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STUDY ON SELF COMPACTING BEAM WITH WELDED WIRE MESH AS SHEAR REINFORCEMENT

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Abstract: This paper presents a study of shear behaviour of concrete beams. Normally shear reinforcement of concrete beams consist of traditional stirrups. Replacing these stirrups by welded wire mesh eliminates some of the detailing problems inherent in traditional rebar in the Reinforced Concrete Construction resulting in easier and faster construction, and better economy and quality control. In this present study behaviour of rectangular concrete beams with Shear reinforcement as Welded mesh in self compacting concrete was carried out. One control beam with conventional reinforcement and remaining with welded wire mesh as shear reinforcement at constant shear span to depth ratio is carried out. In this present study shear behaviour of self compacting concrete beams with channel shaped shear reinforcement in one, two and three layers were studied.

Index Terms – Self compacting concrete and welded wire mesh.

I INTRODUCTION

The use of self compacting concrete (SCC) is steadily increasing, mainly in the precast industry, and large amount of research has been conducted on the fresh and hardened properties of SCC. In comparison with a vibrated concrete (VC) of the same strength class, self-compacting concrete (SCC) typically has a lower coarse aggregate content and, possibly, a smaller maximum aggregate size. This may result in reduced aggregate interlock between the fracture surfaces of a SCC. Since aggregate interlock plays an important role in the shear strength of slender beams, SCC beams may have shear strength lower than that of similar VC beams, but studies on that subject are still limited. By the use of small percentage of transverse reinforcement the shear capacity of beams can be increased. All reinforced concrete beams require shear reinforcement, calculated or minimum ratio. Theoretically, calculated shear reinforcement is only required when the externally applied shear force V exceeds the design shear resistance of the member without shear reinforcement. However, for various reasons, including avoiding brittle fracture, minimum shear reinforcement should be provided. Welded wire mesh generally consists of wires arranged in two orthogonal directions and is prefabricated in a production line. Because of its economy, ease, and faster of construction as well as better quality control, 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. Nowadays, the welded wire mesh (WWM) was used to enhance both flexural and shear behaviors of RC beams.

II MATERIALS AND METHODS

Ordinary Portland Cement (OPC Grade 53) was used in this study. Class C flyash is the mineral admixture taken from the thermal power plant. Properties of cement and flyash were tested. M sand with maximum size of 4.75 mm confirming to grading zone II as per IS 2386(1) - 1963 was used as fine aggregate. Coarse aggregate of 20 mm maximum size was used as coarse aggregate. MASTER GLENIUM SKY 8233 superplasticizer was used as chemical admixture. It is free of chloride & low alkali also compatible with all types of cements. The fresh and hardened properties of SCC depends on chemical composition of both mineral and chemical admixture.

Table 1 Performance Data of MASTER GLENIUM SKY 8233

Aspect	Light brown liquid
Relative Density	1.08 ± 0.01 at 25˚c
pH	≥ 6
Chloride iron content	< 0.2 %

III MIX PROPORTION

The mix proportion for SCC-25 grade of concrete was arrived, and design was done basedon IS 10262:2009. The sequence of mix design is as below

- Designation of desired air content (mostly 2 %)
- Determination of coarse aggregate volume
- Determination of sand content
- Design of paste composition
- Determination of optimum water – powder ratio and superplasticizer dosage in mortar
- Finally the concrete properties are assigned by standard tests

Table 2 Mix Proportion

Material	Cement	Fly ash	Fine aggregate	Coarse aggregate	Water
Weight (kg/m^3)	510	90	1051.763	614.908	186
Ratio	1 : 1.7 : 1				
W/C Ratio	0.364				

