Improving Strength Properties of Fiber Reinforced Concrete with Alccofine

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Abstract : This experimental work deals with the effects of alccofine in concrete by optimum replacement of cement and variation of steel fibers to determine the workability and compressive strength. In this work 42 cube samples of size 150*150*150mm were cast by 10% of alccofine as constant with different percentages of steel fibers 1,2,3,4 and 5 respectively. From the results, it was found that strength was increased with optimum replacement of alccofine with increasing the % of steel fibers after 7&28 days curing. For the experimental values best fit model was developed. Using ANSYS, all the concrete cubes were studied and determined the values of deformation, principle stresses and shear stresses.

Keywords **:** ***Alccofine, ANSYS, Compressive Strength, Steel Fiber.***

I. INTRODUCTION

Concrete is mainly used materials throughout the globe in all construction activities. Aggregates were used as a filler material and cement is used as a bonding agent which influences the strength parameter. The concrete is used widely all over the world. It has many disadvantages. It releases one ton of Co2 for the production of one ton concrete, which effects the environment due to the hydration of cement while setting. Indeed it is essential to replace the cement by a chemical admixture for improving the concrete characteristics. A new material alccofine 1203 has been introduced now in industry. It's a supplementary cementitious material suitably replaces cement in concrete. Alccofine is a range of ultra fine mineral additives for concrete, which improves the performance of concrete in wet and hardened stage. In addition, fibers are added as a micro reinforcement to improve the strength of concrete. Using fiber in the concrete increases the compressive strength to exhibit ductile behavior. Fibers generally reduce the workability of concrete, but the presence of ultra fine material helps in counteracting the workability

II. LITERATURE REVIEW

P.C.Satpute et al carried out the experimental work for properties of M25 grade concrete such as compressive strength, flexural strength, split tensile strength, creep behavior, impact resistance and toughness with the mixture of steel and glass fibers. In order to reduce the cracking, improve the permeability parameters, bleeding of water and abrasion resistance in concrete, fibers like steel and glass were added to concrete. To improve the tensile strength of concrete, steel fibers were introduced in optimum proportions.

A.Sumathi et al investigating the high strength concrete with alccofine as admixture and reinforced with steel fibers to study the mechanical and durability properties. Partially replacement of alccofine with fibers showed the marginal increase in strength and durability when compared to control concrete. The result implies that the split tensile and flexural strength is improved in the Alccofine with steel fibers.

P.B.Sonawane et al carried out the experimental work is mainly focus on the study behavior of PCC using mineral admixture alccofine as replacement to cement and fiber for reinforcing. Alccofine are replaced and steel fiber was added up to 5% by weight of cement for producing concrete. Alccofine has very high pozzolanic reactivity. It reduces drying shrinkage and resists the shrinkage cracking width. It helps to improve the compressive strength and durability of concrete. The compressive strength rapidly increases with the addition of alccofine content. The properties like shear, torsion and bending is also improve due to addition of steel fibers in concrete, the addition of fibers resists the development of internal micro crack in the concrete, which are responsible for the failure of the structure.

Akshit Mahrajan et al and S.G.Jeurkar et al found that the structural behaviour of plain cement concrete with marble and dust powder and steel fiber. In this study to relatively improve the tensile and flexural strength of concrete along with its compressive strength using Marble Dust Powder (MDP) and steel fibers in standard concrete. Use of MDP by weight of cement as replacement to it different variations and further addition of HE steel fibers in various mixes. For compressive strength test, the cubes were casted and tested in CTM to obtain the compressive strength of masses. This study reveals that MDP and fiber mixed concrete provide much better properties in improving compressive, split tensile and flexural strength and use of fibers provide better properties in controlling cracks and high strengths. The results revealed that the steel fiber reinforcement prevents the problem of cracking. Particularly those related to strength, performance and durability.

