ANALYSIS ON STRENGTHENING OF RC FRAME BY SIFCON LAMINATES USING ANSYS

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Abstract - *Nowadays natural and man-made disasters play an important role in the design of structural members. The structures have to be designed in a good manner to resist higher seismic and impact forces. Strengthening of the existing RC framed buildings for seismic resistance is a challenging engineering problem. A lot of research work is being done in this field to find an effective and economic technique. One such strengthening technique includes the use of SIFCON laminates. SIFCON (Slurry infiltrated fibrous concrete) is an innovative construction material possessing high strength, improved ductility, impact resistance, and enhanced energy absorption capacity. Structural members possessing inadequate strength may be strengthened by externally bonding the members with SIFCON laminates. This study deals with the strengthening of the RC frame with externally bonded SIFCON laminates. Here the load-deflection response of the RC frame with and without SIFCON laminates will be analyzed using ANSYS. For validation, a simply supported concrete beam was considered and analyzed in ANSYS 18.1 then the load-deflection values were determined. Three types of fiber volume (8%, 10%, and 12%) and three various thicknesses (10mm, 15mm, 20mm) were discussed in this investigation. The deflection value was decreased by increasing the fiber volume and thickness of the laminates. Even though the failure of beams and excessive deflection of beam do not fail suddenly due to the use of U-wrapping of SIFCON laminates.*

***Key Words*: Fiber, Laminates, RC frame, Load- deflection, ANSYS.**

1. INTRODUCTION

Reinforced concrete structural members often have to face modification and improvement of their performance during their service life. The main changes contributing factors are changing in their use, new design standards, deterioration due to corrosion in the steel caused by exposure to an aggressive environment, and accident events such as earthquakes etc. In such circumstances, there are two possible solutions: replacement or strengthening. Full structure replacement might have determinate disadvantages and difficulty such as high costs of labor and material, a stronger environmental impact, and inconvenience due to interruption of the function of the structure e.g. traffic problems. When possible, it is often better to repair or upgrade the structure by strengthening. In the last decade, the development of strong epoxy glue has led to a technique that has great potential in the field of upgrading structures. The technique involves gluing steel plates or fiber-reinforced polymer (FRP) bars to the surface of the concrete.

SIFCON is a high-strength, high-performance material containing a relatively high volume percentage of steel fibers as compared to steel fiber reinforced concrete (SFRC). It is 'high- volume fibrous concrete'. If the percentage of steel fibers in a cement matrix could be increased substantially, then a material of very high strength could be obtained, which he christened as SIFCON. While in conventional SFRC, the steel fiber content usually varies from 1 to 3 percent by volume, it varies from 4 to 20 percent in SIFCON depending on the geometry of the fibers and the type of application. The process of making SIFCON is also different, because of its high steel fiber content. While in SFRC, the steel fibers are mixed intimately with the wet or dry mix of concrete, prior to the mix being poured into the forms, SIFCON is made by using infiltrating a low-viscosity cement slurry into a bed of steel fibers 'pre-packed' in forms/ moulds. SIFCON has high cementitious content without coarse aggregates. However, it may contain additives such as fly ash, micro silica, and latex emulsions. The matrix fineness must be designed so as to properly penetrate (infiltrate) the fiber network placed in the moulds, since otherwise, large pores may form leading to a substantial reduction in properties. A quantity controlled of high - range water -reducing admixture (super plasticizer) may be used for improving the flowing characteristics of SIFCON. All types of steel fibers, namely, straight, hooked, or crimped can be used. The HPFRCCs were developed in the 1990's to improve the performance characteristics of fiber reinforced concrete. The objectives of works are;

1. To study the performance of RC beam with and without SIFCON laminates.
2. To analyze the load- deflection response using ANSYS.
3. Comparison of SIFCON laminates with various thicknesses and various fiber volumes.

2. STRENGTHENING OF RC FRAME

Slurry infiltrated fibrous concrete (SIFCON) is another type of high performance fiber reinforced concrete made by using infiltrating steel fiber bed with a specially designed slurry of cement. Various experiments in SIFCON have shown that

SIFCON is an innovative construction material possessing both high strength and large ductile, for reinforced concrete members, SIFCON used as an externally bonded strengthening material.

2.1 Model Details

M20 grade concrete is used for the RC frame. For the laminate, hooked end steel fiber of 0.5mm diameter, 30mm length, and aspect ratio of 60 is used. The fiber volume various from 8%, 10%, 12%, and mix ratio (cement: fine aggregate) is 1:3 is used for the making of SIFCON laminates. The thickness of laminates various from 10mm, 15mm, 20mm. Dimension of the column is about 120x120x1000mm, beam of 120x120x1000mm and footing of 120x120x1400mm.

