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Experimental Investigation of Reinforced Concrete Beam with Rectangular Spiral Shear Reinforcement

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ABSTRACT

Present study gives the shear behavior of Rectangular spiral reinforced beam of M25 grade of concrete. The spiral reinforcement is use to increase flexural strength of a beam. It is found that shear cracks are proportionally increase with spacing of shear reinforcement it is observed that the longitudinal reinforcement plays very important role to minimize shear cracks.

The present experiment carries 27 beams having cross section 2000mm x 150mm x 150mm, 2000mm x 150mm x 300mm, 2000mm x150mm x 450mm. Each set consist of 9 Nos. of beams. In each set 3 beams are control beam and other 6 are made with rectangular spiral shear reinforcement with spacing 100 mm and 150 mm.

Experimental result includes ultimate loads & first cracking loads, mid span deflection and crack pattern of the beam. Result shows that beams with rectangular spiral shear reinforcement carries more load compared to control beam and evaluate less deflection compared to control sections. Initial cracks appear for higher loads in case of rectangular spiral reinforced beams

Hence rectangular spiral shear reinforcement shows better response in terms of load carrying capacity and deflection at mid span.

Keywords- Rectangular spiral reinforcement, shear, Control beams, tests

I. INTRODUCTION

Reinforced concrete is most widely accepted material for the rapid urbanization of city. It is widely used in the construction industry all over the world. The use of reinforced concrete has increased due to its noticeable advantages like high modulus of elasticity, freeze thaw resistance, chemical resistance, low creep, shrinkage and permeability.

A predominant failure mode of beam members is shear failure and the shear action leads to compression in a diagonal direction and tension in a perpendicular to it. The following factors are influenced the shear behavior of beams. The various factors are (i) Shear span to effective depth ratio (a/d) (ii) Longitudinal reinforcement steel ratio (ρ) (iii) Aggregate type (iv) Strength of concrete (v) Type of Loading (vi) Support conditions.

The reinforced concrete beam subjected to shear forces and shear cracks which are diagonally towards axis of beam. To minimize such effect we provide shear reinforcement in beams. Usually the shear reinforcement is individual vertical stirrups or continuous reinforcement.

It is generally recognized that the use of continuous spiral reinforcement in Reinforced Concrete (RC) elements with cyclic cross section can substantially improve the strength and the ductility of the concrete and also the overall seismic response as well as capacity of the structural element. Previously, the use of continuous spiral reinforcement has been implemented in RC elements with rectangular cross-sections. The implementation of the use of rectangular spiral reinforcement in elements with rectangular cross-sections is a new technology that is estimated and it can enhance the capacity and the performance of these RC members. It is accepted that the use of rectangular spiral reinforcement in reinforced concrete elements can substantially improve the strength and the ductility of the concrete.

Fig.1 Rectangular Spiral Reinforcement.

1.1 Advantages

- Rectangular spiral reinforcement resists more shear cracks.
- Use of rectangular spiral reinforcement improves shear capacity of beam.
- Rectangular spiralreinforcement enhances torsional capacity.
- It is having high energy dissipation capacity than conventional beam.
- Rectangular spiral reinforcement beam shows smaller shear crack width in comparison with conventional vertical stirrups.
- It can quickly install on place easily.
- It reduces labor time and cost for installation

1.2 Disadvantage

- Preparation of rectangular spiral reinforcement cage is somewhat hectic job for workers.
- Highly skilled labor required to prepare such cage

II. EXPERIMENTAL PROGRAM

Three categories of beams sizes are considered with varying depth. (150mm, 300mm,450mm). Total nine numbers of reinforced concrete rectangular beams were cast for the experimental study in each set. Three are taken as controlled beam, three beams are casted as rectangular spiral reinforcement with spacing 100 mm and three beams are casted as rectangular spiral reinforcement with spacing 150 mm.

