Seismic Retrofitting of Reinforced Concrete Beams with Baslt Fibre Mat

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Abstract--- Earthquake is one of the major disaster which is responsible for massive destruction of human life and materials. To reduce the impact of earthquake, all the important structures need to be effectively strengthened for improving the performance and life of the structure. RC structures often face modifications and improvement of their performance during their service life. This paper represents the change of Reinforced concrete structural components which are found to exhibit distress because of earthquake loading. In this research work, basalt fiber mat is used to wrap around the beam specimen and determining the load carrying capacity of the specimen.

KEYWORDS: Retrofitting, basalt fiber mat, ultimate load, ductility ratio

1. INTRODUCTION

Retrofitting is the categorized as the modification of building or existing building. Retrofitting can be achieved by incorporating the techniques which will reduce the impact of earthquake on building so that the building will meet the seismic demands for load carrying members or as a whole. Some of the structural parameters include strength, stiffness & ductility ratio can be improved by this retrofitting technique. Increasing the properties and member load carrying capacity, earthquake responses can be minimized effectively.

Retrofitting technique can be adapted to all the structural works which entirely depends on the following factors which includes, material availability, technology used, and cost, duration of work, functional and aesthetic requirements. This technique can be either local retrofit or global retrofit and that is based on the effectiveness on usage of structural members. Structural level retrofit can be defined as the simplest method to increase the seismic resistance of new as well as existing buildings. Jacketing construction is one of the preferred methods of seismic retrofitting which can be applied by External confinement of fiber reinforced polymers of Basalt fiber reinforced composite.

2. LITERATURE REVIEW

[1] Song et al. (2004) determined the mechanical properties of Steel Fiber Reinforced Concrete (SFRC) for different volume fractions of (0.5%, 1.0%,1.5%, and 2.0%). Test results shows that maximum compressive strength of the SFRC gained at 1.5% volume fraction will be 15.3% improvement; whereas split tensile strength and modulus of rupture of SFRC enhanced by increasing the fiber volume fraction, attaining 98.3% and 126.6% enhancements, respectively, at 2.0% fiber.

[2] Shahawy et al. (1996) analyzed the flexural behavior of RC beams with epoxy bonded Carbon Fiber Reinforced Polymer (CFRP) laminates. The observation of the study included crack load (first), cracking behavior (flexure & shear), deflections, service loads, and ultimate strength and failure patterns. A theoretical analysis was also carried out to compare with experimental results.

[3] Abdel-Jaber et al. (2007) looked into the behavior of shear strengthening of RC beams using Carbon Fiber Reinforced Polymer (CFRP). The investigation was carried out to determine the shear behavior of RC beams strengthened by CFRP strips in different configurations using epoxy adhesives. Two types of CFRP materials, namely pultruded and pregpag materials were used and a comparative study was made between the results was carried out for finding the best configuration for strengthening. It was observed that application of CFRP in the shear spans increased the strength between 19%and 56%. Also, the greater increase in shear strength was achieved by providing sheets over the entire depth of the shear span.

[4] Giuseppe Oliveto And Massimo Marletta (2005) evaluated the traditional and innovative methods of seismic retrofitting. Importance will be given for reducing the stiffness of the building which is vulnerable to earthquake. For reducing the stiffness, seismic base isolation method was adopted. Sway of the building can be minimized by such method and also the minimal drift is produced. From the observation, it was concluded that, elastomeric bearings used in base isolation are very effective in reducing the energy absorption characteristics of the building.

3. MATERIALS USED

Cement:

Cement is used is OPC 53 grade. It is conformed to IS: 12269 were used in the present study.

Table 1 Cement properties

S.No	Properties of Cement	Attained from standard tests
1	Specific gravity of OPC 53 Grade cement	3.15
2	Initial setting time	45 minutes
3	Final setting time	386 minutes
4	Standard consistency (%)	30
5	Fineness (%)	4

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Fine aggregate:

River sand is completely replaced by M-Sand. The properties of M-Sand were tested and it is shown in the table 2.

Table 2 M-Sand properties

S.No	Properties of M-Sand	Attained from standard tests
1	Specific gravity	3.15
2	Fineness modulus	3.0
3	Water absorption (%)	0.5

Coarse Aggregate:

20mm coarse aggregate is used in this project work as per IS: 2386-1963 (I & II). Table 3 shows the coarse aggregate properties.

