Experimental Study on Sfrm Concrete

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Abstract - Cement concrete is the mostly used material for various constructions. Concrete has good strength and durable properties. The main ingredient in the conventional concrete is Portland cement. Cement production is consuming a significant amount of natural resources. The ill effect the advent of newer materials and construction techniques and drive admixture has taken new things and it has become necessity for future. The use of new mineral admixtures has considerably increased within the concrete industry for attaining a high strength, durable concrete for major applications in the constructions such as high rise buildings, tall structures, nuclear power plants etc. The essential need of additives both chemical and mineral is must to improve the performance of concrete. Plain concrete possesses very little tensile strength, limited ductility and little resistance to cracking, hence this present study use of Metakaolin and hook ended steel fiber reinforced concrete into ordinary cement concrete. In this experiment metakaolin at various percentages as 0%, 5%, 10%, 15%, 20% by weight of cement and steel fiber content of 0%, 2.5%, 5%, 7.5% and 10% is used. It also includes the effect of aggregate size on strength of concrete 6mm, 10mm, 12mm aggregate sizes are used throughout the experimental work. In this experiment various mechanical properties of concrete like compressive strength, split tensile strength, flexural strength were observed at the age of 28 days of curing. In experimental results of compressive strength, flexural strength & flexural deformation of FRM are compared with FE results using ANSYS.

Introduction

Shelorkar (2013) experimented on steel fiber reinforced concrete by using metakaolin. The effect of addition of 1.5% steel fiber of the total weight of concrete and 8% metakaolin of total weight of cement was investigated. A total of 144 specimens were casted for testing the properties such as compressive strength, split tensile strength, flexural strength. It was observed that its compressive strength, tensile strength and flexural strength of concrete was increased by 8.91%, 26.94% 58.28% respectively. **Patil (2012)** experimented on high performance concrete by using different percentages of metakaolin by weight of cement. The results of the study indicate that the workability and strength of high performance concrete (HPC) 7.5% increased by high reactive metakaolin (HRM). high performance concrete was also indicated better resistance by using chlorides and sulphates when the high performance concrete mixes were exposed to these chemical age of 180 days.

Shende (2012) investigated on M-40 grade of concrete with mix proportions to evaluated compressive strength, flexural strength, and tensile strength of Steel Fiber Reinforced Concrete (SFRC).The results obtained was analyzed and compared with a control mix. It was observed that mechanical properties with 3% of fiber in concrete was more as compared 0%, 1%, and 2% fibers in concrete.

Murali (2012) reported on use of metakaolin as partial replacement of cement. This study was deals with the properties of concrete with varying percentage of replacement of metakaolin .The result indicated that with optimum quantity of metakaolin the strength of concrete mix was increased as compare to conventional concrete.

Ali (2011) experimental investigation was carried out to obtain the mechanical properties of two types of UHPC mixes, namely silica fume and metakaolin in addition with the use of three different percentages of steel fibers. The ANSYS computer software was used for nonlinear model analysis. Parametric study was carried out to investigate the effect of pozzolanic admixtures like silica fume, metakaolin and steel fibers. The compressive strength of UHPC mixes with silica fume was high as compared with UHPC mix metakaolin.

Muttoni (2007) carried out test on a series of large scale unreinforced and reinforced UHPC beams, to investigate the effect of the amount and type of reinforcement on structural behaviour. Casting and testing of reinforced concrete deep beams was done with different L/B ratio to investigate the strain distribution pattern at mid-section of the beam. This study presented analysis of deep beams subjected to two points loading with three different L/B ratios using nonlinear finite element method. In ANSYS software SOLID 65 and LINK 8 elements were to used represent the concrete and reinforcing steel bars. The comparison between ANSYS result and experimental results were made in terms of strength, flexural strain and deflection of concrete beam. From the flexural strain graph it was observed that smaller the L/B ratio the deviation in stress strain pattern was high.