2.2 Modeling and Meshing

The RC frame was modeled with SIFCON laminates three faces of the beam. SIFCON laminates with various thicknesses and various fiber volumes were modeled. The meshing of a beam as fine mesh of element size 0.02mm was provided.

2.3 Supports and Loading

Fixed support was provided at the right and left sides of the frame. The point load was applied at the mid span of the beam.

3. MODEL STUDY

3.1 Model with No Laminates

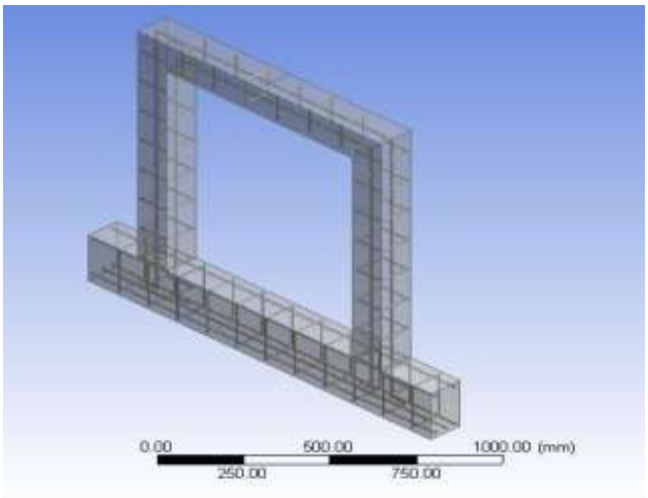

Fig -1: Model with no laminates

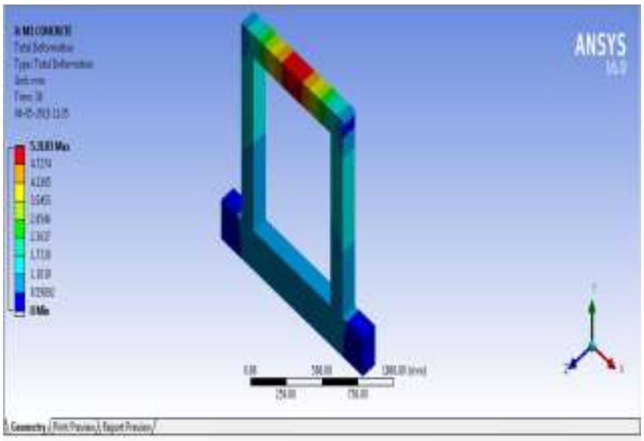

Fig -2: Deformation

3.2 Model 2

SIFCON laminates of 10mm thickness and fiber volume of 8%.

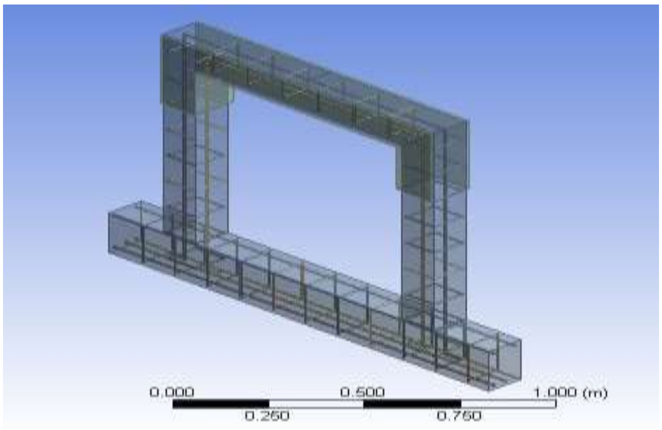

Fig -3: Model 2

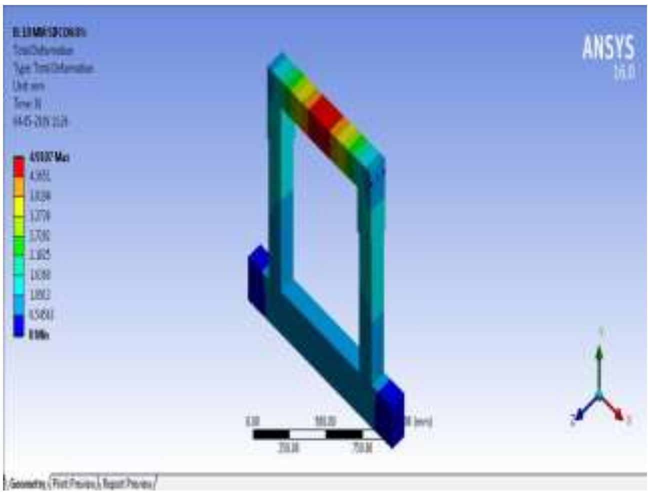

Fig -4: Deformation

3.3 Model 3

SIFCON laminates of 10mm thickness and fiber volume of 10%.