Table 3 M-Sand properties

S.No	Properties of Coarse aggregate	Attained from standard tests
1	Specific gravity	2.72
2	Water absorption (%)	0.5
3	Fineness modulus	7.3
4	Particle shape	Angular

Water:

potable water is used and the water should be free from impurities

Super plasticizer:

Super plasticizer is a high range water reducing admixture in which Conplast SP430 is in this research work. To improve the flow characteristics, i.e. workability and to achieve a better slump, chemical admixture is used in small percentage.

Epoxy resin and hardener:

It is used as a bonding agent between the basal fiber mat and concrete surface. Thermosetting resin is used in this work.

Basalt fiber

Basalt fiber mat is a fabric woven type mat which is derived from the igneous rock type basal rock. It is one of the new polymers which have its better thermal resistance. It has high tensile strength 2800-4800MPa.

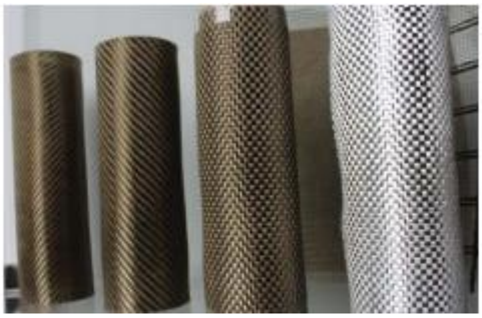

Fig 1 Basalt fiber

Reinforcement details:

The reinforcement of 3 specimens are four numbers of 8mm diameter were used for main reinforcement of 300mm spacing c/c, 2 no's of 8mm diameters were used for top reinforcement and 2 numbers of 12mm diameters were used for the bottom reinforcement of beam. The stirrups of 6mm dia and 30 mm c/c from the face of beam of 300mm c/c.

Casting and Curing:

The mould sides are oiled and it is free from absorbing the cement paste. The reinforcement cages are place inside the moulds with sides, top and bottom cover blocks. Concrete mixing is done in 3 layers and compacting using tamping rod. Test specimens were remolded at the end of 48 hours of casting.

Fig 2 Casting of Beam and surface finishing

Fig 3. Curing of Specimens

Control specimen

The beam size of 1500* 220mm reinforced with two numbers of 12mm diameter cast with M30 concrete is taken as control beam. Control beam is cured for 28days and tested under two point loads using loading frame. Loading is applied to the beam. In this case we took two beams. The beam of size same as the control beam.

The beams are braking at 40 kN using loading frame. Then the beams are chipping up to neutral axis from the bottom. The epoxy resin and hardener is taken as correct proportions and paste the chipping space of the beams. Then the basalt fiber mat single layer wrapping and double layer wrapping of beams separately. After two days the beams are tested. The initial crack occurred at 50 kN for single layer wrapping and the initial crack occurred at 40 kN for double layer wrapping. The failure is a compression failure.

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S.No	Load in kN	Deflection in mm			Strain	
		D1	D2	D3	Compression	Tension
1	0	0	0	0	0	0.00001
2	10	0	0.97	0.78	0	0.00001
3	20	1.84	1.20	1.89	0	0. 00001
4	30	2.42	2.32	2.55	0.00001	0.00001
5	40	2.65	2.25	2.92	0.00001	0.00002
6	50	4.00	4.01	3.45	0.00001	0.00002
7	60	4.12	4.75	4.25	0.00001	0.00002
8	70	6.12	6.56	7.36	0.000004	0.000024
Initial Crack = 40 kN Ultimate Crack = 70 kN						

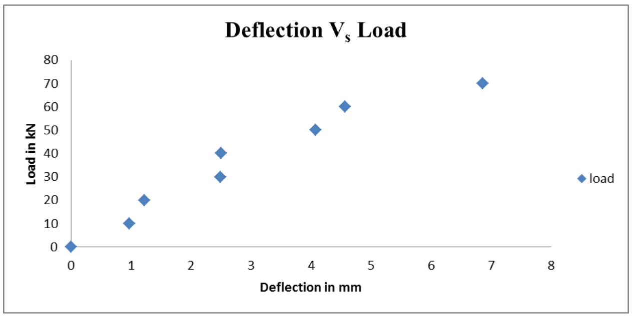

Figure 4. Graph between Deflection and load

CONCLUSION

1. The load carrying capacity (ultimate) of beam is increased 41.9% compared to control beam
2. Deflection of the beam is decreased by 8.24% in comparison with control specimen.
3. Initial crack of the beam is decreased 25% compared to control beam.
4. It can be concluded that basalt fiber can be used as a retrofitting material for structural elements.
5. It is planned to study the behavior of basalt mat fiber in reinforced concrete beam under cyclic loading.
6. Basalt fiber mat used for retrofitting of beam it reduces the crack width.

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