R.Chitra et al carried out the improving strength properties of concrete using steel fiber. The result showed that addition of steel fiber caused an increase in the tensile strength. The partial use of these fibers in optimum ratio may have an influence in reducing crack generation repeatedly while applying shock or impact loads.

P.R.Kalyana Chakravarthy et al reveals the comparative study on compressive strength of normal concrete verses coconut shell concrete using steel fiber. The steel fiber addition will improve the resistance of conventional concrete members from cracking, deflection and other serviceability conditions. In this study 0.5% to 2% by volume

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fraction of steel fibers is replaced. The increase in percentage of steel fiber in volume fraction will improve the compressive strength of concrete.

S.K.Kulkarni et al investigates the strength parameters of concrete with fiber reinforced by using hooked and steel fibers. The significant improvement in compressive, split tensile and flexural strength is noticed with the increase in proportion of hooked and steel fibers in concrete.

B.Kaviya et al reviews on the effect of alccofine replacement. Alccofine influences the high strength behavior at the earlier stages of concrete. 15% replacement of Alccofine showed the improvement in strength to large extent. It increases the durability and resistance to chemical attack and also reduces the heat of hydration. The relative cost of alccofine is cheaper then cement hence it is economic with higher strength.

III. EXPERIMENTAL WORKS

Ordinary Portland cement was used for casting concrete. The 53 grade cement with 3.12 specific gravity is utilized for the experimental works. The particle size distribution for a typical Portland cement. About 10 wt % of the cement is made of particles larger than 50µm and only a few wt % particles larger than 90µm. The Blaine fineness of OPC usually from 300-500m2/kg (3000-5000cm2/g). Standard specified fine and coarse aggregates were used. All the preliminary tests were conducted as per IS: 383-1970. Table 1 shows physical and chemical properties of alccofine used. The Physical properties of Steel fiber were presented in Table 2. Table 3 shows preliminary test results of concrete materials. In this work alccofine 1203 was used. Alccofine is a micro fine mineral additives used as replacement in concrete which improves the performance of concrete in wet and hardened stage. The water causes the hardening of concrete through a process called hydration. Excess of water reduces increases workability and decreases strength of concrete

Table- I: Physical and Chemical Properties of Alccofine Used

Physical and Chemical properties	Alccofine
Colour	White
Specific gravity	2.86+_0.02
Appearance	Powder
Bulk Density (kg/m^3)	600-700
Glass content	>90%
Silica dioxide (SiO_2)	33-35 %
Calcium oxide (CaO)	31-33 %
Aluminum oxide(Al2O3)	23-25 %

Table- II: Physical properties of Steel fiber used

Description	Values
Length of fiber	60mm
Thickness (diameter) of fiber (d)	0.75mm
Aspect ratio (l/d)	60
Tensile strength	2000Mpa
Specific gravity	7.82
Modulus of Elasticity	200Gpa

Table- III: Preliminary Test Results

Tests	Materials	Values
Specific gravity (G)	Fine aggregate	2.56
	Coarse aggregate	2.6
	Cement	3.12
	Alccofine	2.83
	Steel fiber	7.82
Sieve analysis	Fine aggregate	4.78
	Coarse aggregate	4.8
Water absorption	Fine aggregate	1.50%
	Coarse aggregate	0.51%

