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A comparative study of welded and tied shear reinforcement in beams

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ABSTRACT

This paper presents an experimental investigation on reinforced concrete beams in which the spacing of shear reinforcement is varied and the bends of longitudinal and shear reinforcements are connected by two methods namely tying and welding. In one set of beams, stirrups were tied to the longitudinal bars to form three dimensional cages. For second set of beams, the stirrups were welded at the bends to the longitudinal bars. The spacing of transverse reinforcement was taken as 100 mm, 150mm and 200 mm. The beams were tested and first crack load and ultimate load carrying capacity of the beams were observed. Results of the study inferred that beams with 200 mm stirrup spacing whose bends welded to the longitudinal bars performed well in terms of load carrying capacity.

KEY WORDS: Shear reinforcement, concrete beams, tied reinforcement, welded stirrups, Ultimate load, first crack load

1. INTRODUCTION

Welded wire reinforcement is the recent advance in structural engineering and it is widely used in columns and beams, because of its economy, ease, and faster of construction as well as better quality control. Recent studies have also shown that welded wire reinforcement can be a good substitute for the conventional reinforcement and yielded excellent results both in strength and ductility. Confining the core of a reinforced concrete column with lateral reinforcement will significantly increase the strength and the ductility of the column. It also reduces the spalling of the concrete cover. The present investigation is aimed at comparing the load carrying capacity of conventional beams and beams with welded reinforcement bends. Although only nominal stirrups are generally required; the spacing of these stirrups was taken as the major study parameter. Totally six beams were casted three with tied stirrups and three with welded stirrups. The position of crack and the crack pattern for beams with different stirrup spacing were observed. Also the ultimate load carrying capacity of both tied and welded stirrups were compared.

2. EXPERIMENTAL INVESTIGATION

The materials required for the concrete beams are cement, fine aggregate, coarse aggregate, water, reinforcement bars. Cement used in the investigation was 53 Grade Ordinary Portland cement confirming to IS: 12269: 1987 with specific gravity of 3.14. The fine aggregate conforming to zone - 2 according to IS 383: 1970 was used. The sand passing through IS 4.75 mm sieve was used with specific gravity of 2.64

The coarse aggregate which pass through 20 mm and retained on 12.5 mm IS sieve were selected with specific gravity of 2.77. Potable water was used in the experimental work for both mixing and curing purposes. Reinforcements are often added to concrete to increase the load carrying capacity and durability. The reinforcement bars were used according to IS 800:2007. Mild steel Rods of 10 mm diameter were used as longitudinal reinforcement and 8 mm diameter were used as transverse reinforcement. Two types of reinforcement have been used with different set of beams. Tied reinforcement and welded reinforcement are used for different spacing of shear reinforcement.

Figure.1.Tied Reinforcement

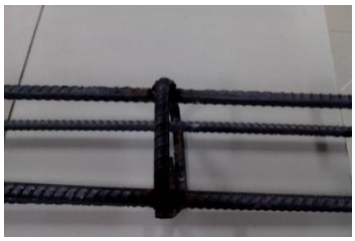

Figure.2.Welded Reinforcement

The beam was designed according to IS 456:2000 with the dimension 700 mm X150 mm X 150 mm. The beam was casted with the mix proportion 1:1.5:3 and a water cement ratio of 0.5 were used. Totally six number of beams were casted with three different spacing of transverse reinforcement. The spacing's of transverse reinforcement were 100 mm, 150mm and 200 mm. A set of three beams were casted in such a way that the reinforcement joints were tied and another set of three beams were casted with the welded reinforcement joints. M20 grade of concrete was used for the beam casting. The specimens were tested after 28 days curing. The compressive strength of concrete at 28 days was 23.4 N/mm²and the split tensile strength of the cylinder was 2.9 N/mm². These beams were tested for obtaining the first crack load and ultimate load.

Experimental setup: The beams were simply supported with an overhang of 70 mm on both the sides. The beams were loaded at two points - at distances of 234 mm (span/3) from either support. A hydraulic jack with a maximum capacity of 50 T was used to apply loads. The load at first crack and deflection at first crack were noted. The deflection values were determined with the help of dial gauge kept under the loading point.

