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EXPERMENTAL STUDY OF MODULUS OF ELASTICITY DUE TO CHANGE IN STEEL FIBER REINFORCED CONCRETE AND SIZE OF AGGREGATES

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Abstract— This paper presents a experimental study considers the effect of aggregate size &steel fibers on the modulus of elasticity of concrete. The modulus of elasticity of concrete is a very important parameter reflecting the ability of concrete to deform elastically. Modulus of elasticity of high strength concrete is very important in avoiding excessive deformation, providing satisfactory serviceability, and avoiding the most cost-effective designs. The present experimental study considers the effect of aggregate size and steel fibers on the modulus of elasticity of concrete. Crimped steel fibers at volume fraction of 0%.0.5%, 1.0% and 1.5% were used. Study on effect of volume fraction of fibers and change of aggregate size on the modulus of elasticity of concrete was also deemed as an important part of present experimental investigation. This work aims in studying the mechanical behavior of concrete in terms of modulus of elasticity with the change of aggregate size reinforced with steel fibers of different series for M30 and M50 grade concretes.

Index Terms— steel fibers, different size of aggregates, compressive test, split tensile test, cement, water, vibrator, weighing machine

1.Introduction

The usage of fibers from the past few years was increasing drastically. Due to its flexibility in usage and accuracy in attaining required properties fiber RCC usage is increasing day by day. [6] To make its usage more feasible engineering properties like Compressive &tensile strength, flexible strength, durability, flexural toughness and resistance to impact, various changes are to be adopted [2]. There by the mechanical properties depend on type, size, shape, surface texture of aggregates and the amount of fiber added[1]. SFRC is being increasingly used to improve static and dynamic tensile strength, energy absorbing capacity and better fatigue strength.To avoid miscellaneous properties like wise honey combing, bleeding& segregation to fresh concrete and spiking, cracking to horded concrete, the change in the workability properties should be implemented [5].This paper suggests a new volume fraction of fibers to be used in producing SFRC with in 0.5% to 1.5%.the addition of fibers [3] may reduce the workability of the mix & will cause balling which will be extremely difficult to separate by vibration [8]. The experimental observations indicated that with an increase in volume of fibers strength and toughness and peak stress increases with a slight reduction in young's modulus. The main advantages of these fibers fast& perfect mixable fibers & high performance and crack resistance, optimization costs with lower fiber dosages, steel fibers reduces the permeability & water migration in concrete[5]. From this work it is observed that with increase in % volume of fibers the young's modulus decreases with an increase in strain fraction [7].

2. Existing techniques:

The influence of the fiber distribution and orientation on the post-cracking behavior of steel fiber reinforced self-compacting concrete. A result data obtained has been analyzed and compared with a control specimen (0% fiber). However higher percentage of fiber can be used with special fiber adding techniques and also placement procedures. According to ACI 544, 3R-08, aspect ratio is referred to the ratio of fiber length over the diameter. The normal range of aspect ratio for steel fiber is from 20 to 100. Aspect ratio of steel fiber greater than 100 is not recommended, as it will cause inadequate workability, formation of mat in the mix and also non uniform distribution of fiber in the mix.

It is found that the splitting tensile test overestimates the post-cracking parameters. Specimens with notched plane parallel to the concrete flow direction show considerable higher post-cracking strength than specimens with notched plane perpendicular to the flow direction.

3. Contribution:

This is an experimental set up of casting SFRC cylindrical specimens standard size with change of aggregate sizes such as 20mm,16mm,10mm and with varying percentages of fibers such as 0%,0.5%,1% &1.5% to study the stress-strain relationship in tension & compression aspect ratios of steel fibers used in concrete mix are varied between 50 and 100.

The experimental program was designed to determine the modulus of elasticity of M30 & M50 grade concrete standard cylinders for M30/20 mix proportion 0.46:1:1.26:3.12 and M50/20 mix proportion 0.39:1:0.74:3.08 under the compression and split tensile tests.

