FLEXURAL BEHAVIOUR OF RC BEAM EXTERNALLY BONDED WITH ALLOY STEEL SHEET USING EPOXY

RAMVILAS BASVAN K[1], SRINIVASAN R[2]

[1.]ME STUDENT, [2.]ASSISTANT PROFESSOR ADHIYAMAAN COLLEGE OF ENGINEERING,HOSUR.

ramvilas5116@gmail.com,bksrinivasan8@gamil.com

Abstract

Strengthening of structures have gained importance in the past few decades owing to the high cost involved in their reconstruction and also to ensure safety by improving their strength under adverse conditions. alloy sheets ensures that the material has enough surface smoothness to avoid stress concentrations in addition to high tolerance and concentricity. The aim of this paper is to study the influence of the externally bonded alloy steel sheets on the flexural behaviour of the RC beams. For this purpose, flexural strength of the control beams and the beams bonded with the alloy steel sheets are determined by experimental means and will be compared to validate the novelty in the use of the externally bonded steel sheets on the surface of the beams by means of epoxy. This paper aims to bring out the novel advantages of using alloy sheets for strengthening the beams through the critical review of literature and observe their behaviour through experimental means.

Keywords: Strengthening, Alloy sheets, Flexural behaviour, External bonding.

1. INTRODUCTION

The aim of the study was to investigate the flexural strength of RC beam externally bonded with alloy steel sheets with laboratory loading tests under two point loading .The sheets were attached externally on the tensile side and side faces of the beam. The sheet bonding is adopted in this study as it is found to be a rapid method to increase the bending and shear capacity of the beam.

2. PRINCIPLE OF PLATE BONDING TECHNIQUE

Strengthening by plate bonding is mainly applied in order to increase the flexural capacity and shear capacity: steel plates are bonded to the tension side of reinforced concrete structure, thus act as an additional longitudinal reinforcement and as a result flexural capacity increases. In the similar way as the above, shear capacity is found to increase by bonding steel plates to the side faces of reinforced concrete structure.

3. SPECIMEN AND TEST ARRANGEMENTS

In the experimental program, reinforced concrete beam was designed as doubly reinforced section using M40 grade concrete and Fe 415 grade steel and having cross section 120mm x 150mm by limit state method. The tension reinforcement of 2nos-12mmdia bar, compression reinforcement of 2nos-12mmdia bar and stirrups having 8mm dia at 200mm centre to centre was design by limit state design. The steel sheets were bonded on the tensile side and side faces of the beam. The thickness of alloy sheet, which were bonded on RC beams were 1.5mm and 2mm respectively.. The length of beam was 1500mm and the length of the bonded sheet is 1450 mm. The bonding faces of the steel plates and beam surface are roughened and cleaned thoroughly. Then epoxy adhesive (Sikadur-31) is mixed in accordance with the manufacturer's instructions. The epoxy is uniformly spread all over the roughened web of the beams and the steel plates to a thickness of 1 mm and the plates are then bonded to the beams. After bonding operations are completed, specimens are cured for 28 days under laboratory conditions before testing.

3.1.Specimen arrangement figures:




Fig.1 fig.2 fig.3 fig.4

Experimental work doing the step by step procedure preparation of beam specimen.then alloy steel sheet attached from bottom and side faces of beam.

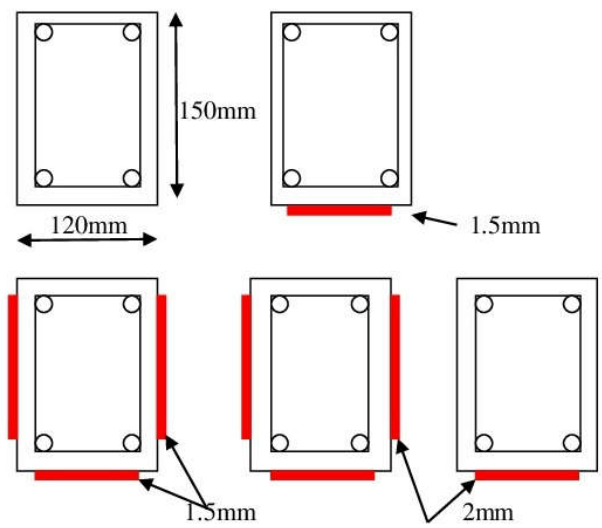

Fig 5: Different Configuration of sheets.

