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Finite Element Analysis of RC Beams with Externally Bonded SIFCON and SIMCON Laminates using ANSYS

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***Abstract*- As the number of civil infrastructure systems increases worldwide, the number of deteriorated buildings and structures also increases. Complete replacement is likely to be an increasing financial burden and might certainly be a waste of natural resources if upgrading or strengthening is a viable alternative. This paper presents the results of analytical studies concerning the flexural strengthening of RC beams using externally bonded High Performance Fibre Reinforced Cementitious Composites (HPFRCCs) like Slurry Infiltrated Fibre CONcrete (SIFCON) and Slurry Infiltrated Mat CONcrete (SIMCON). Models of RC beams were made with both SIFCON and SIMCON and a conventional beams. Two types of beams are selected i.e., normal and ring beams. U wrapping of laminates are done. Comparisons were made between analytical results of SIFCON and SIMCON.**

Keywords — Fibre Reinforced Cementitious Composites (HPFRCCs), Slurry Infiltrated Fibre CONcrete (SIFCON) and Slurry Infiltrated Mat CONcrete (SIMCON)

1)INTRODUCTION

The development of civil infrastructure is one of the main factors that uses the national wealth in the form of money as well as resources. In present days new techniques and methods are experimented in the civil engineering field to have better infrastructure. The early day deterioration of reinforced concrete structures has invoked an urgent need for the development of promising, long-lasting and economic methods for repair, retrofit and new construction.As the civil infrastructure develops worldwide, the number of deteriorated structures also increases. Complete replacement of buildings is much expensive
and will result in the wastage of natural resources, which may be saved or used for other purposes, if the building is more durable. This is why upgrading or strengthening of various structural elements has got much importance. A promising new way of strengthening is using advanced composites like High-Performance Fiber Reinforced Cementitious Concrete (HPFRCC). HPFRCCs are a group of fibre-reinforced cement based composites which possess unique ability to flex and self-strengthen before fracturing. Another desirable property of HPFRCCs is their low density, which requires less energy to produce and handle. They are combination of fine aggregates, a super plasticizer, polymeric or metallic fibres, cement and water. Two types of HPFRCCs are SIFCON (Slurry infiltrated fibre concrete) and SIMCON (Slurry infiltrated mat concrete). They are combination of cement, fine aggregate, fly ash, micro silica and steel fibres. They are high strength, high performance material containing high volume percentage of steel fibres.

2) OBJECTIVES

- To study behavior of externally bonded RC elements with U wrapped SIFCON and SIMCON laminates.
- To develop finite element model in ANSYS and study the behavior of RC elements

3)SCOPE

The focus of this study is to determine if a RC beam is strengthened using SIFCON and SIMCON laminates and study the load deformation characteristics of the strengthened beam and compare it with conventional beam.

3) MODELING

Total number of 6 beams are made. 3 models each for normal and ring beams are made. One among them is conventional and other two are strengthened beams with SIFCON and SIMCON laminates. Laminates are U wrapped on the beams.

Size of the normal beam is 125X250 mm. Length of the beam is 3000mm. Longitudinal reinforcement provided is 2 no.s of 10mm dia bars at top and 2 no.s 12mm dia bars at bottom. Transverse reinforcement provided is 6 mm dia bars at 150mm c/c. Size of the ring beam is 125X250 mm. Length of the ring beam is 6500mm. Diameter of the ring beam is 2125mm. Longitudinal reinforcement provided is 4 no.s of 12mm dia bars. Transverse reinforcement provided is 6 mm dia bars at 150mm c/c. Grade of concrete is M25. Thickness of laminates is 25mm. Type of loading is two point loading.

Density, compressive strength, Tensile strength and modulus of elasticity of SIFCON laminates are 1950 kg/m^3, 90.20 N/mm^2, 14 N/mm^2 and 3.05×10^4 N/mm^2 respectively. Density, compressive strength, Tensile strength and modulus of elasticity of SIFCON laminates are 18000 kg/m^3, 88 N/mm^2, 17 N/mm^2 and 2.7×10^4 N/mm^2 respectively. Figures of models are given below.