2.1 BEAM SPECIMEN FOR TESTING.

The experimental programs consisted of a total twenty seven rectangular beams designed as under reinforced concrete. Out of these all beams nine beams are of size 150mm ×150mm ×2000mm, 2Nos-10 mm diameter bars were used for tension reinforcement at bottom of each beam, 2Nos-10 mm at the top of each beam as a anchor bar and 6 mm diameter shear reinforcement. Other nine beams are of size 150mm ×300mm ×2000mm, 3Nos-12 mm diameter bars were used for tension reinforcement at bottom of each beam, 2Nos-10 mm at the top of each beam as a anchor bar and 6 mm diameter shear reinforcement, and remaining nine beams having size 150mm ×450mm ×2000mm, 2Nos-16 mm & 1Nos-12 mm diameter bars were used for tension reinforcement at bottom of each beam, 2Nos-10 mm at the top of each beam as a anchor bar and 6 mm diameter shear reinforcement. The reinforcement details of beam used for experiment has illustrated in the Fig. 2. The beams were casted by using M25 grade concrete. Beams were tested using two-point loading on a Universal Testing Machine of capacity 1000 kN.

2.2 Preparation of Test Specimen.

The detail of test specimens is given in Table 2. The surface of the beams was cleaned using polish paper to remove dust on surface of beam. Table-1 The detail of test specimens

No	Type of Beam	Beam Designation	No. of specimen (each set)
I	Controlled Beam	CB150, CB300, CB450	3
II	Rectangular Spiral Reinforcement Beam (With 100mm shear spacing)	RSR150-100, RSR300-100, RSR450-100,	3
III	Rectangular Spiral Reinforcement Beam (With 150mm shear spacing)	RSR150-150, RSR300-150, RSR450-150,	3

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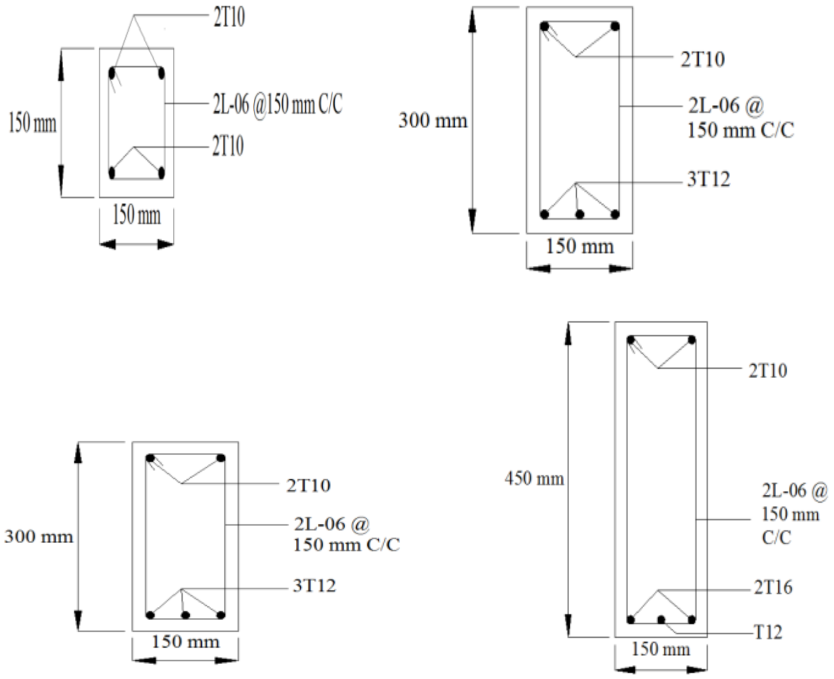

Fig.2 reinforcement detailing of control beam design for flexure

2.3 Test Setup

All beams were tested under universal testing machine. The load was applied by using Universal Testing Machine of capacity 1000 kN. During testing mid span displacement is measured by using dial gauge having a least count of 0.01mm with every load increment. Cracks formed on the surface of beam were observed and mark. We assembled two point load testing arrangement, as shown in fig.-3 and fig.-4