IV. EXPERIMENTAL RESULTS AND DISCUSSION

After conducting the preliminary tests for concrete ingredients, as per Indian standard IS: 10262-2009, concrete mix was designed for M25 grade mix. Mix ratio is 1:1.43:2.47:0.45. In this program 42 cube samples of size 150mm were casted for different percentages of steel fibers with optimum replacement of cement as the percentage of 10% alccofine, Workability test results are presented in Table 4. From the Table 4 and found that the workability of concrete goes on reducing while increasing of steel fibers with 10% of alccofine. From the test results slump value for the reference mix is 62 mm it is value goes on reducing up to 22 mm on increasing steel fibers with 10% of alccofine. Compressive strength after 7 days and 28 days test results are presented in Table 5. But on the contrary to slump values, compressive strength goes on adding steel fibers with 10% of alccofine. The compressive strength for reference mix 18.70 N/mm2, while adding steel fibers with 10% of alccofine the compressive strength was found to be increases up to 32.56 N/mm2 for 7 days curing. The compressive strength for reference mix 27.38 N/mm2, while adding steel fibers with 10% of alccofine the compressive strength was found to be increases up to 43.97 N/mm2 for 28 days curing. From figure 2 and 4 Max percentage improvement over reference concrete was found as 60.18 and 51.55. It can be easily predicted compressive strength for increasing steel fibers with 10% of alccofine concrete after 7 and 28 days curing by using best fit models shown in figure 3 and 5. All the values are closely matched with experimental values by referring R2 values as 0.951 and 0.978 from figures 3 and 5.

Table- IV: Workability Test on Concrete Cube

Mix	W/C Ratio	Water Content		Height in ('mm')		Slump Value in ('mm')
		%	Ml	Initial	Final	
CC	0.45	45	4950	300	238	62
R	0.45	45	4950	300	247	53
ASF_1	0.45	45	4950	300	253	47
ASF_2	0.45	45	4950	300	262	38
ASF_3	0.45	45	4950	300	269	31
ASF_4	0.45	45	4950	300	275	25
ASF_5	0.45	45	4950	300	278	22

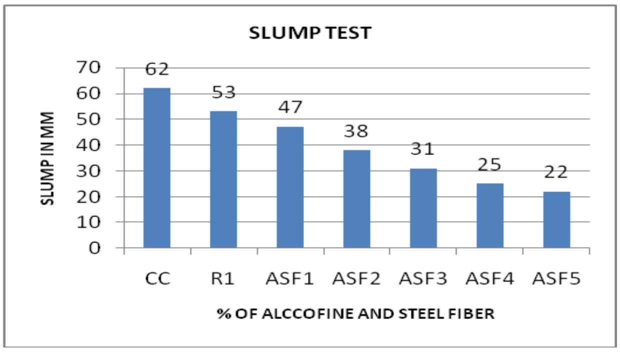


Fig. 1. Workability Test

Table- V: Compressive Strength Test on Concrete Cube

Mix	Compressive Strength N/mm^2 After	
	7 Days curing	28 Days curing
CC	18.70	27.38
R1	22.89	35.12
ASF1	23.42	37.18
ASF2	28.71	41.24
ASF3	29.63	42.91
ASF4	31.40	43.44
ASF5	32.56	43.97

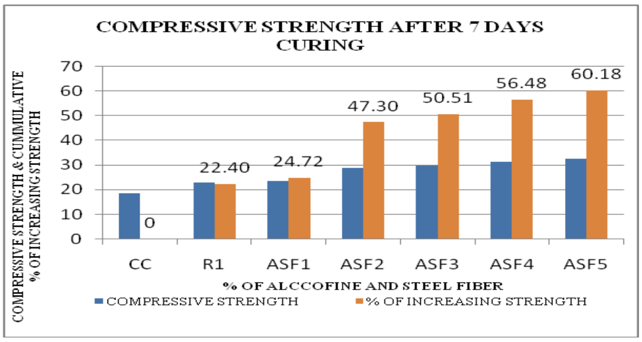


Fig. 2. Compressive strength & cumulative % of increasing strength after 7 days curing