IV FLOWABILITY AND PASSING ABILITY

Self compacting concrete has the properties such as filling ability , passing ability and segregation resistance. Various workability methods are available for self compacting concrete such as slump flow test ,V- funnel test , L – box test ,U – box test , fill box test. The slump flow test is done to know the horizontal flow of concrete in the absence of obstructions . It gives good assessment of filling ability. During the slump flow test , the viscosity of SCC mixture can be estimated by measuring the time taken for the concrete to reach a spread diameter of 500 mm from the moment the slump cone is lifted. The higher the slump flow (SF) value, the greater its ability to fill formwork under its own weight. A value of at least 650mm is required for SCC. The T50 time is a secondary indication of flow. A lower time indicates greater flowability. The Brite EuRam research suggested that a time of 3-7 seconds is acceptable for civil engineering applications, and 2-5 seconds for housing applications.
The L – box test assesses the flow of the concrete, and also the extent to which it is subject to blocking by reinforcement. If the concrete flows as freely as water, at rest it will be horizontal, so the blocking ratio (H2/H1) is 1. Therefore the nearer this test value, the 'blocking ratio', is to unity, the better the flow of the concrete. The EU research team suggested a minimum acceptable value of 0.8.The observed value is unity and hence the mix is good enough with its passing ability.

Fig. 1 Slump Flow Testing

Fig. 2 L – box Testing

Table 3 Test Result on Fresh State Test

SL. NO.	Trial Mix	Slump	T_{50} cm (Sec)	L - box
1	SCC 1	450	40	0.2
2	SCC 2	480	37	0.4
3	SCC 3	400	23	0.6
4	SCC 4	580	18	0.8
5	SCC 5	600	6.18	0.9

IV HARDENED STATE TEST

The properties of hardened concrete, such as compressive strength, split tensile strength and flexural strength of concrete mixes were determined by casting 150 x 150 x 150 mm cube specimens, 150 x 300 mm cylinder specimens and 100 x 100 x 500 mm beam specimens as per IS specifications.

Table 4 Test result on Hardened State Test

Sample Number	Compressive Strength of Cube (N/mm^2)	Split Tensile strength (N/mm^2)
1	23.5	2.27
2	24	2.63
3	24.2	2.41
Average	23.9	2.33

V TEST ON BEAM

Two point bending test provides values for the modulus of elasticity in bending E_f, flexural stress σ_f, flexural strain ε_f and the flexural stress – strain response of the material. This test is very similar to three point bending flexural test. The major difference being that with the addition of fourth bearing points is put under maximum stress as opposed to only the material right under the central bearing in the case of three point bending. The shear strength of the specimens is tested using a 30 ton loading frame. A dial gauge is attached at the bottom of the beam to determine the deflection at the centre of the beam. For the testing of the specimen the supports are provided at a distance of 130mm from the edges of the beam. The effective span of the beam is 990 mm in the case of 1250 mm beam. A proving ring of 500kN is connected at the top of the beam to determine the load applied.