3.1 Test procedure: This experimental program consists of twenty four cylinders for each grade namely M30/20mm/0 % ,M30/20mm/0.5 % ,M30/20mm/1%,M30/20mm/1.5%,M30/16mm/0%M30/16mm/0.5%,M30/16mm/1%,M30/16mm/1.5%,M30/10mm/0%,M30/10mm/0.5%,M30/10mm/1%,M30/10mm/1.5%forM30gradeandM50/20mm/0%,M50/20mm/0.5%,M50/20mm/10%,M50/20mm/1.5%,M50/16mm/0%,M50/16mm/0.5%,M50/16mm/1%,M50/16mm/1.5%,and0/10mm/0%,M50/10mm/0.5%,M50/10mm/1% ,M50/10mm/1.5% for M50 grade concrete. The arrangement of the cylindrical specimen subjected to split tensile loading and compressive loading.

3.2 Compression test: Then place the cylinder in test setup and apply the load continuously without any After 28 days curing, the cylindrical specimens were tested in the compression testing machine of capacity of 200 tons. An extensometer of gauge length 200mm and a least count of 0.002mm has been used to note the deformation values. So a cylinder mounted with an extensometer was used to find out the deformation values during loading. The vertical strips of extensometer were removed before placing the cylinder in test setup so as to avoid the damage of extensometer during loading shock to note the deformation values. And stop the applying of the load after the specimen has failed. The compressive strength of the specimen can be calculated by

Compressive strength (MPa) = Failure load / cross sectional area

3.3 Split tensile test: In Split tensile strength test, cylinder specimens of dimension 150 mm diameter and 300 mm length were cast. The specimens were demoulded after 24 hours of casting and were transferred to curing tank where in they were allowed to cure for

28 days. The strain gauges of 350Ω resistance capacity and a gauge factor of 2.1 have been used to note the strain values. After the strain gauges have been attached to the specimens, they were tested under compression testing machine of Capacity 200 tons. Split Tensile strength was calculated as:

Split Tensile strength (MPa) = $2P / \pi DL$ Where ,P=failureload, D=diameter of cylinder,

L = length of cylinder.

4. Results:

4.1 Modulus of elasticity in compression: the failure stress values increases with the increase of steel fiber content. And the percentage increase in failure stresses were 51.8%, 45.8% and 57.14% for M30 grade and 38.5%, 40% and 35.71% for M50 grade concrete. The following are the graphs showing the relationship between stress and strain of casted specimens after testing in compression.

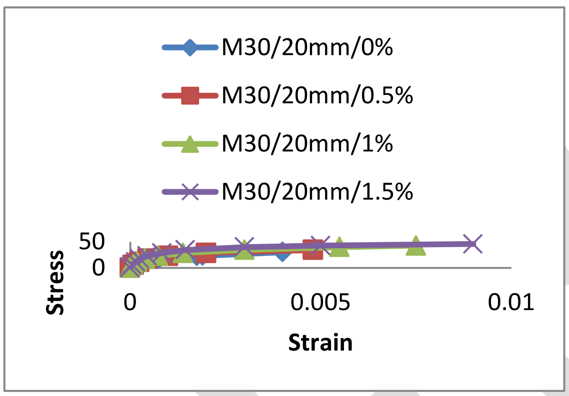

Fig1:Stress Vs strain graph for M30/20mm

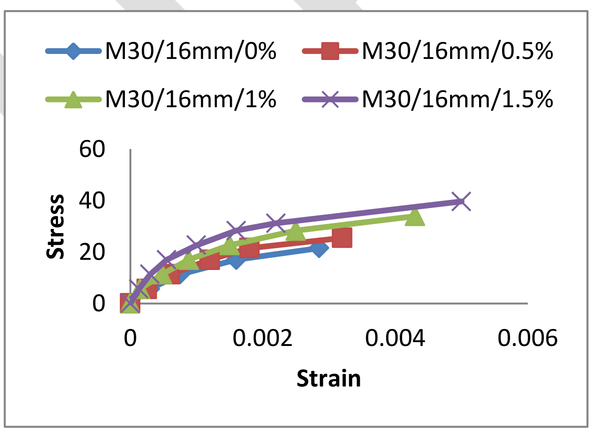

Fig2:Stress Vs strain graph for M30/16mm

Percentage increase in modulus of elasticity of steel fiber based concrete mixes were 118.36%, 117.42% and 326.2% for M30 grade and 140%, 92.76%and 120.6% for M50 grade concrete

