Strengthening of RC Beam with Steel Plate as Shear Reinforcement

[1]Anandhi.L, [2]Ramamoorthy.S, [3]Dr.K.Dhanasekar
[1,2]Assistant Professor, Associate Professor, Civil Department ,Agni College of Technology
[3]Professor, Civil Department,Panimalar Engineering College

***Abstract*: In this study, galvanised steel plates are used to improve flexural and shear performance of reinforced concrete. The purpose of this work is to present the results of a study carried out to characterize the structural behavior of RC beams with enrolled steel plate. Further, the study aims to evaluate the ability of predicting the ultimate shear capacity of concrete beams. In order to improve its flexural strength and brittleness, a technique of placing steel plate as shear reinforcement will be introduced to the concrete. This study is also aims to improve the strength of reinforced concrete by providing enrolled steel plate along with stirrups by gas welding. From experimental investigations that the strengthened beams exhibited more strength and ductility comparison to the control beams. The results indicate that internally encased galvanised steel plate can be effectively used to rehabilitate or strengthen concrete beams, and analytical methods needed to describe their behaviour are available based on the strain compatibility conditions.These tests should provide information regarding the ability of the internally encased galvanised steel plates to withstand aggressive environments and cyclic loads.**

Key Words: RC Beams, Flexural Strength, galvanised steel plates,Welding

1.INTRODUCTION

It was learnt that steel plates were encased in the reinforced concrete. Some scientists are discussed about the combination of both hot rolled steel and cold formed steel plates were used in the reinforced concrete and to determine the shear behaviour of concrete. In this work, it is proposed to use these steel plates in concrete and to determine the shear and flexural behavior of concrete.

2. EXPERIMENTAL INVESTIGATION

2.1TEST RESULTS

2.1.1Test on cement

Table 1 Test for Specific gravity of cement

S.No	Description	Trial-1	Trial-2	Trial-3
1	Empty weight of bottle, w_1	109 g	110 g	109 g
2	Weight of bottle + cement, w_2	173 g	179 g	151 g
3	Weight of bottle +cement + diesel, w_3	412 g	420 g	393 g
4	Weight of flask + diesel, w_4	359 g	362 g	358 g
5	Specific gravity, G_c	3.11	3.21	3.15

Average specific gravity of cement, G_c= 3.15

Table 2 Test for consistency of cement

Percentage of water	Depth of penetration (mm)
25%	3
30%	6
35%	8

Consistency of cement = 30%

Table 3 Test for setting time of cement

S.No.	Initial setting time (mins)	Final setting time (mins)
1	27	540
2	25	520
3	28	555
Average	26	538

S.No	Trial No.	Trial-1	Trial-2	Trial-3
1	Weigh of empty bottle, w_1	650 g	652 g	649 g
2	Weight of bottle + sand w_2	1235 g	1450 g	1400 g
3	Weight of bottle + sand +water w_3	1811 g	1950 g	1920 g
4	Weight of bottle +water w_4	1450 g	1455 g	1452 g
5	Specific gravity G_s	2.61	2.63	2.65

Table 4 Test for Specific gravity of sand

Average G_s= 2.63

IS sieve designation	% retained	% passing	Cumul% retained	Remarks
4.75mm	0.2	99.8	0.2	As per IS 383-1970 it is conformed to zone III
2.36mm	0.4	99.4	0.6	
1.18mm	9.8	89.6	10.4	
600μm	24.9	64.7	35.3	
300μm	55.5	9.2	90.8	
150μm	8.1	1.1	98.9	
75 μm	0.5	0.6	99.4	

Table 6 Test Results of Fine Aggregate

Description	Result obtained	As per IS 383-1970
Specific gravity	2.61	2.55 minimum
Bulk density	1653.06kg/m^3	-
Surface moisture	0.11%	-
Water absorption	1%	-

Inference

The properties of fine aggregate satisfy the allowable limits of IS 383: 1970.