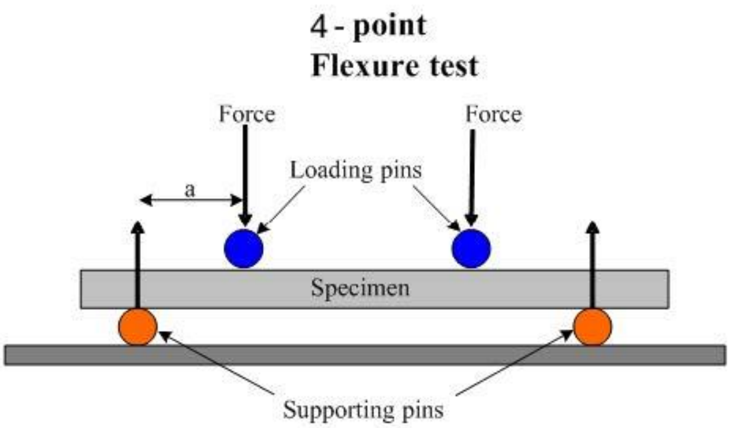

Fig. 3 Four Point Flexure Test

VI RESULT AND DISCUSSIONS

6.1 LOAD – DEFLECTION BEHAVIOUR

Due to increase in the load, deflection of the beams starts, up to certain level the load v/s. deflection graph will be linear that is load will be directly proportional to deflection. Due to further increase in the load, the load value will not be proportional to deflection, since the deflection values increases as the strength of the materials goes on increasing material loses elasticity and undergoes plastic deformation. The deflection and the corresponding load, of SCC beam with different layers and shape of welded wire mesh is compared with SCC beams with vertical stirrups. It is observed that mid span deflection of the specimens SP1, SP 3, and SP 5 are having more or less same deflections. Specimen SP 4 having high deflections compared to that of other specimen. Specimen SP 2 having high deflection at the mid span, it is due to the absence of shear reinforcement at the mid span section, it is less stiffer than that of other beam specimens. Specimen SP 4 is also having high deflection and compared to the specimen SP 4 it is observed that the flexural strength of the specimen SP4 is lower than the specimen SP2. Here

SP1 : Specimen from both the supports L/4 length of the specimen welded mesh as well as L/2 of the specimen conventional stirrups

SP 2 : Specimen from both the supports L/4 length of the specimen welded mesh and L/2 of specimen no stirrups

SP 3 : Specimen from both the supports L/3 length of the specimen welded mesh as well as L/3 of the specimen conventional stirrups

SP 4 : Specimen from both the supports L/3 length of the specimen welded mesh and L/3 of specimen no stirrups

SP 5 : Conventional beam

It is observed for specimens having one layer and two layers of WMM. Especially after the cracking load. The beams with two WWM layers experienced higher initial stiffness than that of one WWM layer. At failure, the use of one layer of WWM increased the value of mid-span deflection by 22.6% compared to that of beam without WWM, and using two layers of WWM increased the deflection at failure by 60.34% than that of beam without WWM. This was due to the increase in the shear resistance of the beam having two layers of WWM that delayed the propagation of shear and flexural cracks located in the shear span.

