# Strengthening of flexural and shear deficient RCC beam with nano composite jacketing

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**Abstract** - *Retrofitting of structures has become an inevitable in the construction activity. It is necessary to improve the load carrying capacity of damaged structural members and it could be achieved by strengthening externally, through a jacketing technique. For the case of beam, various types of solutions were introduced as a part of strengthening the deformed structure. One of the main solutions to strengthen the deformed beam is by providing ferrocement jacketing. In order to strengthen and improve the performance of the deformed beams, it is need to find out the best method of providing jacketing. For that, here conduct analysis by change in length of jacketing. Then findout the parameters like ultimate deflection, ultimate load and ductility of the beam.. The main objective of the study is to compare different models and identify the best method of providing jacketing which enhance both ultimate loads carrying capacity and ductility of the beam.*

***Key Words***: **ANSYS, Ferrocement , Two point load, Nano SiO2 based mortar, Retrofit**

## 1. INTRODUCTION

Ferrocement Jacketing is preferred as one of the acceptable and viable way for strengthening of structural members. As per ACI committee, Ferrocement is a thin construction element with thickness in the order of 10–25 mm, which comprises of rich cement mortar and steel wire mesh as the main reinforcing material for confinement of the structural elements. For ferrocement mortar, 3% nano silica based cementitious matrices are used for jacketing.

The structural element like beam is mainly undergo flexural and shear deformation. In order to improve the strength of structural deficient beam , here select a flexural and shear deficient beam. And provide jacketing at different length at bottom of the structurally deformed beam. Two point loading is provided on different beams with simple supports at both ends. The analysis of the beams conducted using ANSYS software, such that the parameters like total deformation , load carrying capacity, ductility of different beams are studied and compare to find out the best method of jacketing to improve the strength of deformed beam.

## 2. OBJECTIVES

• To create models of different structurally deficient beams with jacketing at different length.

• To analyse and compare the parametric effect like ultimate deflection, ultimate load and ductility improvement of nano composite strengthened beam.

## 3. METHODOLGY

The study's major goal is to improve the strength and performance of deformed beams in terms of ductility and ultimate load carrying capacity. For the beam specimen, surface of the beam were cleaned and roughened. The beam were wrapped with square and expanded wire mesh. A 10 mm thick cement mortar was applied to the surface of the beam. For that 3% of nanosilica could be used as a flowable nano $SiO_2$ based mortar. A 10 mm flowable nano $SiO_2$ based mortar was applied to the surface of beam. The ferrocemnt retrofitted beam specimens were left for curing. Then, the beam specimens are tested for two point load in a loading frame. Complete analysis is performed using the ANSYS WORKBENCH software.

## 4. NUMERICAL STUDY

### 4.1 Modelling of beam

The beam with rectangular cross section was selected . From references the selected beams had a cross section (width and thickness) of 150 × 300 mm and were 2.0 m length . One bottom layer of two 12 mm Grade 550 MPa reinforcing bars was used for the tension reinforcement of all RC beams. A top layer of two 8 mm Grade 550 MPa reinforcing bars was used as hangers of the 10 mm closed stirrups. The stirrups were placed and spaced at 100 mm along the beam's span to avoid the possibility of shear failure.

In order to make FD+SD ( flexural and shear deficient )beam the diameter reinforcement in the tensile zone is reduces to 10mm and number of stirrups provided throughout the length of the beam is reduces. Here models of this FD+SD beam, and other deficient beam with jacketing at different length like 500mm, 1000mm, 1500mm,2000mm of the beam

Figure1 to 5 are subjected to two point loading and the loading is provided at l/3 distance from both ends of the beam. And the supports of the beam are simply supported with one end hinged and the other end roller. The ANSYS WORKBENCH is used to carry out the entire analysis.