3.Scope

To prevent the risk of environmental hazards during cement manufacturing instead of supplementary cementitious materials such as metakaolin as well as steel fibers are used. The research work has been carried out to determine the fresh and hardened properties of normal concrete and steel fiber reinforced metakaolin concrete. In this work some percent of metakaolin replaced by cement as well as fibers. It was found that the mechanical properties of concrete such as compressive strength, flexural strength and split tensile strength were increased as compared to the normal concrete. This study will help to understand the effect of addition of hook ended steel fiber and metakaolin on hardened properties of concrete. It also includes the effect of aggregate size on strength of concrete with 6mm, 10mm, 12mm aggregate sizes used in the experimental work.

4.Objectives

Following are the objectives dissertation work-

1. *To study the fresh concrete properties of normal concrete and Steel Fiber reinforced metakaolin concrete.*
2. *To study the hardened concrete properties such as compressive strength, flexural strength & split tensile strength of SFRM concrete by using 6mm, 10mm, and 12mm size of aggregate.*
3. *To study the mechanical properties such as compressive strength, flexural strength & flexural deformation of SFRM concrete mix M60 over conventional concrete mix 60.*
4. *To study the flexural deformation of SFRM concrete using ANSYS.*

5.Modeling

In the present work, tests have been carried out on cube and beam specimens of hardened concrete. The ANSYS computer software used for nonlinear model analysis. To find out mechanical properties analytically the modeling is done in ANSYS. The modeling is used to define properties of materials such as poissions ratio, density and modulus of elasticity etc. The results of these specimens were simulated in ANSYS software for validations. The size details of the specimen are as follows.

The dimensions of compression cube used to make model are

Length (L) : 150mm

Width (b) : 150mm

Thickness (t) : 150mm

The dimensions of flexure beam used to make model are

Length (L) : 500mm

Width (b) : 100mm

Thickness (t) : 100mm

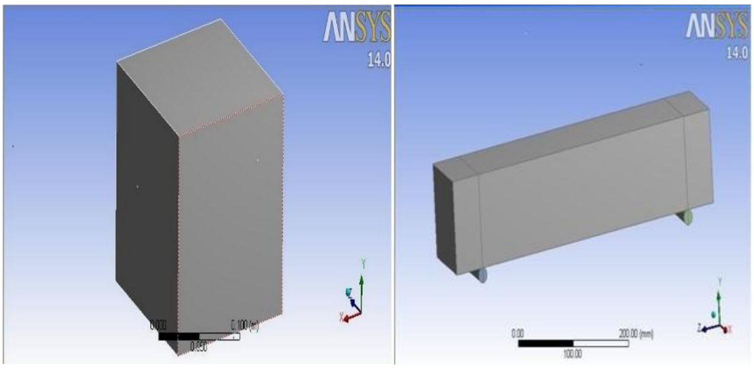

Figure 5.1: Geometry of cube and beam

6.Result and Discussions

The experiments were conducted to find the mechanical properties of SFRMC. For this the percentage of steel fiber varies from 0 to 10% and metakaolin varies from 0 to 20%. The tests on hardened concrete were carried out according to relevant standards wherever applicable. Results of hardened SFRMC are compared with normal concrete as well as ANSYS.

Table 6.1: Mechanical properties of SFRMC

Size of Aggregate (mm)	Mix Designation	Compressive Strength (*fcu*) (MPa) 28 Days	Flexural Strength (*fcr*) (MPa) 28 Days	Split Tensile Strength (f_t) (MPa) 28 Days
6	Normal Concrete (NC)	67.11	6.75	7.36
	NC+ 2.5 % S.F+5 % MK	68.10	7.06	7.92
	NC+5 % S.F + 10 % MK	65.92	7.21	8.58
	NC + 7.5 %S.F +15 % MK	65.62	7.85	8.96
	NC + 10 % S.F + 20 % MK	64.44	8.6	9.1
10	Normal Concrete (NC)	67.70	6.9	7.12
	NC+ 2.5 % S.F+5 % MK	70.67	7.23	7.64
	NC+5 % S.F + 10 % MK	69.33	7.35	7.69
	NC + 7.5 %S.F +15 % MK	67.84	8.01	7.87
	NC + 10 % S.F + 20 % MK	65.48	8.72	8.06
12	Normal Concrete (NC)	65.18	5.67	6.65
	NC+ 2.5 %	67.11	6.06	6.88