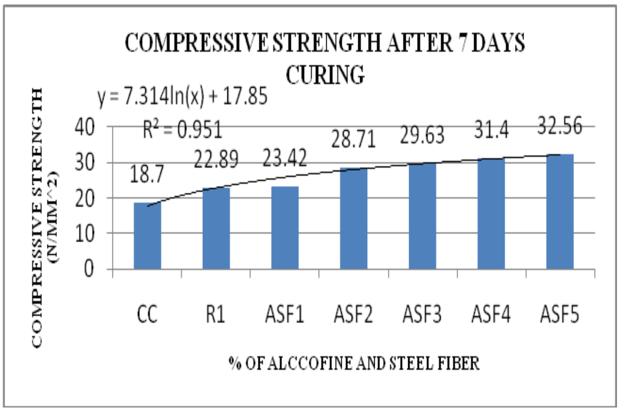


Fig. 3. Best fit model for compressive strength after 7 days curing

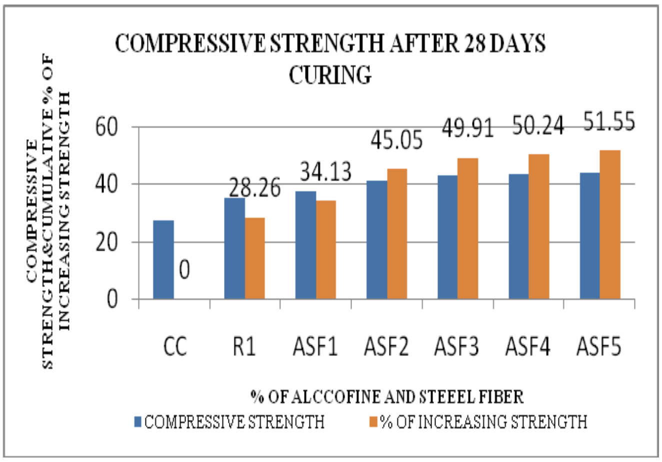


Fig. 4. Compressive strength & cumulative % of increasing strength after 28 days curing