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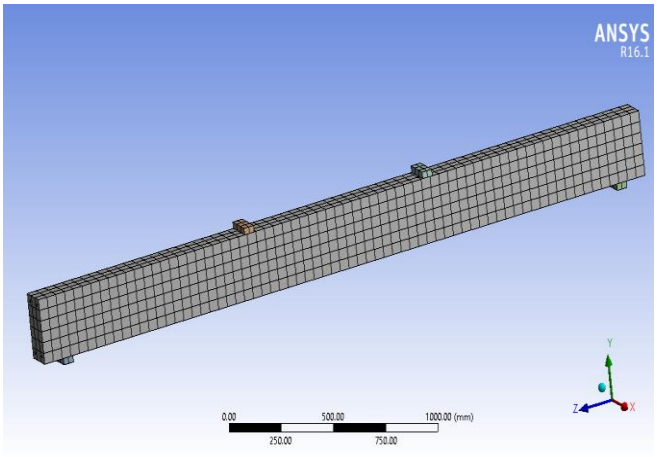

Figure 1 Normal beams without laminates

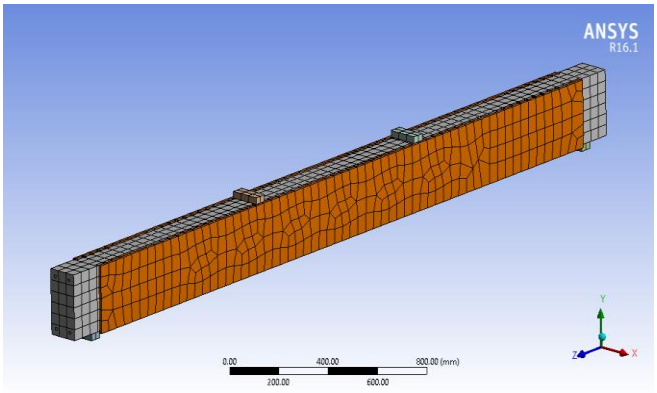

Figure 2 Normal beams with laminates

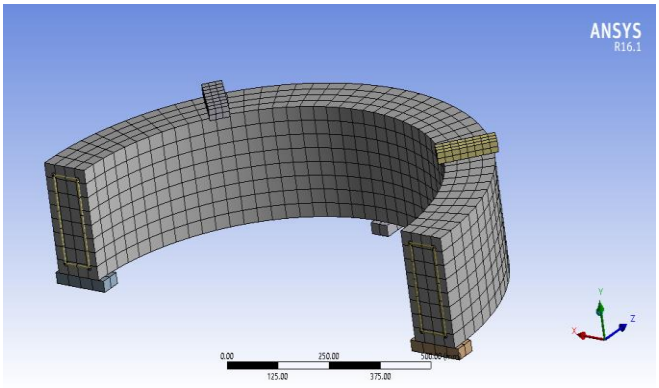

Figure 3 Ring beams without laminates

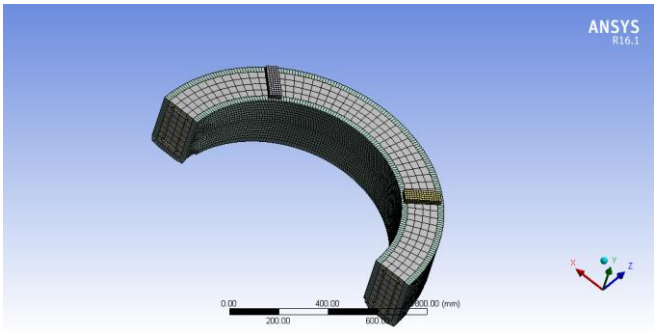

Figure 4 Ring beams with laminates

4) RESULT

1. Normal beams.

The deformed shape of models are given below

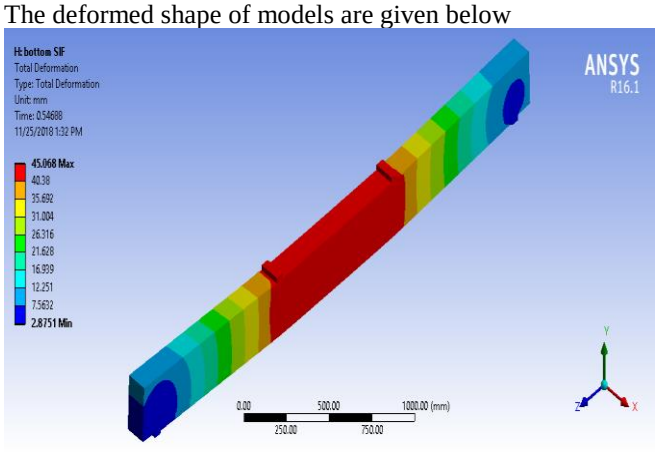

Figure 5 Normal beams without laminates

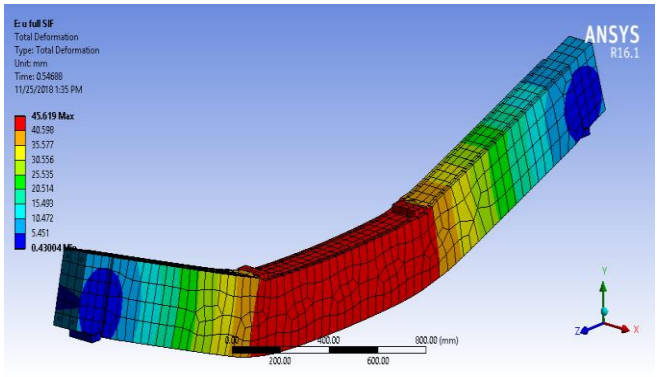