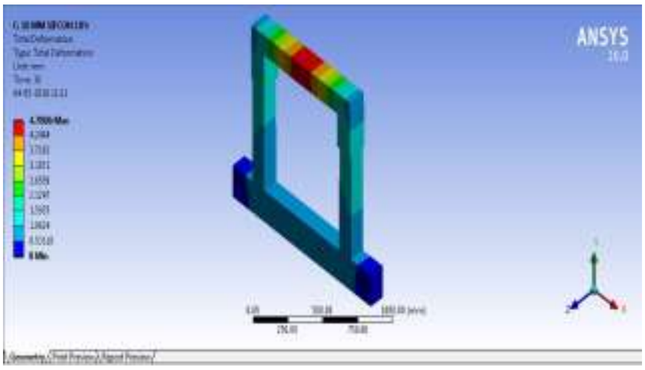

Fig -5: Deformation

3.4 Model 4

SIFCON laminates of 10mm thickness and fiber volume of 12%.

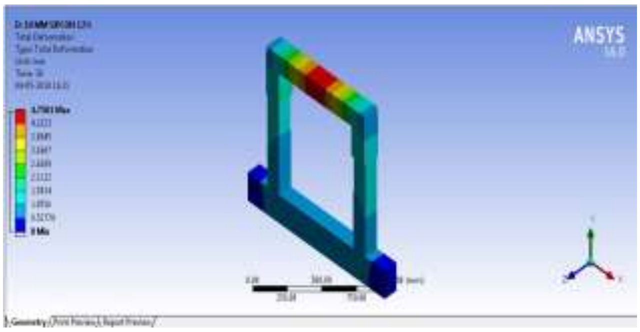

Fig -6: Deformation

3.5 Model 5

SIFCON laminates of 15mm thickness and fiber volume of 8%.

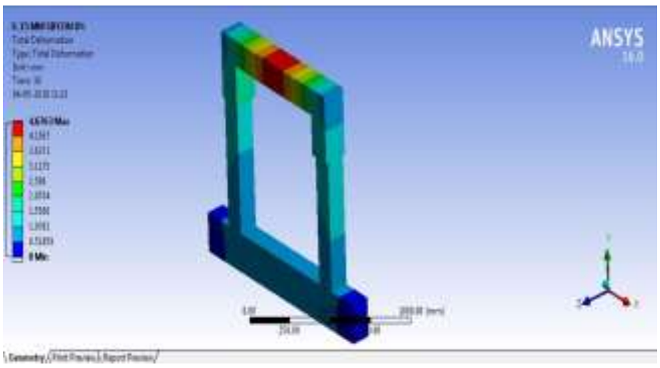

Fig -7: Deformation

3.6 Model 6

SIFCON laminates of 15mm thickness and fiber volume of 10%.

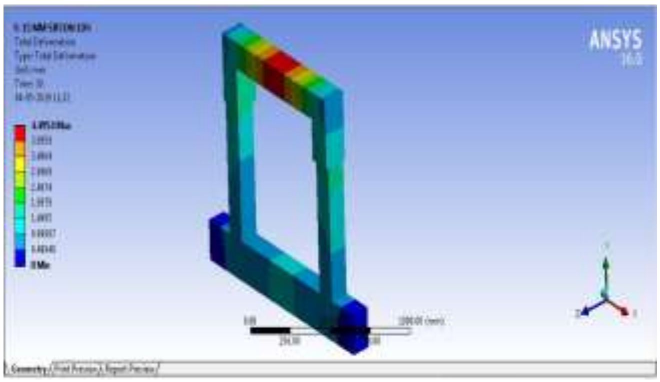

Fig -8: Deformation

3.7 Model 7

SIFCON laminates of 15mm thickness and fiber volume of 12%.