Fig 6:Two point load setup

The manufacturing details of the beams are presented in Table 1.

4. OBJECTIVES

- To Evaluate the bending resistance of alloy steel subjected to flexure.
- To analysis load versus deflection behaviour under flexure.
- To study the various modes of failure.

Specimen designation	**Thickness of plate**	**Width of plate at bottom**	**Width of plate at side faces**
Reference beam	Without plate	-	-
Strengthened beams with bottom plate	1.5mm	100mm	130mm
Strengthened beams with bottom plate	2mm	100mm	130mm
Strengthened beams with bottom plate	1.5mm	100mm	130mm
Strengthened beams with bottom plate	2mm	100mm	130mm

Table 1:manufacturing detail

IV. EXPERIMENTAL SETUP

The beams are tested for their ultimate strengths under two point loading system. The effect on ultimate flexural strengths is studied by variations in thickness of alloy steel sheets (1 and 1.5mm).In the case of control beam (without sheet) which fails as soon as the first critical shear cracks forms. The load –deflection diagram for control beam is given below.

Fig. 7: Experimental test on RC beam

(control beam)

In the case of strengthened beam with 1.5mm sheet at the bottom face which takes additional load compared to control beam and also it provide good ductility. The failure occured after the formation of shear crack and debonding of bottom sheet occured just before the ultimate load. The load–deflection diagram for strengthened beam is given in fig .

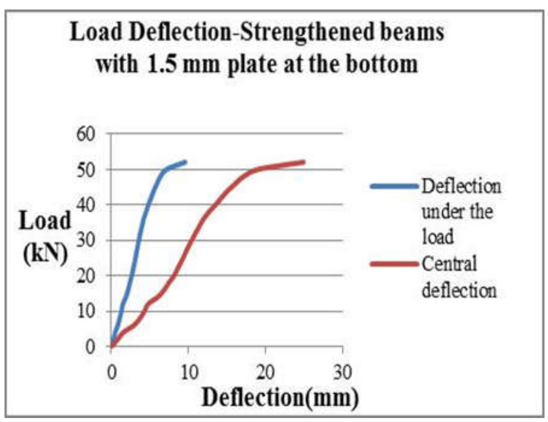

Fig.8

Fig. 9: Typical failure of RC strengthened beam with

continuous steel sheet(1.5mm) at bottom.

In the case of strengthened beam with 2mm cold formed steel sheet at the bottom face which took additional load compare to control beam and also it provides less ductility compared to 1.5mm thickness. The failure occurs after the formation of shear crack. The load–deflection diagram for strengthened beam is given in fig 8.

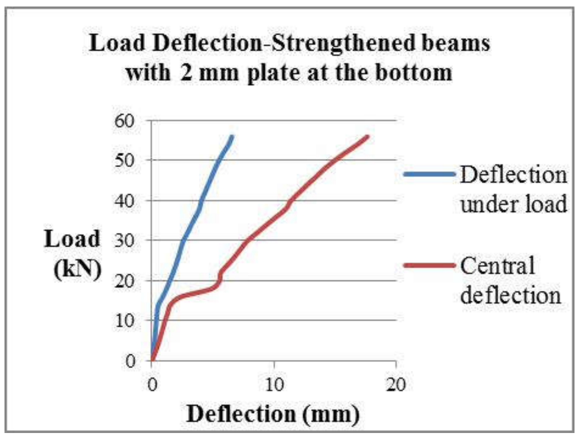

Fig.10:

Fig.11: Typical failure of RC strengthened beam with
continuous steel sheet (2 mm) at bottom

In the case of strengthened beam with 1.5mm sheet at side and bottom face of the beam, which took additional load compared to control beam and also it provides good ductility. The debonding of side plate occurs at 38 kN and then cracks occurred near the support. The load –deflection diagram for strengthened beam is given in fig 10.