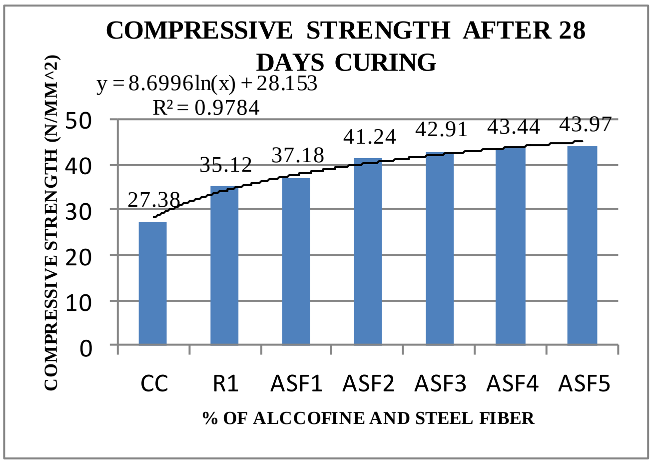


Fig. 5. Best fit model for compressive strength after 28 days curing

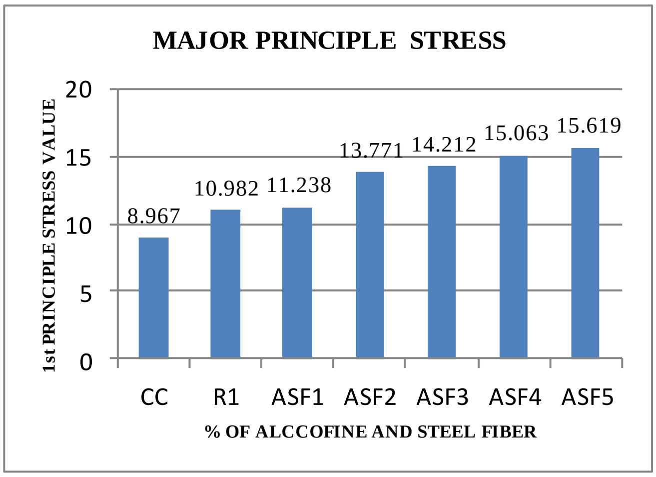


Fig. 6. Major Principle Stress (Tension) after 7 days curing curing

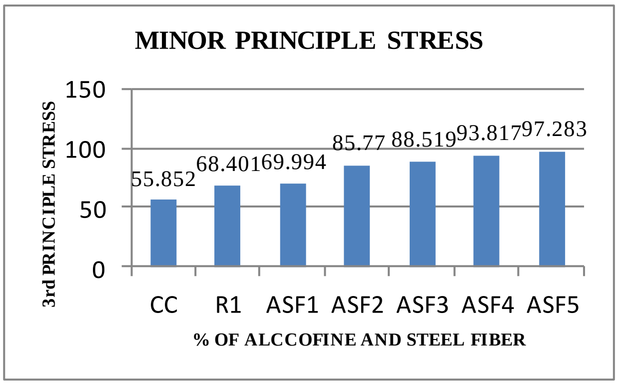


Fig. 7. Minor Principle Stress (Compressive –ve) after 7 days curing

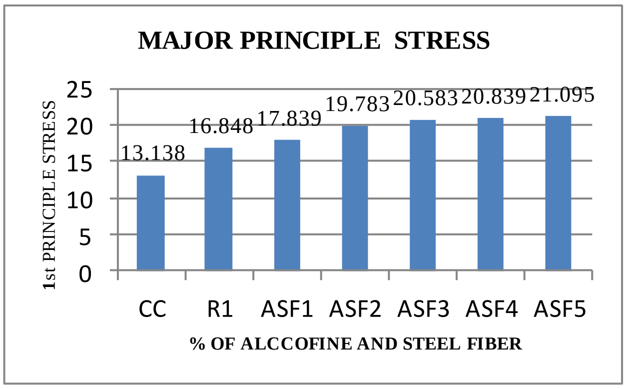


Fig. 8. Major Principle Stress (Tension) after 28 days curing

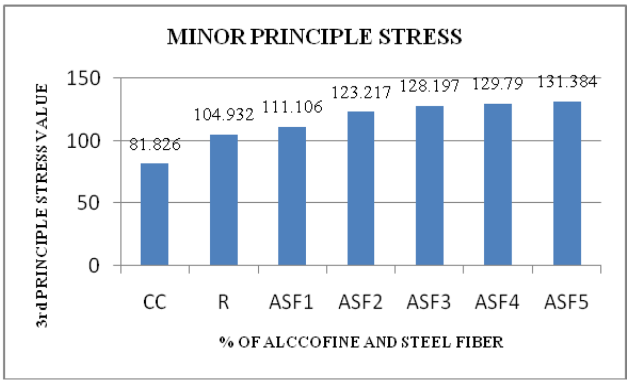
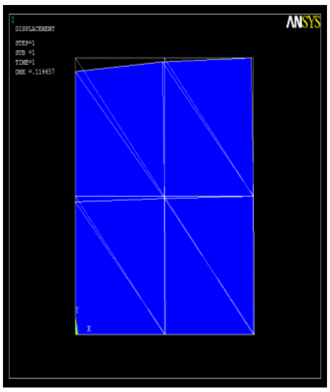
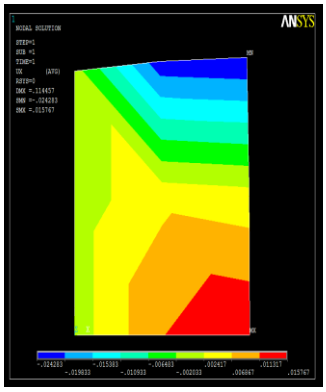
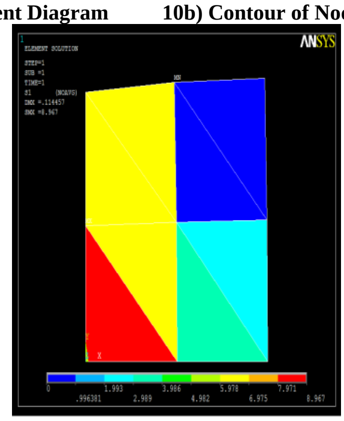