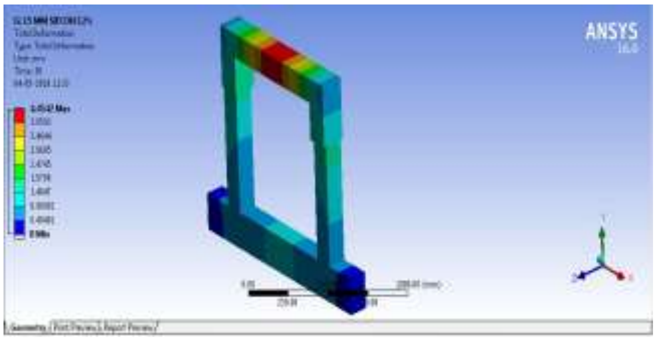

Fig -9: Deformation

3.8 Model 8

SIFCON laminates of 20mm thickness and fiber volume of 8%.

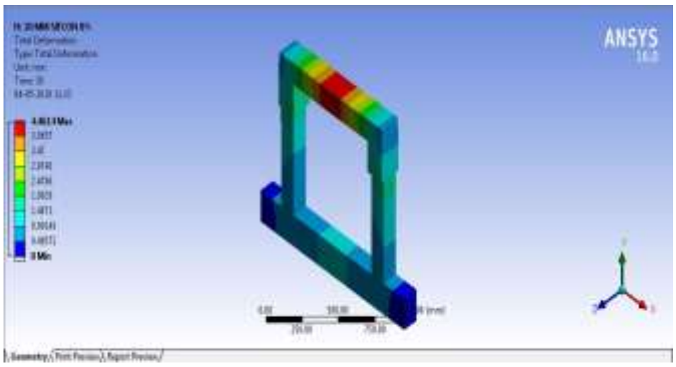

Fig -10: Deformation

3.9 Model 9

SIFCON laminates of 20mm thickness and fiber volume of 10%.

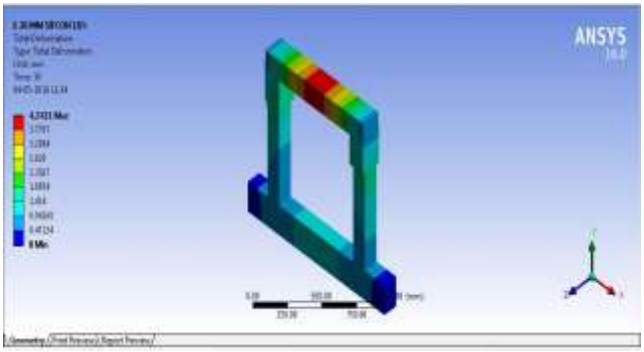

Fig -11: Deformation

3.10 Model 10

SIFCON laminates of 20mm thickness and fiber volume of 12%.

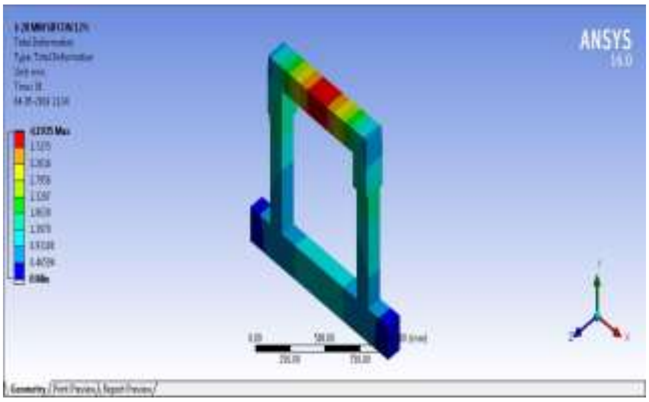

Fig -12: Deformation

Table -1: Comparison of maximum deflection

Sl. No	Models	Max. Deflection (mm)
1	Model 1	5.3183
2	Model 2	4.9107
3	Model 3	4.7806
4	Model 4	4.7501
5	Model 5	4.6763
6	Model 6	4.4954
7	Model 7	4.4542
8	Model 8	4.4614
9	Model 9	4.2421
10	Model 10	4.1935

4. CONCLUSION

Strengthening of the frame by the SIFCON laminates decreases the deflection values, due to the increasing of laminates thickness and fiber content. Various types of fiber are used in various studies of SIFCON laminate production, based on the type it affects the structural strength. Failure of the structure can be delayed by using SIFCON laminates. U-wrapping is the most effective way of using laminates; it offers a higher strength to the structure. After the failure of beams and excessive deflection, beams do not fail suddenly due to the use of U- wrapping of SIFCON laminates. By strengthening, the performance of the weakest structure can be improved and it will protect many lives from sudden failure. Additionally, no minimum concrete cover is needed to prevent corrosion of the reinforcement, if laminates are provided.

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