Figure 6 Normal beams with laminates

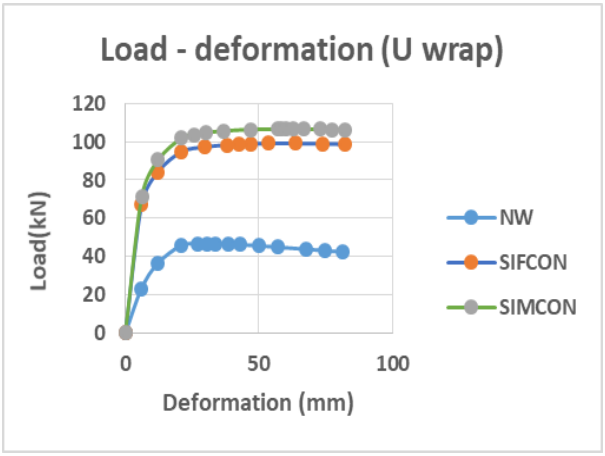

Figure 7 Load deformation graph of normal beams

The above graph shows load deformation graph of normal beams. NW denotes the beam is without laminates. SIFCON denotes the beam is with SIFCON laminates and SIMCON denotes the beam is with SIMCON laminates.

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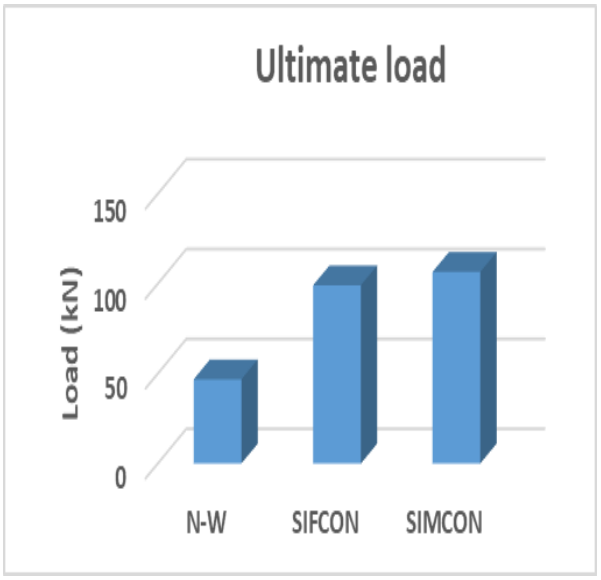

Figure 8 Ultimate load of normal beams

The bar chart shows the ultimate load values of NW , SIFCON and SIMCON respectively.

