International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 07 Issue: 04 | Apr 2020 www.irjet.net p-ISSN: 2395-0072

EMERGENCY REPAIR OF PARTIALLY DAMAGED BEAM BY NSM METHOD

Ms. Syamili T[1], Mrs. Divya K.K[2]

[1]*Ms.Syamili T, M Tech Structural Engineering, VVIT, Kerala*
[2]*Mrs. Divya K K, Associate Professor and Head in the Department of Civil Engineering, VVIT, Kerala*

Abstract - *Nowadays, in civil construction structures are being strengthened and repaired even after their life years. A lot of new innovative materials are used for this purpose. We can use such materials by replacing reinforcement, coarse aggregate, fine aggregate as modified concrete.in present life, repairing the structures by preserving cultural values is being important. For example, the great Taj Mahal. Retrofitting method is mainly used for those cases when the historical values and cultural values have more importance. And so that, retrofitting method have great role in construction field. This method is very effective in case of cost, labor and time.it mainly focus on the strength and its aesthetic appearance by modifying, after its life span here in retrofitting, methods like jacketing rod or bar embedded through section methods are commonly used. In this paper application of retrofitting by embedded through section method is explained. and in that, strips are introduced into the grooves to strengthen the beams. Strengthening can be done in two ways by using Basalt Fiber Reinforced Polymer strips or BFRP strips and Carbon Fiber Reinforced Polymer strips or CFR strips. Here control beam with a smaller number of strips which results in law shear deficiency is constructed. It is modified and strengthened by using BFRP and CFRP strips. In this thesis, the comparison of CFRP strips and BFRP strips are done to find which is more effective. The best effective method is finding out on the basis of ductility, load carrying capacity. After finding out the best method, load carrying capacity and ductility are measured by repeating the method with different parameters like orientation, number of strips, size of grooves.*

***Key Words*: BFRP strips, CFRP strips, Grooves, Concrete, Strengthening, structural behavior**.

1. INTRODUCTION

In civil engineering, concrete is one of the most important term because of its multiple advantages. Reinforced concrete structures poses adequate strength still it requires regular repairs and strengthening, because of many reasons. This initiates the importance of retro fitting. It repairs and strengthen the existing structures economically, hence it improves the lifespan of those and it eliminates the possibility of damage. There were used many prevailing techniques for strengthening. To overcome the demerits of those methods, new techniques such as jacketing, Ferro cement, isolators, etc. are introduced. Retro fitting by fiber reinforced polymer is the highlighting method now. It is found that fiber reinforced polymer is more efficient than conventional ones. However, it is expensive. Jacketing method provide good strength in considerable cost. fiber reinforced polymer concrete is also used in the form of jacketing in retro fitting, because of its unique properties like high stiffness to weight ratio, fatigue resistance, high strength to weight ratio, durability, water tightness, high tensile strength, high ductility, light in weight property. And also, other than jacketing, fiber reinforced polymers can be used in the form of bars, rods, strips and can be installed by embedded through section method.

1.1 What is Retrofitting

It simply means repairing or modifying anything like buildings, bridges, other structures, etc, after it is made or constructed. It may be either strength wise or aesthetic wise. It results in good efficiency, improved resistance and strength, increase in overall lifespan. It reduces wastage of materials and reduces public nuisance. The method includes processes like restore, replace, recycle, reconstruction, rehabilitation, renewal, and preservation. In the case of domestic buildings, damages can be cured with time and it may not affect our daily life in many cases. But in the case of public structures, the situation may not be same. It may affect the public life very well. But there is an option to dismantle or reconstruct. And when it comes to the structures of historical or cultural importance, it is not practical to reconstruct or renovate. There lies the best option, retro construction.

1.2 Importance of Retrofitting

In the present, retro fitting has crucial role as it maintain efficient results. It is better to maintain an existing building as in the way it is. And in the view of sustainability, it is more efficient than constructing a new structure. Main advantage of retro fitting can be taken in the basis of economical comfort. Main benefits of retrofit existing buildings are, Energy efficient, Cost saving, keep cultural values, Significant reduction in carbon emission, Provide better comfort And Reduced greenhouse emission

2. OBJECTIVES AND SCOPES

- To analyze the flexural behavior of RC beam using NSM retro fitting method by retro fitting method done u sing basalt fiber strip and also using CFRP strip
- To determine the best effectiveness method based on load carrying capacity and ductility properties and compare with conventional concrete beams

- To determine the effect of various parameters during retro fitting, such as number of strips used, Size of strip
  The main scopes are,
- Significant reduction in debonding
- Understanding and delaying the debonding of CFRP and BFRP sheet
- Find the innovative debonding techniques