### 4.2 Materials for casting of beam

A concrete mixture, C50 was used to cast the beam specimens, having an average cube compressive strength of about 50 MPa after 28 days of curing. The density, youngs modulus, poisons ratio of concrete mix are 2350 kg/m3,30000MPa,0.2. The nanosilica is provided for jacketing has 10 mm thickness and for wire mesh thickness is 1.35mm. Wire mesh of solid 45 is provided having longitudinal elastic modulus is 138000MPa, transverse elastic modulus 85000MPa and poisons ratio is 0.3.
The steel reinforcement of beam specimens were reinforced with Grade 550 steel reinforcement bars and stirrups. The average modulus of elasticity, density, yield strength, and tensile strength of the steel reinforcement was 200GPa, 7850 kg/m3, 550MPa, and 640MPa, respectively

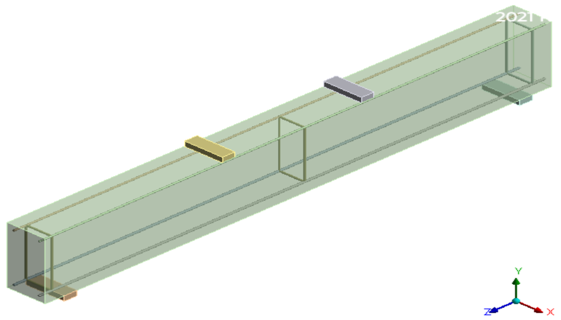

**Fig -1**: Model of FD+SD beam

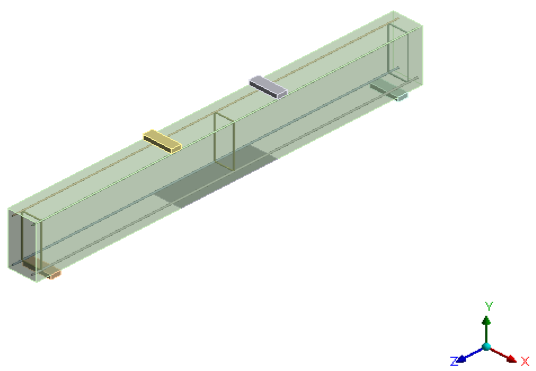

**Fig-2:** Model of FD+SD beam with jacketing at 500mm length

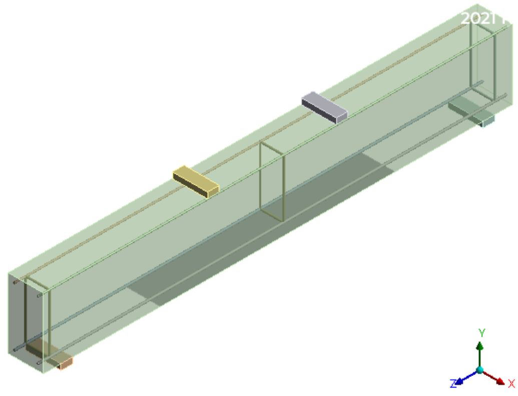

**Fig-3:** Model of FD+SD beam with jacketing at 1000mm length

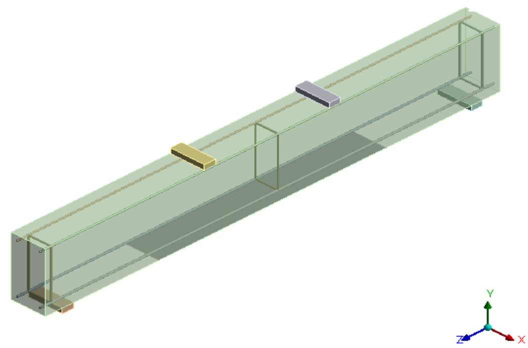

**Fig-4:** Model of FD+SD beam with jacketing at 1500mm length

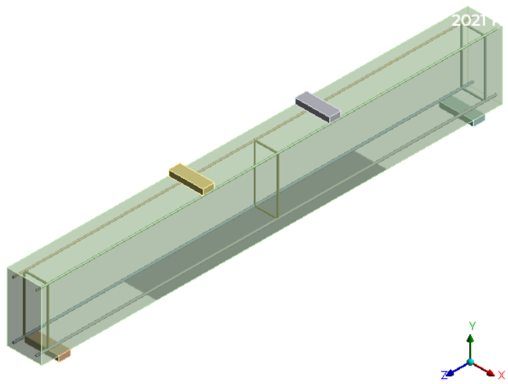

**Fig-5:** Model of FD+SD beam with jacketing at 2000mm length

## 5. RESULT AND DISCUSSIONS

All the specimens modelled were subjected to two point loading. From the analysis, Figure 6 to10 represents the deformation results of specimens.