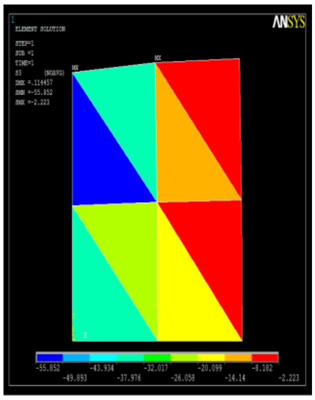
Fig. 9. Minor Principle Stress (Compressive –ve) after 28 days curing





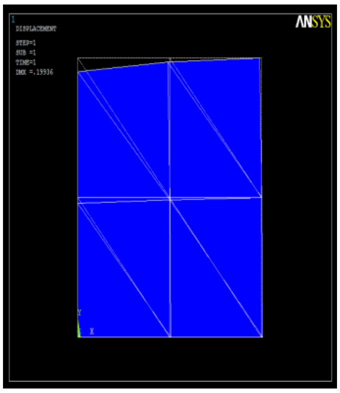
10a) Displacement Diagram **10b) Contour of Nodal Displacement**

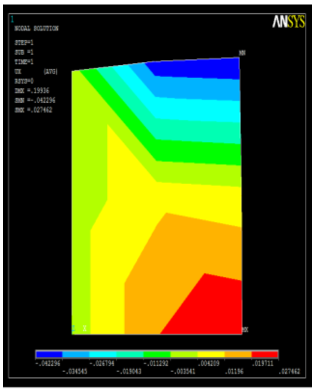




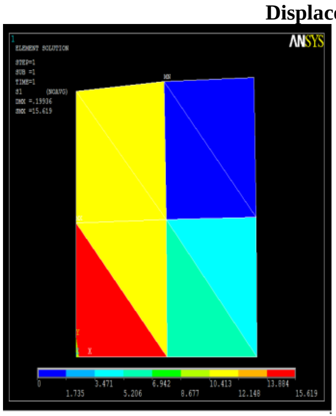
10c) Max Major Principle Stress **10d) Max Minor Principle Stress**

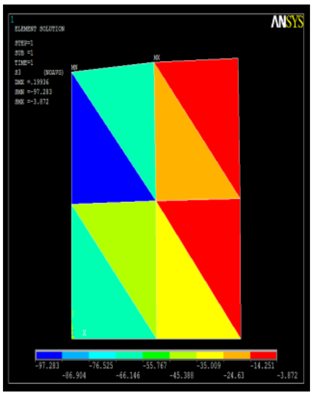
Fig. 10. Stress Contour of Concrete Mix After 7 Days Curing





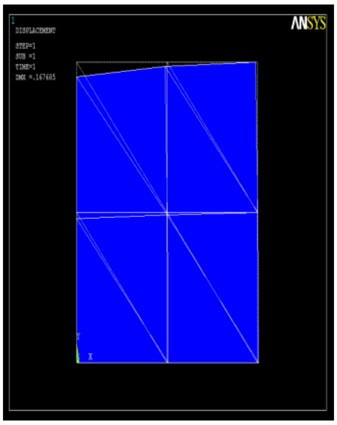
11a) Displacement Diagram 11b) Contour of Nodal Displacement

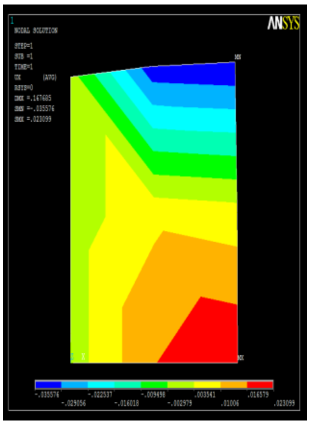




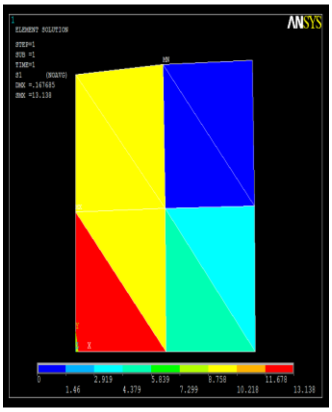
11c) Max Major Principle Stress 11d) Max Minor Principle Stress