2.1.3 Coarse Aggregates test

Table 7 Sieve Analysis of Coarse Aggregate

IS sieve designation	% retained	% passing	Cumul % retained	Remarks
80mm	0	100	0	As per IS 383-1970 it is conformed to 20mm size
40mm	0	100	0	
20mm	46.6	53.4	46.6	
10mm	53.4	0	100	
4.75mm	0	0	100	

Table 8 Specific gravity of Coarse Aggregate Test

Description		Weight of sample
Weight of empty pycnometer (w_1)	=	625gm
Weight of pycnometer + C.A (w_2)	=	825gm
Weight of pycnometer + C.A + water(w_3)	=	1620gm
Weight of pycnometer + water (w_4)	=	1492gm

The test results of coarse aggregates are given in Table

Table 9 Test Results of Coarse Aggregate

S.No.	Description	Values
1	Specific gravity	2.70
2	Bulk density	1350kg/m^3
3	Surface moisture	0.086%
4	Water absorption	0.5%

Inference

The properties of coarse aggregate satisfy the allowable limits of IS 383 : 1970

2.1.4 TEST ON CUBE

Table 10 Compression test on concrete cube

Day	S.No.	Compressive load (kN)	Compressive strength (MPa)
7th day	1	394	17.5
	2	400.5	17.8
	3	391.5	17.4
	Average		17.6
14th day	1	535.5	23.8
	2	513	22.8
	3	544.5	24.2
	Average		23.6

2.1.5 CASTING OF TEST SPECIMENS

Casting of Specimen

Beam moulds of size 1100mm x 150mm x 150mm were used for casting the rectangle RC beam. The fresh mix of concrete waspoured into the mould and the top surface was finished smooth with trowel.

Welding of Plate

The steel plates were encased on all the four side faces of the beam reinforcement. The thickness of galvanised steel plate, which were encased on RC beams is 2mm respectively. The width of the plate was 60mm and the width of the beam was 150 mm. The length of plate was in three proportions and they were 750mm, 500mm, 250mm and the length of the beam is 1100 mm. The galvanised steel plates were placed on the reinforcement by means of gas welding.

ISSN: 2278-0181

2.1.6 RESULTS AND DISCUSSION

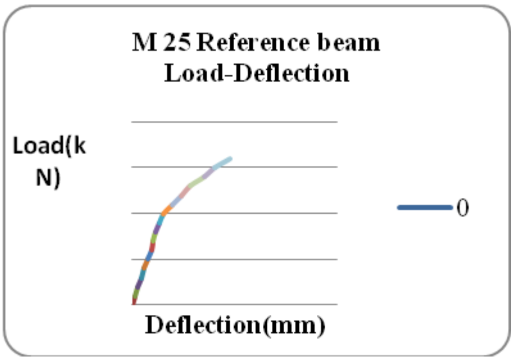

FIGURE 1 Load –Deflection Behaviour of Reference Beam

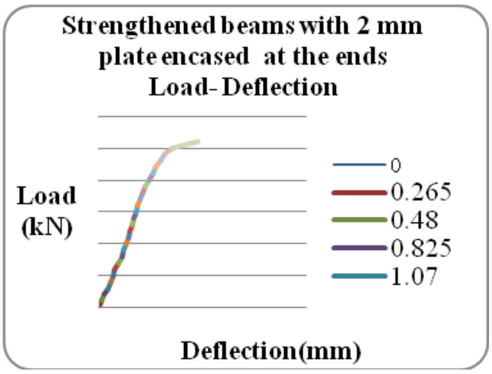

FIGURE 2 Load-Deflection Behaviour of Strengthened beams with 2mm plate encasedat the ends

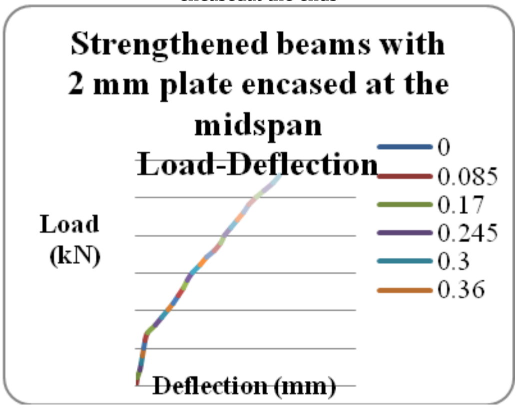

FIGURE 3 Load Deflection Behaviour of Strengthened beams with 2 mm plate encased at the midspan

