EXPERIMENTAL AND ANALYTICAL INVESTIGATION OF RC BEAM WITH WELDED WIRE MESH AS SHEAR REINFORCEMENT

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Abstract - *This paper presents experimental and analytical investigation of reinforced concrete beam with welded wire mesh as shear reinforcement in flexural and shear behaviour with different parameters. In this the experimental work part contains six specimens on the behaviour of Rectangular concrete beams with Shear reinforcement by Welded mesh was carried out. One Control beam with conventional reinforcement and five other beams with varies welded mesh were cast and tested under two point loading. The finite element method is used to study the behavior of these reinforced concrete beams by using ANSYS computer program. A parametric study has been carried out by using ANSYS program to investigate the effects of welded wire mesh as shear reinforcement. The comparison was carried out between experimental and ansys on various conditions.*

***Key Words*: RC Beam, welded wire mesh, Finite element analysis, ANSYS**

1. INTRODUCTION

The development of reinforced concrete structures was been largely employed under different methods and various situation based upon the conditions in engineering practice. Reinforced concrete was been used in every place to withstand high strength to the building structures. As a renowned firm, we are involved in manufacturing and supplying a wide assortment of welded mesh, industrial wire products, welded wire products and other wire products. Our assortment includes welded wire mesh, mild steel wire, chain link fencing, barbed wire and galvanized wire. The use of welded wire mesh as the shear reinforcement in the flexural and shear behaviour. The welded wire mesh has a better characteristic strength and excellent bonding capacity. It is formed from stainless steel that has extraordinary strength and reliability. This corrosion resistance meshed wire is long lasting. Welded mesh has been widely used in buildings that Weld mesh can be a good substitute for the conventional reinforcement and yielded excellent results both in strength and ductility. The welds have strong mechanical anchorage behaviour at each the intersections are further responsible in imparting an immense deal of homogeneity to the R.C.C section as a whole. The two dimensional uniform stress distribution of the welded mesh with the concrete achieves better plate behaviour in the slab. There is no cutting of bars, no marking and spacing them out, and above all no laborious tying of binding wires. The usage of thinner wire lends the fabric as extremely flexible in handling. WWF is the only solution for the thin and tough spine of thin and efficient structural elements such as folded plate roofs, folded plate precast roof girders or hyperbolic paraboloid shells. It can be used as Structural Slabs & Walls, Roads or Pavements, Precast Members.

1.1 Details of experimental test

The experimental test comprises the following tests were conducted in the laboratory as per relevant Indian Standard codes. Basic tests were conducted on fine aggregate, coarse aggregate, and cement to check their suitability for concrete making. The properties of fine and coarse aggregates, sieve analysis of fine and coarse aggregates, tests on cement were found. The study aims to investigate the strength related properties of concrete of M20 grade. All cubes, cylinders and beams were cast as per the M20 grade of concrete. Totally six cube specimens and six cylinders and six beams were cast. Cubes and cylinders were taken both 7 days and 28 days test.

1.2 Beam details and test

Six beams were casted under different conditions and tested. One is control beam and the other five beam was with and without welded mesh by varying at different length. The beam specimens are of size 2000mm X 200mm x 100mm, reinforced with 2 numbers of 12mm diameter HYSD bars in tension and 2 numbers of 8mm diameter HYSD bars in compression zone as hanger rods. The specimen is also provided with shear reinforcement in the form of 6mm diameter mild steel bar two legged stirrups at 120mm Centre for control beam and weld mesh of grid configuration 76.2 mm x 50.8 mm and of diameter 2mm with various span sizes for other specimens. Welded wire mesh generally consists of wires arranged in two orthogonal directions and is prefabricated in a production line.

SP 1: The Specimen is fully stirrup with welded mesh.

SP 2: From both the supports L/4 length of the specimen welded mesh as well as L/2 of the specimen conventional stirrups.

SP 3: From both the supports L/4 length of the specimen welded mesh and L/2 of specimen no stirrups.

SP 4: From both the supports L/3 length of the specimen welded mesh and L/3 of specimen conventional stirrups.

SP 5: From both the supports L/3 length of the specimen welded mesh and no stirrups for remaining length.

SP 6: Fully Conventional stirrups.

All beams were tested in reaction type loading frame of capacity 500 KN. The span of the beams kept as 2100 mm with simply supported end condition and was tested under two point loading applied at one third span points through a stiff beam. Deflections of the beams were measured by three LVDTs at midspan.

Fig -1: Reinforcement detail

Fig -2: Casting of beam

Fig -3: Beam specimens

Fig -4: Testing of Beam specimens

2. ANALYSIS

The Finite Element modeling of a beam is carried out using ANSYS 16.0 software. Solid 65 elements were used to model of concrete and LINK180 were used to model the steel.

Concrete : The Solid element (Solid 65) has eight nodes with three degrees of freedom at each node and translations in the nodal x, y, and z directions. The element is capable of plastic deformation, cracking in three orthogonal directions, and crushing.