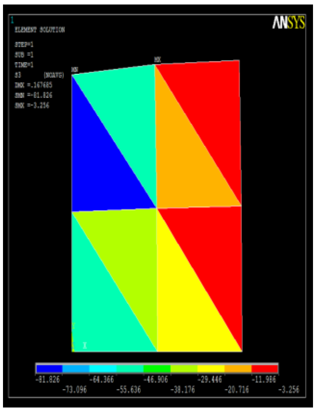
Fig. 11. Stress Contour of Concrete Mix with ASF5 after 7 Days Curing





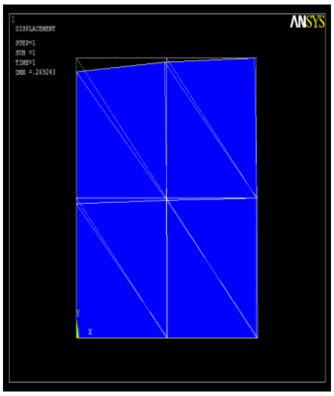
12a) Displacement Diagram 12b) Contour of Nodal Displacement

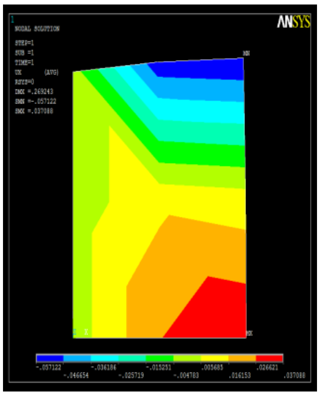




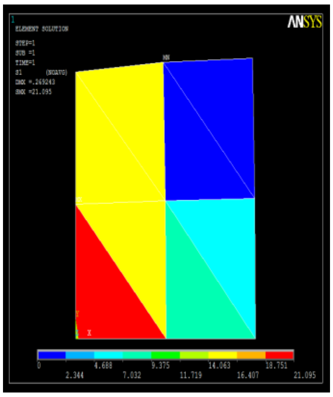
12c) Max Major Principle Stress 12d) Max Minor Principle Stress

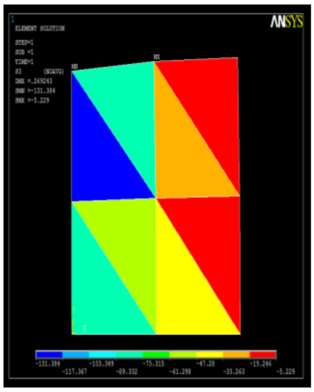
Fig. 12. Stress Contour of Concrete Mix after 28 Days Curing





13a) Displacement Diagram 13b) Contour of Nodal Displacement





13c) Max Major Principle Stress 13d) Max Minor Principle Stress

Fig. 13. Stress Contour of Concrete Mix with ASF5 after 28 Days Curing

V. RESULT AND DISCUSSION

The following conclusions were arrived based on the experimental results

1) From the workability test results, slump value slightly decreases with optimum replacement 10% alccofine with varying percentage of steel fibers in concrete.
2) Compressive strength of concrete mix ASF_5 has higher strength than reference mix after 7&28 days, when compared to other percentage of steel fiber. The compressive strength for reference mix 18.70 N/mm² and 27.38 N/mm². The compressive strength for ASF5 32.56 N/mm² and 43.97 N/mm².
3) Best fit models were developed for all the mixes for predicting compressive strength of experimental values. Graphs were

presented for all the experimental values and best fit models and found that both values were closely matched.

4) By using ANSYS software, concrete specimen were discretised after forming axis symmetric modeling, displacement and stresses contours were presented for tested concrete mixes.

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