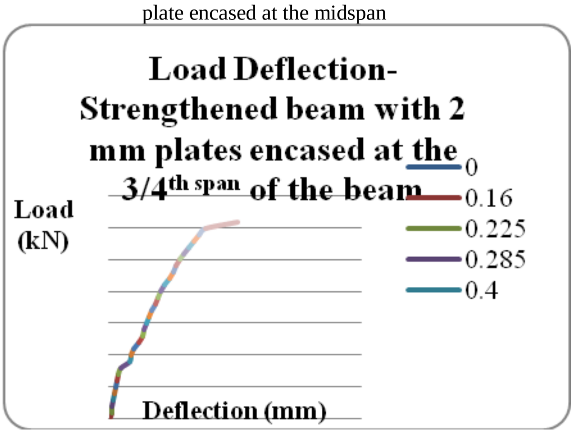

FIGURE 4 Load -Deflection Behaviour of strengthened beam with 2mm plate encased at 3/4th span of the beam

CONCLUSION

- From experimental investigations that the strengthened beams exhibited more strength and ductility comparison to the control beams. The results indicate that internally encased galvanised steel plate can be effectively used to rehabilitate or strengthen concrete beams, and analytical methods needed to describe their behaviour are available based on the strain compatibility conditions.
- Also it can be inferred from observations that lesser the thickness 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 internally encased
- More investigations have to be carried out in the future to address the problem of the diagonal cracks due to internal stress developed.
- 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.
- Before this type of strengthening procedure is safely applied, further studies involving the durability of these internally encased galvanised steel plate reinforced beams are needed. These tests should provide information regarding the ability of the internally encased galvanisedsteel plates to withstand aggressive environments and cyclic loads.

REFERENCES

[1]. Ammar A. Ali, Saad N. Sadik and Wael S. Abdul-Sahib. (2012), ‘Strength and Ductility of Concrete Encased Composite Beams’, Engineering and Technology Journal, Vol.30, No.15, pp.2701-2714.
[2]. Chung K.F., Yu W.K and Wang A.J. (2005), ‘Structural performance of cold formed steel column bases with bolted moment connections’, Steel Compos Struct, Vol.5, No.4, pp.289–304.
[3]. Elkersh I. (2010), ‘Experimental investigation of bolted cold formed steel frame apex connections under pure moment’, Ain Shams Engineering Journal, Vol.1, pp.11–20.
[4]. EN 1993-1-3 (2006), Eurocode 3: Design of steel structures - Part 1-3: General rules - Supplementary rules for cold-formed members and sheeting
[5]. Gardner L., Saari N. and Wang F. (2010), ‘Comparative experimental study of hot-rolled and cold-formed rectangular hollow sections’, Thin-Walled Structures, Vol.48, pp.495–507.
[6]. Hanaor A. (2000), ‘Tests of composite beams with cold-formed Sections’, Journal of Constructional Steel Research, Vol.54, pp.245–264.
[7]. IS 10262 (1982) - Recommended guidelines for concrete mix design.
[8]. IS 12269 (1993) - Ordinary Portland cement, 53 grade – Specification.
[9]. IS 383 (1970) - Specification for coarse and fine aggregate from natural resources for concrete.
[10]. IS 456 (2000) - Plain and reinforcement concrete- code of practice.
[11]. IS 801 (1975) - Code of practice for use of cold formed light gauge steel structural members in general building construction.
[12]. Johnson R.P. (1970), ‘Research on steel concrete composite beams’, ASCE Journal of Structural Division, Vol. 96, No.3, pp.445–59.
[13]. Kumar B.R., Patidar A.K. and Santhi H. (2013), “Finite Element Analysis Of Concrete Filled Cold Formed Steel Sections Using Ansys’, International Journal of Engineering Research & Technology, Vol No.1, pp.11-18