2: Compressive Strength Test (28th day test)

S.No	Grade of concrete	Type of sample	Sample name	Load(KN)	Compressive Strength(N/mm2)	Average Strength(N/mm2)
1	M35	Nano RHA concrete	A	1040	46.22	48.665
			B	1095	48.665	
			C	1150	51.112	
2	M35	Normal Concrete	A	980	43.555	38.9629
			B	780	34.666	
			C	870	38.667	

Table 4.3: Compressive Strength Test (56th day test)

S.No	Grade of concrete	Type of sample	Sample name	Load(KN)	Compressive Strength(N/mm2)	Average Strength(N/mm2)
1	M35	Nano RHA concrete	A	1142	50.17	50.073
			B	1140	50.567	
			C	1200	53.333	
2	M35	Normal Concrete	A	1050	47.777	47.555
			B	1100	47.998	
			C	1090	48.332	

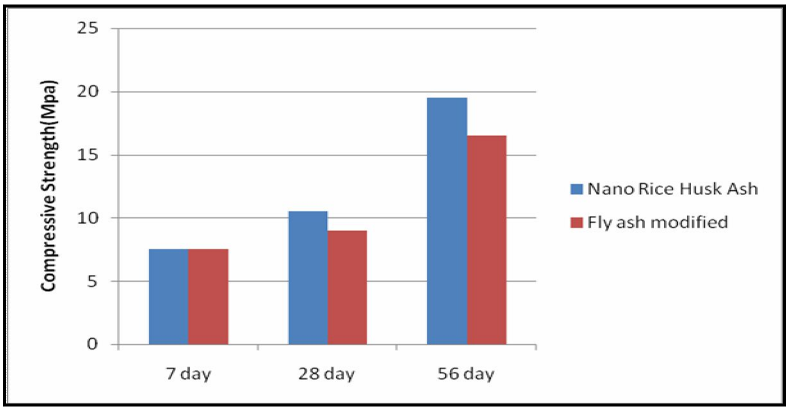

Figure 4.1: Compressive strength Result

4.2 Split tensile test:

The Split tensile strength results after the 7th, 28th and 56th day curing are given in the Table 4.4, 4.5 and 4.6 respectively.

Table 4.4: Split tensile strength test (7th day)

S.No	Grade of concrete	Type of sample	Sample name	Load(KN)	Split tensile Strength(N/mm2)
1	M35	Rice husk Ash	A	176	2.49
2	M35	Normal Concrete	A	125	1.77

Table 4.5: Split tensile strength test (28th day)

S.No	Grade of concrete	Type of sample	Sample name	Load(KN)	Split tensile Strength(N/mm2)
1	M35	Rice husk Ash	A	275	3.89
2	M35	Normal Concrete	A	200	2.83

Table 4.6: Split tensile strength test (56th day)

S.No	Grade of concrete	Type of sample	Sample name	Load(KN)	Split tensile Strength(N/mm2)
1	M35	Rice husk Ash	A	310	4.39
2	M35	Normal Concrete	A	280	3.96

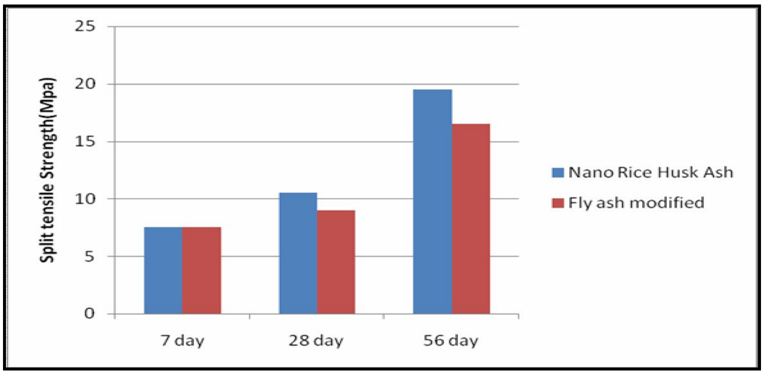

Figure 4.2: Split Tensile strength result

4.3 Flexural Strength Test:

The flexural strength results after the 7th, 28th and 56th day curing are given in the Table 4.2, 4.3 and 4.4 respectively.

Table 4.7: Flexural Strength Test (7th day)

S.No	Grade of concrete	Type of sample	Sample name	Load(KN)	Flexural Strength(N/mm2)
1	M35	Rice husk Ash	A	10	15.00
2	M35	Normal Concrete	A	10	15.00

Table 4.8: Flexural Strength Test (28th day)

S.No	Grade of concrete	Type of sample	Sample name	Load(KN)	Flexural Strength(N/mm2)
1	M35	Rice husk Ash	A	14	21.00
2	M35	Normal Concrete	A	12	18.00

Table 4.9: Flexural Strength Test (56th day)

S.No	Grade of concrete	Type of sample	Sample name	Load(KN)	Flexural Strength(N/mm2)
1	M35	Rice husk Ash	A	26	39.00
2	M35	Normal Concrete	A	22	33.00

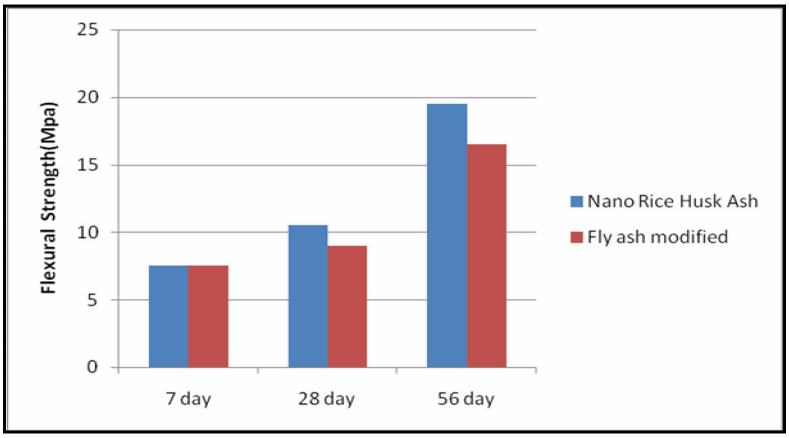

Figure 4.3: Flexure Strength Result

V Conclusion

The readings obtained from the Cube Compressive Strength test, Split tensile Strength test and Flexural Strength test after a curing period of 7, 28 and 56 days shows that concrete containing Nano rice husk ash and fly ash exhibits higher strength than the normal fly ash based concrete

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