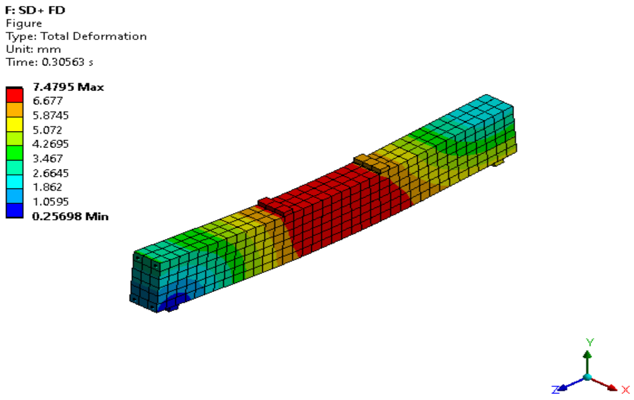


**Fig-6**: Total deformation of FD+SD beam

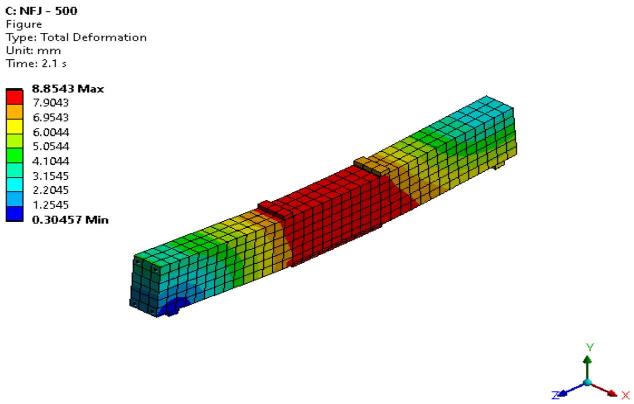


**Fig-7**: Total deformation of FD+SD beam with jacketing at 500mm length

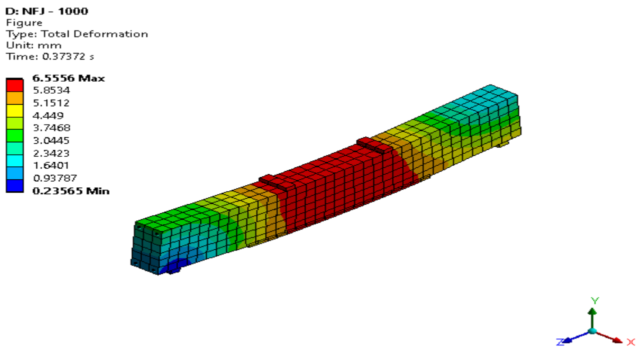


**Fig-8**: Total deformation of FD+SD beam with jacketing at 1000mm length

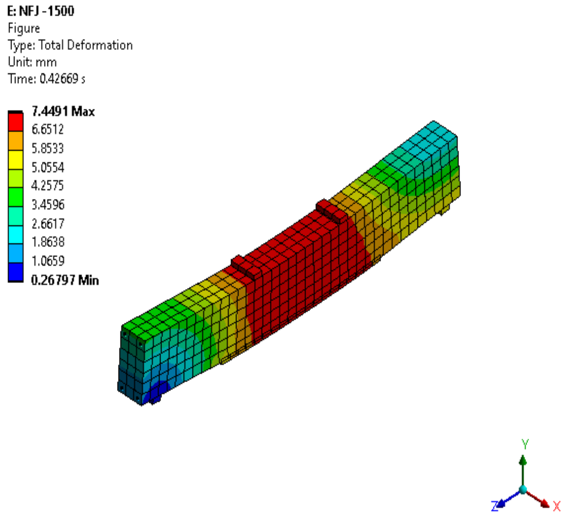


**Fig-9**: Total deformation of FD+SD beam with jacketing at 1500mm length

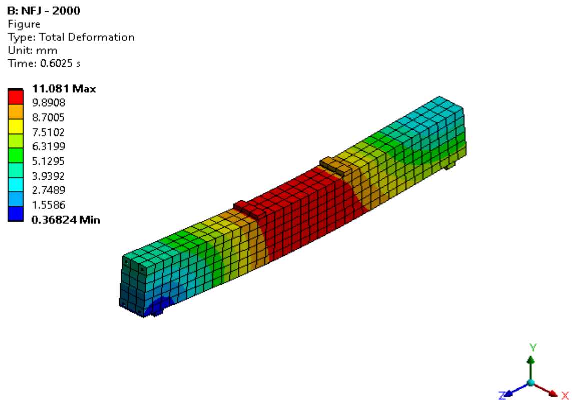


**Fig-10**: Total deformation of FD+SD beam with jacketing at 1500mm length

Table-1 Ultimate loads and deflection of different model

| Specimen | Yield deflection Δy (mm) | Ultimate deflection Δu (mm) | Ultimate load Pu (kN) | Ductility µ |
|---|---|---|---|---|
| FD+SD | 1.19 | 7.48 | 89.77 | 6.29 |
| NFJ 500 | 1.2 | 8.854 | 91.92 | 7.38 |
| NFJ 1000 | 0.87471 | 6.556 | 121.9 | 7.49 |
| NFJ 1500 | 0.8747 | 7.449 | 122.8 | 8.52 |
| NFJ 2000 | 1.79 | 11.08 | 151.1 | 6.19 |

Table1 give the ultimate load and deflection value of different model. Here NFJ represents the nano silica based ferrocement jacketing. This jacketing is provided on shear deficient and flexural deficient (SD+FD) beams at different length such as 500mm,1000mm,1500mm,2000mm.