Table -1: Material properties of concrete

S.NO	PROPERTIES	VALUE
1	Young's Modulus	22.3 x10^3 N/mm^2
2	Poisson Ratio	0.15
3	Density	2500 Kg/m^3

Steel Reinforcement and welded wire mesh

Link-180 element is a uniaxial tension-compression element with three degrees of freedom at each node: translations in the nodal x, y, and z directions. Elastic modulus and yield stress for the steel reinforcement used in this FEM study are taken from the material properties of the steel components used for the experimental tests. The steel for the finite element models is assumed to be an elastic-perfectly plastic material and identical in tension and compression. A Poisson's ratio of 0.3 is used for the steel reinforcement.

Table -2: Material properties of Steel reinforcement &welded wire mesh

S.NO	PROPERTIES	VALUE
1	Young's Modulus	2 x10^3 N/mm^2
2	Poisson Ratio	0.3
3	Density	7850 Kg/m^3
4	Yield stress for steel reinforcement	415
5	Yield stress for steel wire mesh	210

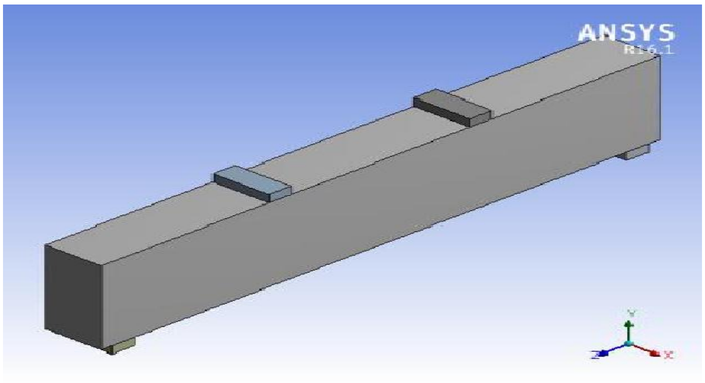

Fig -5: Model of Beam

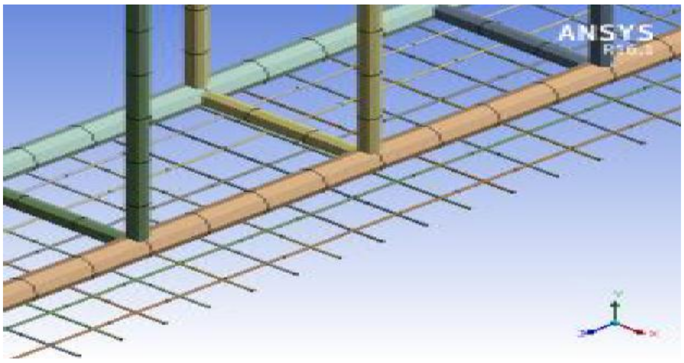

Fig -5: Reinforcement of Beam

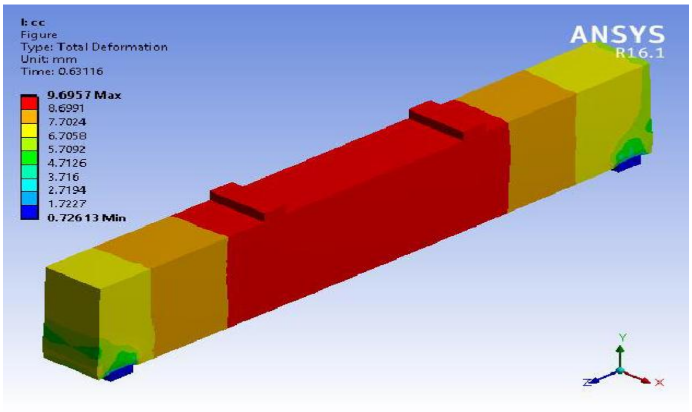

Fig -5: Deformation of Beam(1)

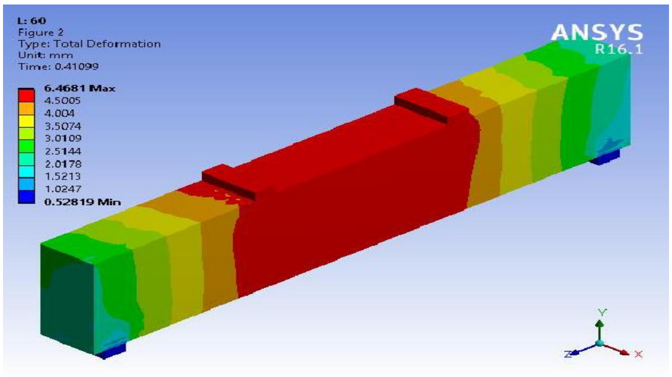

Fig -5: Deformation of Beam(6)

3. RESULTS AND DISCUSSIONS

The results of the experimental investigation on six beam specimens are presented in this chapter.