	S.F+5 % MK			
	NC+5 % S.F + 10 % MK	66.22	6.58	6.93
	NC + 7.5 %S.F +15 % MK	65.63	6.81	7.12
	NC + 10 % S.F + 20 % MK	64.44	7.66	7.4

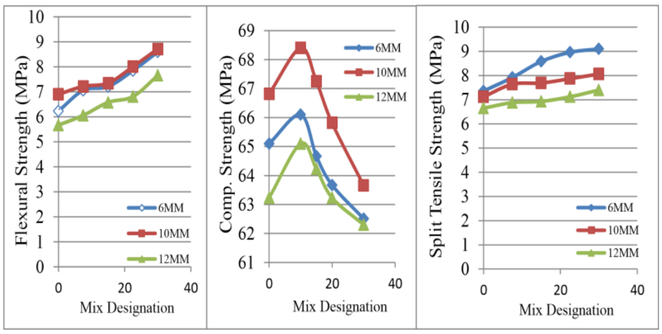

Fig 4.8: Mix Designation vs Flexural Strength, Comp. Strength & Split Tensile strength.

Table6.2:Comparison of result of compressive strength

Size of Aggregate (mm)	Mix Designation	Compressive strength (MPa)	
		Experimentally	Ansys
6	NC	67.11	69.49
	NC+2.5%S.F+5%MK	68.10	70.56
	NC+5%S.F+10%MK	65.92	68.26
10	NC	67.70	70.10
	NC+2.5%S.F+5%MK	70.67	73.17
	NC+5%S.F+10%MK	69.33	71.79
12	NC	67.11	67.49
	NC+2.5%S.F+5%MK	66.22	69.49

	NC+5%S.F+10%MK	65.63	68.57

Table 6.3: Comparison of result of flexural strength

Size of Aggregate (mm)	Mix Designation	Flexural strength (MPa)	
		Experimentally	Ansys
6	NC	6.75	11.56
	NC+2.5%S.F+5%MK	7.06	12.0
	NC+5%S.F+10%MK	7.21	12.33
10	NC	6.9	11.81
	NC+2.5%S.F+5%MK	7.23	12.37
	NC+5%S.F+10%MK	7.35	12.57
12	NC	5.67	9.71
	NC+2.5%S.F+5%MK	6.06	10.36
	NC+5%S.F+10%MK	6.58	11.26

7. Conclusions

The following conclusions are arrived at on the use of steel fiber reinforced concrete with metakaolin

1) Workability by 20% decreaseswith increase in percentage of addition of steel fiber and metakaolin in concrete mix.

2) Dry density of Cube with addition of steel fiber and metakaolin are found to be increased for different aggregate sizes as follows-

a) 6mm aggregate - 2.14%

b) 10mm aggregate -2.17%

c) 12mm aggregate -2.20%

3) Dry density of beam with addition of steel fiber and metakaolin are found to be increase as

Follows-

a) 6mm aggregate -3.10%

b) 10mm aggregate -3.67%

c) 12mm aggregate -2.64%

4) Dry density of cylinder with addition of steel fiber and metakaolin are found to be increase as Follows-

a) 6mm aggregate -1.95%

b) 10mm aggregate -2.29%

c) 12mm aggregate -2.03%

5) Compressive strength is increased by 1.53% for 6mm aggregate, 2.36% for 10mm aggregate and 2.96% for 12mm aggregate as compared to normal concrete. The analytical results obtained are in good agreement with FE results with an error of ±5%.

6) Flexural strength is increased by 21.71% for 6mm aggregate, 26.38% for 10 mm Aggregate and 35.1% for 12mm aggregate as compared to normal concrete. The analytical results obtained are in good agreement with FE results with an error of ±43%.

7) Split tensile strength is increased by 23.64% for 6mm aggregate, 13.20% for 10mm aggregate and 11.3%for 12mm aggregate as compared to normal concrete.

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