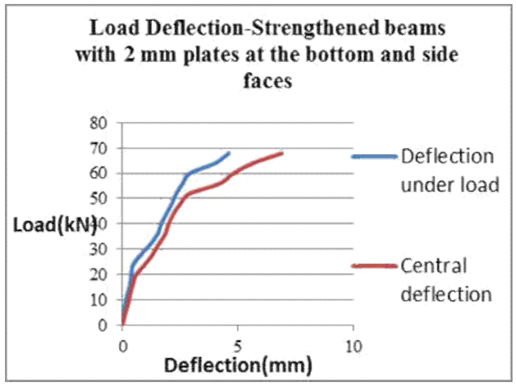

Fig.12:

Fig. 13: Typical failure of RC strengthened beam with continuous steel sheet (2 mm) at bottom and side faces

the case of strengthened beam with 2mm sheet at side and bottom face of the beam, which took additional load compared to control beam and it provides less ductility compare to 2mm thickness sheet. The debonding of side plate occured at about 50 kN. The failure occurred after the formation of shear crack and debonding of bottom sheet occur just before the ultimate load. The load deflection diagram for strengthened beam is given in fig 12.

Specimen	Ultimate load	Percentage of increase in strength	Maximum displacement
Reference beam	34KN	-	11.7mm
Strengthened beam with 1.5mm plate at bottom	55KN	63.55%	27mm
Strengthened beam with 2mm plate at bottom	58KN	76%	17.64mm
Strengthened beam 1.5mm plate at bottom&side faces	65KN	94.75%	26.87mm
Strengthened beam 2mm plate at bottom &side faces	69KN	119%	7.1mm

Table2: Comparison of Control and Strengthened Beam

5. CONCLUSION

From experimental investigations that the strengthened beams exhibited more strength and ductility in comparison to the control beams and also it can be inferred from of the plate used, greater is the ductility and lesser is the stiffness.Also marked improvements in the strength are observed when the steel plates are bonded at the side faces too in comparison to that of case of bottom face alone.

More investigations have to be carried out in the future to address the problem of the debonding in relation to the bonding surface and epoxy thickness. Also shear failure is one more aspect whose has to be studied with respect to the failure mode of the strengthened beam in light of the expected flexural failure.

6. REFERENCES

1. Barnes R.A., BaglinP.S, Mays G.C and Subedi N.K. (2000), ‘ External steel plate systems for the shear strengthening of reinforced concrete beams’, Engineering Structures ,Vol .23, pp.1162-76.
2. JavadVaseghiamiri.MortezaHosseinalibegie. (2004), ‘Determination Of Ultimate Flexural Capacity Of Strengthened Beams With Steel Plates And GFRP’ 13th world conference on earthquake engineering, vol.2, pp.3242.
3. Sallama.H.E.M.,Badawy.A.A.M and Saba.A.M, Mikhail.F.A. (2010), ‘Flexural behaviour of strengthened steel concrete composite beams by various plating methods’, Journal of Constructional Steel Research, Vol.66, pp.1081-87.
4. AwadhE.Ajeel., Rana HashimGhedan and Dina Mukheef Hamza. (2011) ‘Replacing of Internal Tension Bars by External Bonded Plate’, Journal of Engineering and Development, Vol. 15, pp 90-103.
5. Mohammed A., Al-Hassani H. M and Al-Ta'an S. A (2013), ‘Behaviour of Damaged Reinforced Concrete Beams Strengthened with ExternallyBonded Steel Plate’, Tikrit Journal of Engineering Sciences,Vol.20,pp.48-59
6. Seema A.Bhagat., JyotiP.Bhusari. (2013), ‘Improving shear capacity of RC beams using epoxy bonded continuous steel plates’, International Journal of Advanced Technology in Civil Engineering, Vol.2, pp.39-44.
7. Akinropo Musiliuolajumoke., Morgan Dundu. (2014), ‘Flexural failure modes of steel plate strengthened reinforced concrete elements’, Construction Materials and Structures, PP 1074-1079.
8. Ashraf A.Alfeehan (2014), ‘Strengthening Of R.C. Beams By External Steel Plate Using Mechanical Connection Technique’, Journal of Engineering and Development,Vol.3, pp.202-215..

9. Esmaeel Esmaeeli., Joaquim A.O. Barros. (2015) et al, 'Flexural strengthening of RC beams using Hybrid Composite Plate', Composite part B, vol.2, pp.604-20.
10. Anjali.M, EapenSakaria.S. (2015), 'Retrofitting of Concrete Filled Cold Formed Steel Tubular Beams with GFRP Sheets', International Journal of Innovative Research in Science, Engineering and Technology,Vol.4, pp.8612-20