Table -2: Experimental Test Results on Beam Specimens

Specimen	Volumetric ratio	Initial Crack Load (KN)	Ultimate Load (KN)
SP 2	0.630	12	62
SP 3	0.160	14	58
SP 4	0.480	16	62
SP 5	0.164	10	46
SP 6	1	12	60

Table -2: Comparsion of Experimental Test Results and FEM

Specimen	**Ultimate Load (KN)** (Experimental)	**Mid span deflection at Ultimate Load (mm)** (Experimental)	**Ultimate Load (KN)** (FEM)	**Mid span deflection at Ultimate Load (mm)** (FEM)
SP 1	66.54	28.98	72.43	25.66
SP 2	63.92	25.39	67.50	22.95
SP 3	58.81	65.34	61.70	60.87
SP 4	62.09	36.84	70.19	32.44
SP 5	47.68	37.85	53.49	35.15
SP 6	61.17	33.49	77.46	30.73

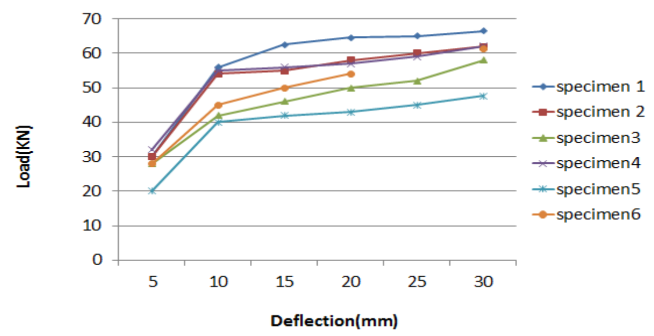

Chart -1: Load deflection behavior for all beam(Experimental)

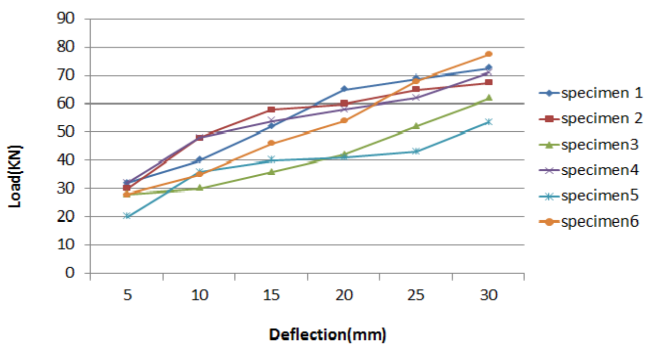

Chart -2: Load deflection behavior for all beam(FEM)

SHEAR FAILURE OF BEAMS

The nominal shear is less than designed shear strength of concrete beam, the minimum shear reinforcement shall be provided. The nominal shear is exceeds designed shear strength of concrete beam, the shear reinforcement shall be provided. The effect of shear stress is greatest in web of the beam and is maximum at the neutral axis and decrease to zero at the extreme edges.

The Modes of failure of all beams are as follows,

- All Reinforced cocnrete beams failed in flexure zone.
- After the first crack load, the reinforcement started yielding and more number of cracks have formed in the flexure zone and extended towards the point loads with increment in loads.
- At the ultimate load, the failure of all concrete beam with welded mesh occurred with crushing of concrete in compression zone.
- In the Specimens SP 3 and SP 5 more number of cracks formed in flexure zone. This is due to the absence of shear reinforcement in the flexure zone at the mid span.
- Specimens SP 2 and SP 5 having less number of cracks formed in flexure zone. It indicates that the combination of weld mesh shear reinforcement with conventional stirrups provide mariginally high strength and cracking reistance.

3. CONCLUSION

Based on the analysis results of the experimental and numerical investigations of the solid and hollow-core slabs, the following conclusions can be drawn:

1. The flexural strength of beam increases nominally and remains unaffected compared to that of control specimen for the fully welded mesh shear reinforcement provided throughout the length of the specimen.
2. Even though Shear Reinforcement was replaced with welded mesh there is no appreciable change in flexural load carrying capacity.
3. The load carrying capacity reduces in the case of specimen provided with very small volume of welded mesh shear reinforcement at the supports only.
4. In the mode of failure and crack pattern of the conventional RCC Beam specimen with welded mesh specimen are similar.
5. Failure mode and load carrying capacity depends on the volumetric ratio of welded mesh provided.
6. When the shear stirrups are completely replaced with welded mesh, when the welded mesh distribute throughout the span, behaviour of beam is better than other beam. Load vs deflection behaviour of this beam also better than other beams.
7.
8. Out of the six specimens tested the specimens with the provision of fully welded mesh of grid configuration 50.8 x 50.8 mm exhibits better performance.
9. Since there is reduction in cost, the use if welded mesh is found to be a suitable alternative to conventional shear stirrups.
10. Finite element analysis using ANSYS was appropriated to model the analyzed beam and a large agreement was succeeded.
11. The general conclusion is that the 3D ANSYS model is able to properly simulate the non linear behavior of the steel fibre reinforced concrete slabs under flexure. The general behavior of the finite element models shows good agreement with observations and data from the experimental tests.

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