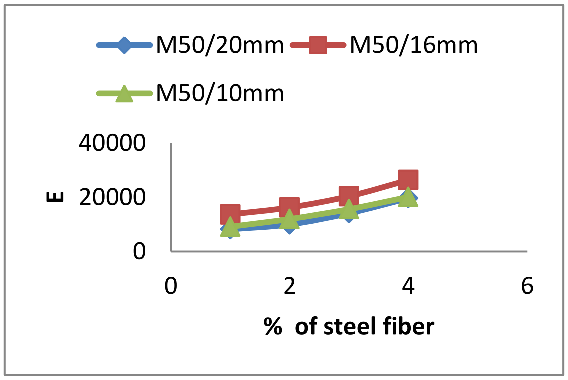

Fig3:E Vs % of fiber for m50

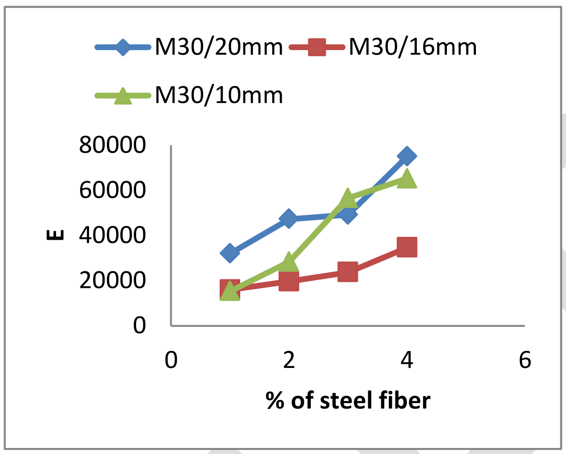

Fig 4: E Vs % of fiber for M30

The percentage increase in modulus of elasticity of steel fiber reinforced concrete at 33% of the maximum stresses were 45.8%,60% and 60% for M30 grade, and 38.83% ,50% and 43.32% for M50 grade concrete. **4.2 Modulus of elasticity in tension:** It is observed that the failure stresses were increased with the increase of steel fiber content. And the percentage increase in failure stresses were 45.8%, 60% and 60% for M30 grade and 38.72%, 50% and 50% for M50 grade concrete. The following are the graphs showing the relationship between stress and strain of casted specimens after testing in tension

The percentage increase in modulus of elasticity of steel fiber reinforced concrete at 33% of the maximum stresses were 45.8%,60% and 60% for M30 grade, and 38.83% ,50% and 43.32% for M50 grade concrete

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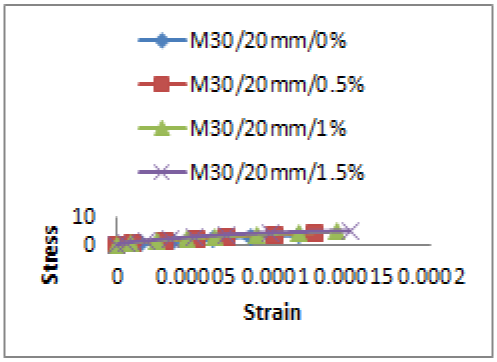
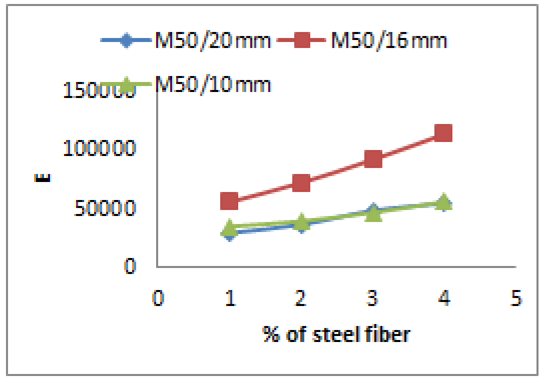
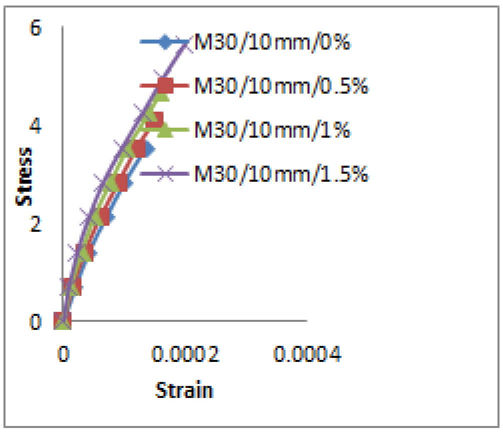