2. Ring beams

The deformed shape of models are given below

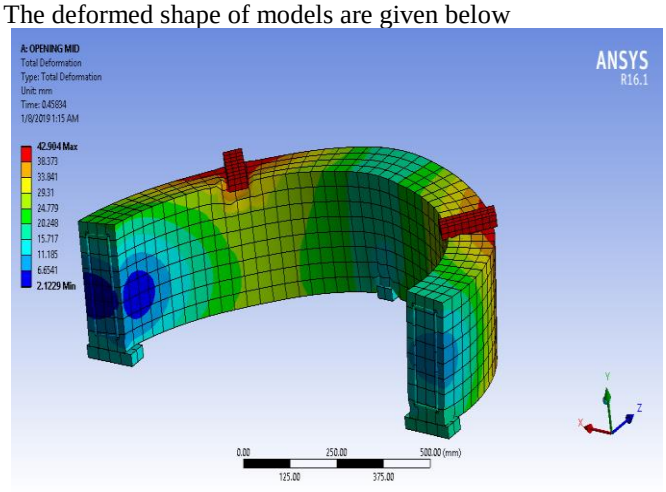

Figure 9 Ring beams without laminates

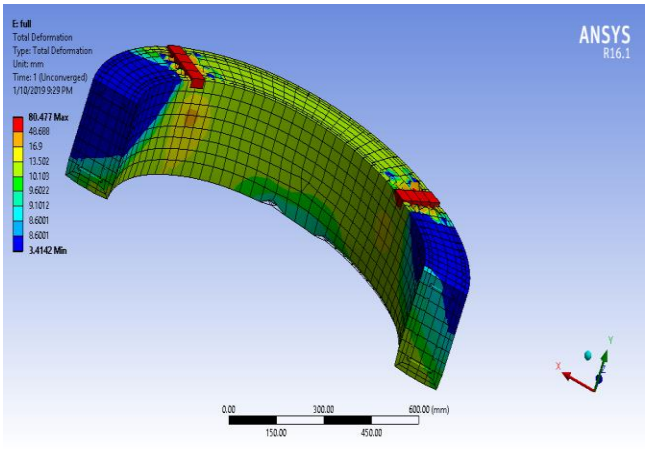

Figure 10 Ring beams with laminates

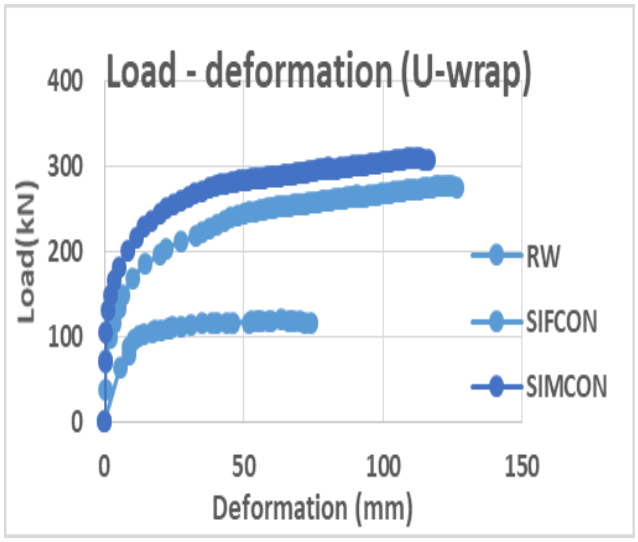

Figure 11 Load deformation graph of ring beams

The above graph shows load deformation graph of normal beams. RW denotes the ring beam is without laminates. SIFCON denotes the beam is with SIFCON laminates and SIMCON denotes the beam is with SIMCON laminates

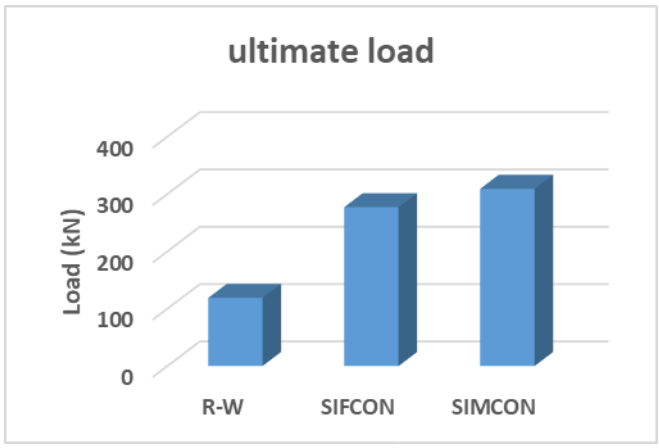

Figure 12 Ultimate load of ring beams

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The bar chart shows the ultimate load values of RW, SIFCON and SIMCON respectively.

4) CONCLUSIONS

- By strengthening of beam using SIFCON and SIMCON, Ultimate load carrying capacity have increased.
- Beams strengthened using SIMCON laminates have more load carrying capacity.
- In case of normal beams for SIFCON and SIMCON laminates, the ultimate load value is 111.6% and 127.78 % respectively are more than that of the conventional beam.
- In case of ring beams for SIFCON and SIMCON laminates, the ultimate load value is 134.43% and 159.01%respectively are more than that of the conventional beam.

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- In case of normal and ring beams for SIMCON laminates, the ultimate load is 14.91% and 11.54% respectively are more than that of the beam with SIFCON laminates.

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