3. METHODOLOGY

Finite element analysis help to get the entire the entire behavior of an RC structures accurately within in minimum cost and time. In finite element analysis and modelling, the structure is divided into a finite number of elements. Each element having well defined physical properties and material properties. Modelling of a reinforced concrete structure is a nonhomogeneous and anisotropic process. It is a challenging practice. Here reinforced concrete beam is modelled by ANSYS16.1 , using ANSYS16.1 both controlled beam and shear deficient beam are modelled and analyzed through the nonlinear and linear behavior up to the failure are noticed, the behavior of reinforcement with in a concrete modelled and its mode of failure ,failure pattern, load of failure are analyzed after using the results find outs the results like load carrying capacity , ductility , etc. and these results are compared with Near surface mounted strengthen beam using carbon fiber reinforced polymer strip and basalt fiber reinforced polymer strip. The analysis of fiber reinforced polymer strip structure needs finite element software consist of modelling of fiber reinforced polymer material, ANSYS16.1 is suitable for the numerical analysis of fiber reinforced polymer strip strengthened beams, the various steps required for the analysis are explained below.

3.1 Selection of Element Type

Mainly here chose the element solid 65 and link 8 i.e., for the modelling concrete solid 65 element is selected which has eight nodes and each node contain three degree of freedom along three mutually perpendicular axis. Link 8 provides easy modelling of fiber reinforced strips such as basalt fiber reinforced polymer strip (BFRP) and carbon fiber reinforced polymer strip (CFRP) [8].

3.2 Selection of Mesh Size

Mesh size selection has equal importance as that of element type.

Here 75mm mesh size is chosen. Meshing help to achieve good result interpretation.

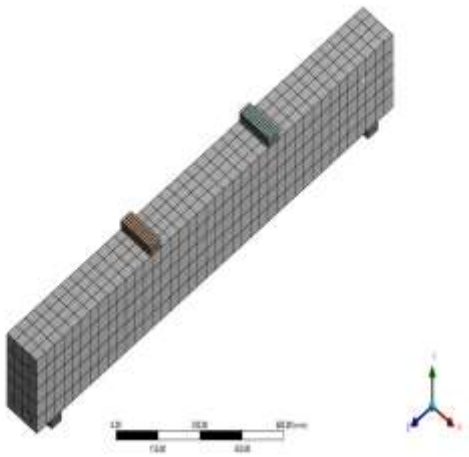

Fig -1: Meshing of beam

3.3 Material Properties Assigning

Different material properties are assigned in different stages of modelling of fiber reinforced polymer strips, reinforcement and concretes are given below

The material properties of concrete are required for design of beams [8] . It is an important factor for design. The Properties of Steel Reinforcement are given bellow [8].Also, here for the design of NSM strengthened beams design using CFRP fiber required [11].

Table -1: Properties of concrete

Properties	Values
Modulus of elasticity	31,500N/mm^2
Poisson's ratio	0.20
Compressive strength	44.7 N/mm^2

Table -2: Properties of steel reinforcement

Properties	Values
Modulus of elasticity	200,000 N/mm^2
Poisson's ratio	0.3
Compressive strength	500N/mm^2
Diameter	8mm&12mm

Table -3: Properties of Properties of Basalt fiber Reinforcement polymer strip

Properties	Values
Modulus of elasticity	20400Mpa

Ultimate tensile strength	1684Mpa
Thickness	0.33

The properties of basalt fiber reinforcement polymer strips are required for the design of NSM strengthened beams design [6]. The epoxy resins properties are given below [8].

Table -4: Properties of Carbon fiber Reinforcement polymer strip

Properties	Values
Modulus of elasticity	165Gpa
Ultimate tensile strength	2800M pa
Thickness	1.2mm

Table -5: Properties of Epoxy Resin

Properties	Values
Modulus of elasticity	3800 N/mm²
Poisson's ratio	0.21
Layer thickness	1.0mm
Ultimate tensile strength	45 N/mm²