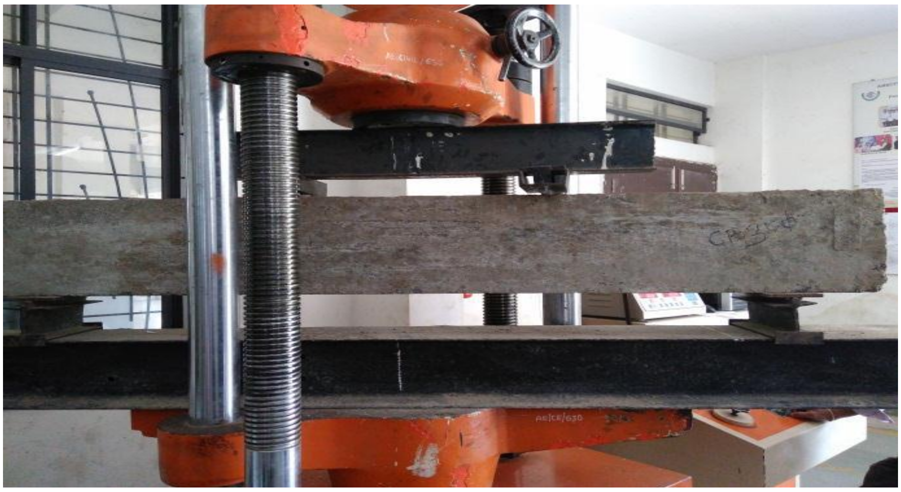

Fig.3 Test set up for control beam.

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Fig.4 Test set up for rectangular spiral reinforcement beam.

2.4 Failure Pattern

The cracks are developed in diagonal direction at two point loading in controlled beam. These cracks are shear cracks. Cracks are minimising in rectangular spiral reinforcement beam. The crack pattern of control beam and rectangular spiral reinforcement beam has been shown in fig.5 and fig.6.

Fig.5 Crack pattern of control beam

Fig.6 Crack pattern of rectangular spiral shear reinforced beam

III. RESULT AND DISCUSSION

All the tested specimens are studied. The load carrying capacity of rectangular spiral shear reinforced beam is more as compared to control beam. It shows that control specimen takes lesser load as compared to rectangular spiral shear reinforced beam. At the same time we have studied the mid span deflection which is always more for control beam as compare to rectangular spiral shear reinforced beam.