3. RESULTS AND DISCUSSION

The two set of beam specimen were cured and tested for obtaining the first crack load and ultimate load. The loading position for two point loading is shown in figure.4.The loads of both tied and welded beams for both first crack and ultimate load are given in table.1.

Figure.3.Experimental setup

Figure.4.Loading positions for two point loading

Table.1.Tied and welded beams for first crack load and Ultimate load

Load at	Stirrup spacing	Tied	Welded	% increase of load carrying capacity
First crack load	100mm	31.65	35.42	11.9
	150mm	28.84	32.76	13.6
	200mm	26.22	30.57	16.6
Ultimate load	100mm	85.21	93.05	9.2
	150mm	79.97	88.3	10.5
	200mm	72.25	80.07	11.7

The comparison chart of both the set of beams for first crack load and ultimate load are given in fig .5 and fig. 6. It was observed from the results as the spacing of the stirrups increases the ultimate load carrying capacity of the tied stirrups decreases where as it is vice versa in case welded stirrup (Table1).

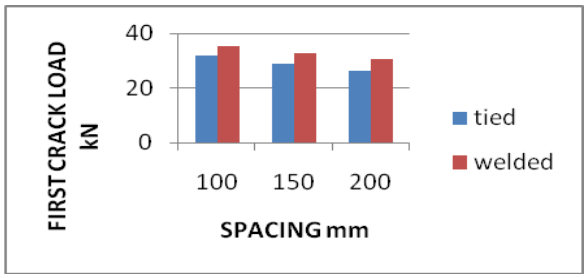

Figure.5.Comparison of first crack load for tied and welded

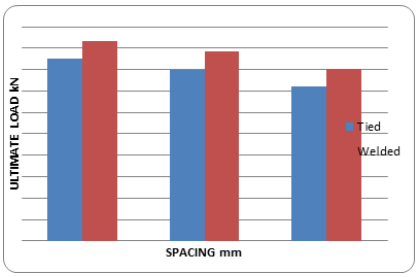

Figure.6.Comparison of ultimate load for tied and welded

Figure.7.Crack pattern in beam with 100 mm spaced tied stirrups

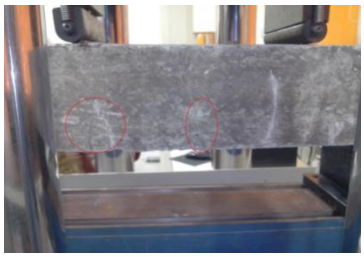

Figure.8. Crack pattern in beam with 100mm spaced welded stirrups

Figure.9.Crack pattern in beam with 150 mm spaced tied stirrups

Figure.10.Crack pattern in beam with 150 mm spaced welded stirrups

Figure.11.Crack pattern in beam with spaced tied stirrups

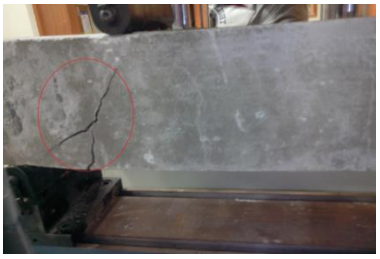

Figure.12.Crack pattern in beam with 200 mm 200 mm spaced welded stirrups

The crack pattern of beam with spacing of 100 mm,150 mm,200 mm 100 mm tied stirrups are shown in fig.7,9,and11.The vertical cracks were found in the tension zone due to bending. They were positioned under the loading points. The crack pattern of beam with spacing of 100 mm, 150 mm, 200 mm welded stirrups are shown in fig .8, 10, and 12.Both vertical and diagonal cracks were found in the tension zone due to bending in welded stirrups. In the type of beams the cracks propagated from the tension zone towards the neutral axis. There was no spalling of concrete in welded reinforcement compared to tied reinforcement.

4. CONCLUSION

- Welded stirrups showed a slightly better behavior in the control of cracks in comparison to the equivalent amount of tied stirrups.
- Although increase in spacing decreases the load carrying capacity the percentage if increase in them does not have much influence.
- Better confinement of concrete is observed in case of welded reinforcement.
- The proposed models, beams with welded reinforcement joints provide better load carrying capacity compared with conventionally tied concrete beams.

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