3.4 Boundary Conditions and Loading Condition

Hinge support or simply supported with two point loadings are provided

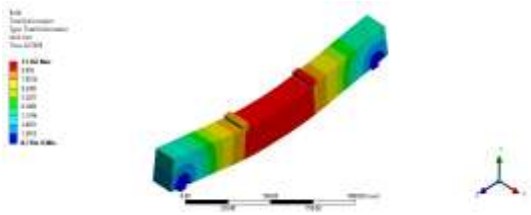

Fig -2: load -deformation behaviour of control beam

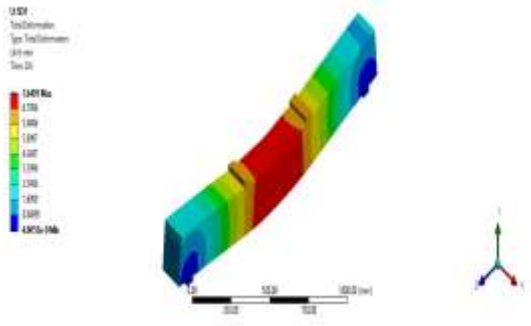

Fig -3: Load -deformation behaviour of shear deficient beam

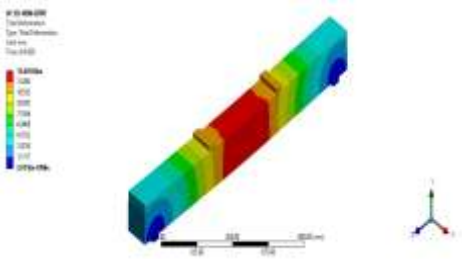

Fig -4: Load -deformation behaviour of NSM BFRP beam

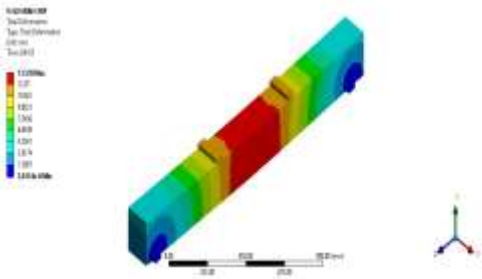

Fig -5: load -deformation behaviour of NSM CFRP beam

Load deformation behavior of shear deficient beam (BEAM1) control beams (BEAM2), NSM CFRP beam (BEAM3) and NSM BFRP (BEAM4) are explained above. From the figures it is clear that the NSM CFRP (Near Surface mounting method using Carbon Fiber Reinforced Polymer strip) beam poses little deformation than that of NSM BFRP near Surface mounting method using Basalt Fiber Reinforced Polymer strip).