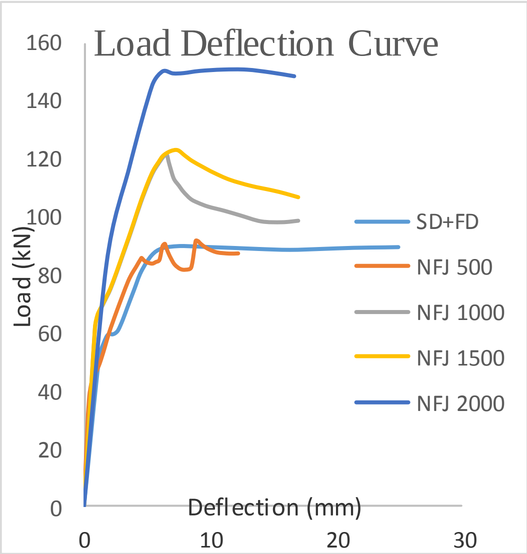


Chart-1 Load deflection curve of SD+FD beam with jacketing at different length

Chart1 give load deflection curve of SD+FD beam and this deficient beam with jacketing at different length such as 500mm,1000mm,1500mm,2000mm at the bottom portion of beam. From this graph it is easy to find out that the load carrying capacity increases with increase in length of jacketing.

## 6. CONCLUSIONS

To evaluate load bearing capacity and stiffness of beam with ferrocement jacketing, analysis is conducted using ANSYS software to the shear and flexural deficient beam and also to the beam with nano-ferro cement jacketing at bottom of the beam with different length. As a result of investigations the following observations were reached.

- Load carrying capacity increases by 40.6% when length of jacketing increases to 2000mm.
- Load deflection curve shows that load carrying capacity is more for jacketed beams compared to SD+FD beams without jacketing.
- Ductility value of beam increases with increase in length of jacketing upto 1500mm,and then it reduces when the jacketing increases to 2000mm.

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