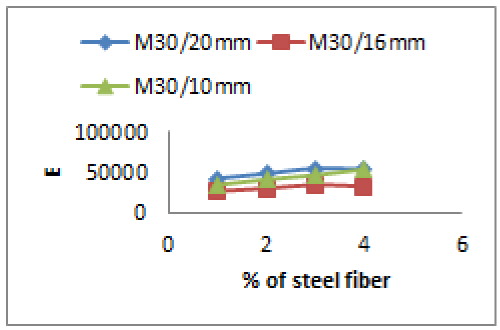
\ Fig 5:Stress strain graph for M30/20



\ Fig7: EVs%of steel fiberforM50



\ Fig 6:Stress strain graph for M30/10



\ Fig 8:EVs%of steel fiberforM30

The relationship between ultimate stress (σ_U) and % of steel fiber content and the percentage increase in the ultimate stress were 45.8%, 60% and 60% for M30 grade, and 38.72% ,50% and 50% for M50 grade concrete

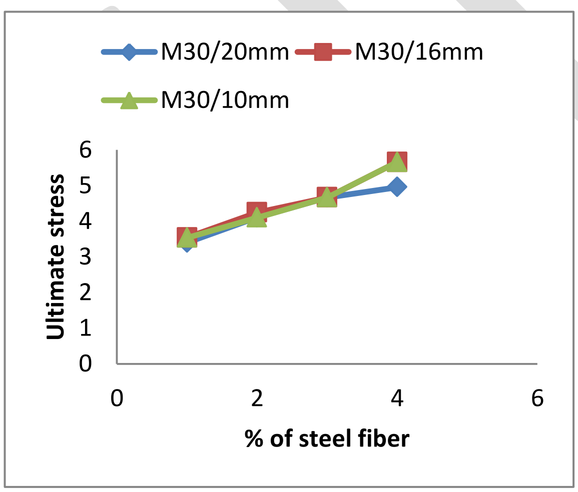


Fig 9:σ_UVs%ofsteelfiberforM30

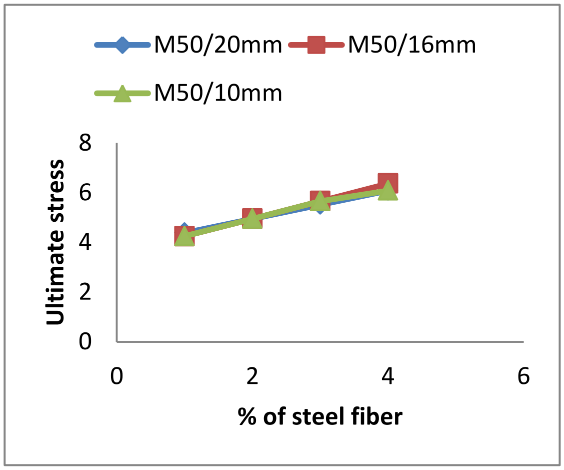


Fig 10:σ_U Vs%ofsteelfiberforM50

Conclusion: It is observed that,the failure stresses increased with the increase of steel fiber content [i.e.0-1.5%] as 51.8%,45.8% and 57.14% for M30 grade and 38.5% ,40% and 35.71% for M50 grade concrete in compression and 45.8%,60% and 60% for M30 grade and 38.72%, 50% and 50% for M50 grade concrete in tension. It is also observed that,the modulus of elasticity (E) value increases with the increase of steel fiber content.It is also observed that,the ultimate stress and modulus of elasticity (E) value were increased with the decrease of aggregate size . From the comparisions of compression and tension reults,it was cleared that the ultimate stress values in tension were higher than those in compression.i.e,5 times for M30 and 14 times for M50 grade concretes.

The modulus of elasticity (E) values in tension were higher than those in compression. i.e,94 times for M30 and 55 times for M50 grade concretes.

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