4. RESULTS AND DISCUSSION

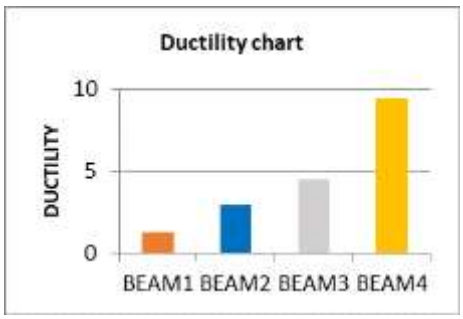

Chart -1: Comparison of ductility of beams

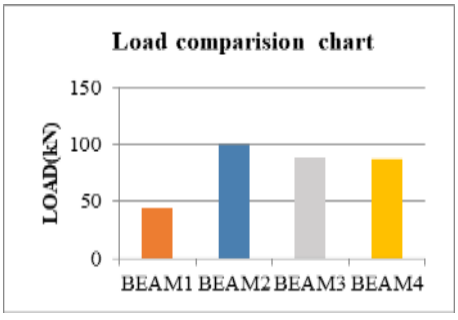

Chart -2: Comparison of Loads on beams

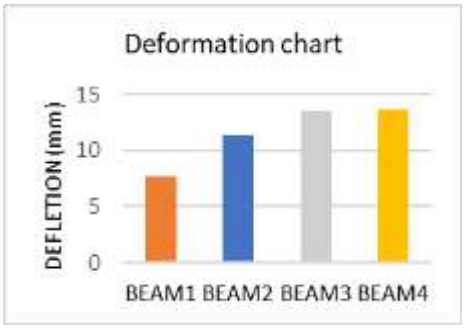

Chart -3: Comparison of deformations of beams

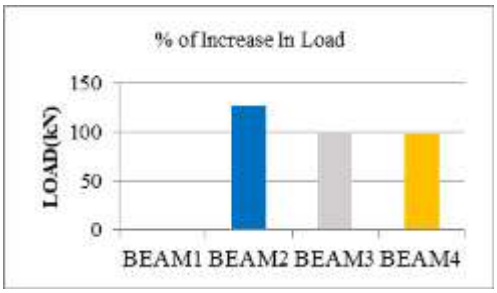

Chart -4: Comparison of Percentage increase in loads on beams

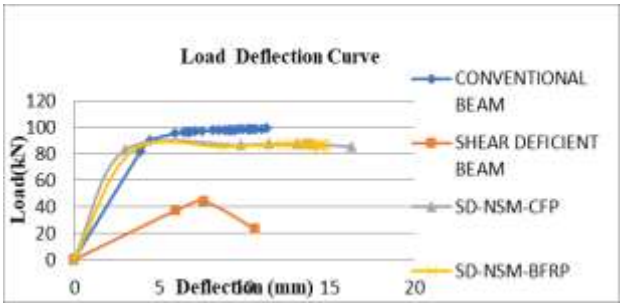

Chart -5: Load Deflection Curves of Beams

Table -6: Result and discussion-1

Specification	Load(kN)	Deflection (mm)
BEAM1	7.65	43.87
BEAM2	11.36	99.64
BEAM3	13.58	88.07
BEAM4	13.61	87.01

Table -7: Result and discussion-2

specification	Yield displacement(mm)	% Increase in load	Ductility
BEAM1	6.01	1.00	1.27
BEAM2	3.90	127.11	2.91
BEAM3	3.01	100.75	4.51
BEAM4	3.42	98.33	3.98

5. CONCLUSIONS

- Flexural characteristics of beams using CFRP strips and BFRP strips are done.
- BFRP provides ductility 3.98 while CFRP Pocess Improved Ductility about 4.51.
- Load Carrying capacity of CFRP about 88.07kN and BFRP 87.01kN.
- Yield displacement of shear deficient beam reduced to 3.012mm due to CFRP strengthening
- Yield displacement of shear deficient beam reduced to 3.42mm because of BFRP strengthening
- Shear deficient NSM –CFRP method is the best effective method compared to BFRP NSM method
- CFRP strip strengthening provides better results ductile properties and load carrying capacity.

REFERENCES

[1] Layla Amaireh, Rajai Z. Al-Rousan, Ayman N. Ababneh and Mohammad Alhassan "Integration of CFRP strips as an internal shear reinforcement in reinforced concrete beams," vol.23, ,2020, pp.13-19.

[2] Ayesha Siddika, Md. Abdullah Al Mamun, Rayed Alyousef, Y.H. Mugahed Amran, "Strengthening of reinforced concrete beams by using fiber -reinforced polymer composites: A review, "vol.25, 2019, pp.100798.

[3] Mohammad A. Alhassan, Rajai Z. Al Rousan, Esmail A. Al Shuqari, "Bond -slip behavior between fiber reinforced concrete and CFRP composites," vol.10, 2019, pp.359-367.

[4] Rojin Azizi and Sayed Behzad Talaeitaba, "Punching shear strengthening of flat slabs with CFRP on grooves (EBROG) and external rebar sticking in grooves", vol.11, 2019, pp.79-95.

[5] Yasmeen Taleb Obada, Ghazi A.F.R. Abu-Farasakh, Ahmed M. Ashteyat, "Retrofitting of partially damaged reinforced concrete beam -column joints using various plate-configurations of CFRP under cyclic loading," vol.198, 2019, pp.313-322.

[6] J. duic, s. Kenno, S. Das," Flexural rehabilitation and strengthening of concrete beams with BFRP composites", vol.2, 2018, pp. 04018016.

[7] Wei Sun, "Development of a testing methodology for the design and quality control of carbon fiber reinforced polymer (CFRP) anchors," vol.164, 2018, pp.150-163.
[8] Nawal Kishor Banjara. Ram Anjaneyulu, "Experimental and numerical investigation on the performance evaluation of shear deficient and GFRP strengthened reinforced concrete beams," vol.137, 2017, pp.520-534.
[9] Rami H. Haddad, OubaidaA.Almomani, "Recovering flexural performance of thermally damaged concrete beams using NSM CFRP strips," vol.154, 2017, pp.632-643.
[10] Keyur p. Kanani and Prof.Mazhar A. Dhankot, "State-of-the-Art Review of strengthening of RC beam in shear by Near Surface Mounting Technique," vol.4, 2016, pp.2321-0613.
[11] A. Khalifa, A. nanni, "Rehabilitation of rectangular simply supported RC beams with shear deficiencies using CFRP composites", vol.16, 2002, pp.135-146.

BIOGRAPHIES

Ms. Syamili T is doing her master of technology in structural engineering at Vedavyasa Institute of Technology, Malappuram, Kerala. Her research interests include retrofitting of structures, concrete technology.

Mrs. Divya K.K is working as Associate Professor and head in the Department of civil engineering at Vedavyasa Institute of Technology, Malappuram, Kerala. interests include structural engineering, costal engineering, concrete technology etc.