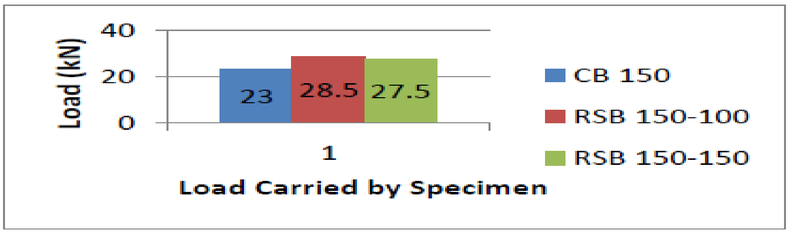


Fig.7 Comparison of experimental behavior for specimen set no.. 1

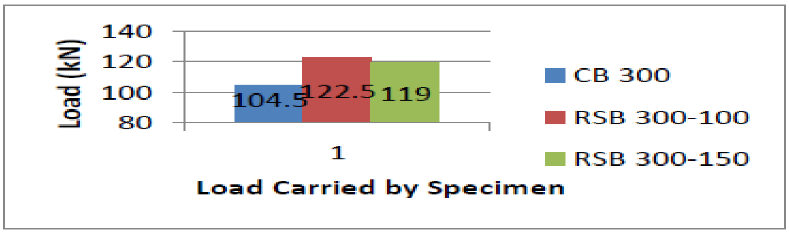


Fig. 8 comparison of experimental behavior for specimen

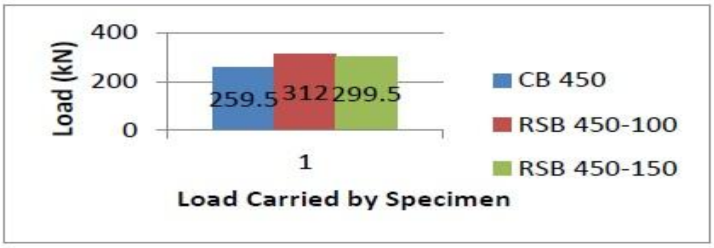
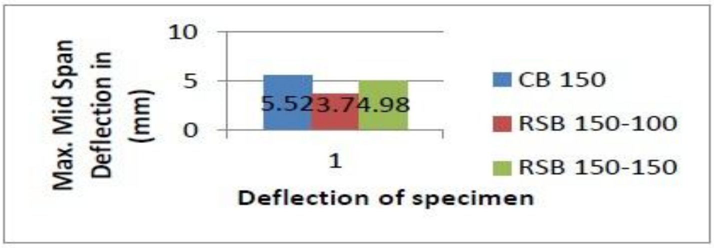


Fig. 9 Comparison of experimental behavior for specimen set no. 3



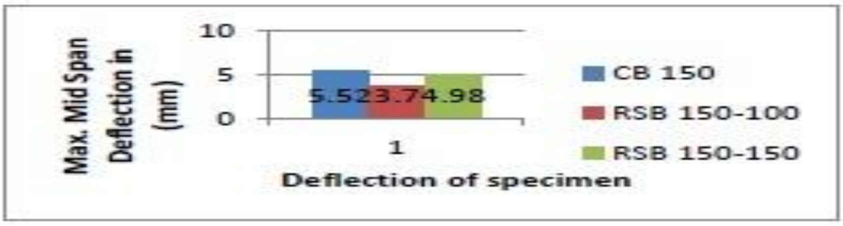


Fig. 10 Comparison of experimental behavior for specimen set no. 1

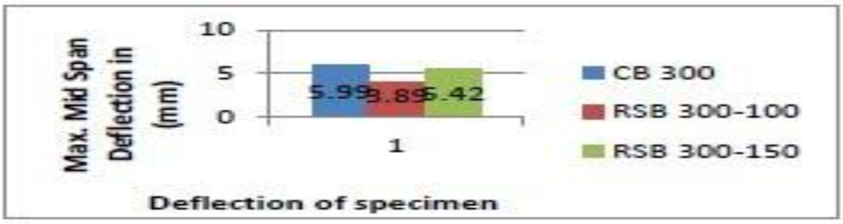


Fig. 11 Comparison of experimental behavior for specimen set no. 2

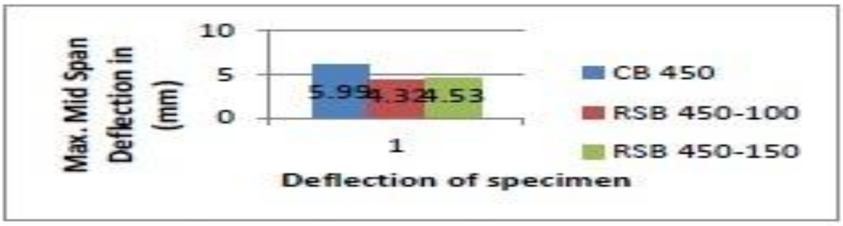


Fig. 12 Comparison of experimental behavior for specimen set no. 3

IV. CONCLUSIONS

The test results are clearly gives an idea that use of rectangular spiral shear reinforcement can enhance the load carrying capacity. Based on experimental results following conclusions are drawn.

1. Beams with spiral reinforcement spacing at 100 mm and 150 mm exhibited 20 % and 17.5% increased shear capacity with respect to the corresponding control beams with vertical stirrups.

2. However the mid span deflection of corresponding beam having rectangular spiral reinforcement spacing 100mm and 150 mm, evaluate less deflection compared to control sections.

3. Initial cracks appear for higher loads in case of rectangular spiral reinforced beams. The load carrying capacity of the rectangular spiral reinforced beams was found to be maximum of all the beams.

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