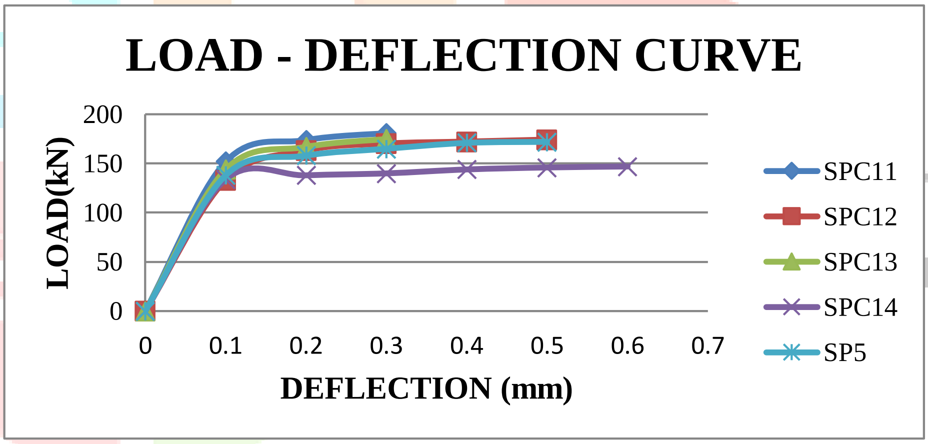

Fig. 4 Load – deflection Curve for one WWM layer specimen and comparison

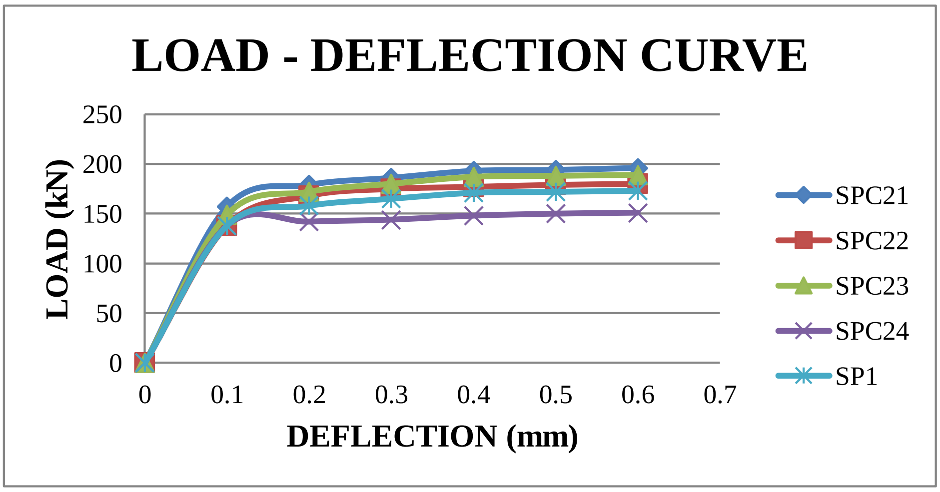

Fig. 5 Load – deflection curve for two WWM layer specimen and comparison

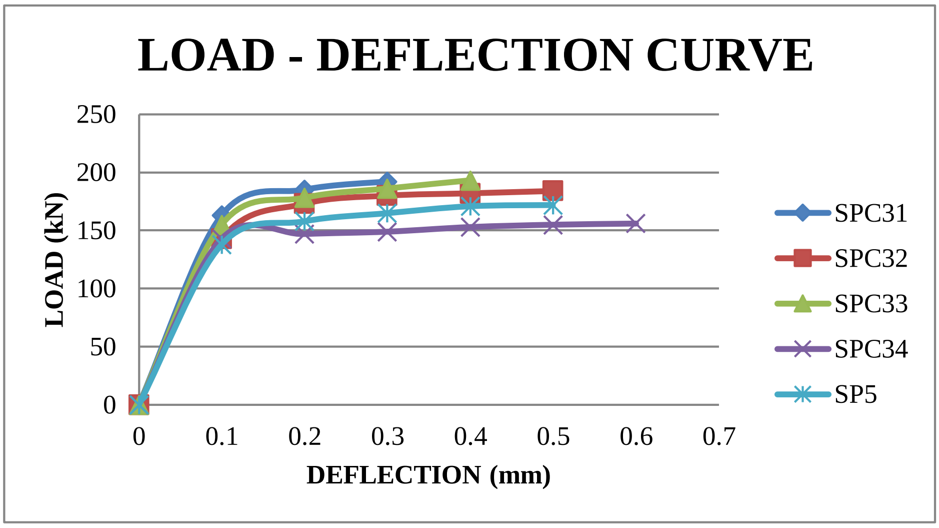

Fig. 6 Load – deflection curve for three WWM layer specimen and comparison

6.2 DUCTILITY

The ratio between the deflection at ultimate load (Δu) and the deflection at yielding load of the RC beams (Δy) was defined as ductility index (*DI*). The rate of increase in the ductility index from beam without WWM to that with one-layer WWM was higher than that from beam with one-layer WWM to that with two- layers WWM and from beam with two layer WWM to that of beam with three layer WWM. Moreover, a significant increase in the ductility index was observed when using two and three layers of WWM compared to the specimens without WWM .

6.3 CRACK PROPAGATION DURING STATIC TEST

In the under reinforced section beam, the member approaches failure due to gradual reduction of compression zone, exhibiting and cracks, which develop at the soffit and progress towards the compression face. It can be observed that the cracks in the control specimen are mainly flexural and the specimens with single layer of mesh also mainly flexural. But when we use the double and triple layer of mesh the cracks are both flexural as well as shear failure.

The modes of failure of all beams are as follows

- All Reinforced concrete 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 SPC12, SPC14, SPC22, SPC24, SPC32, SPC34 more number of cracks formed in the flexure zone. This is due to the absence of shear reinforcement in the midspan.
- In the specimens SPC11, SPC13, SPC21, SPC23, SPC31, SPC33 less number of cracks formed in the flexure zone. It indicates that the combination of weld mesh shear reinforcement with conventional stirrups provide marginally high strength and cracking resistance.

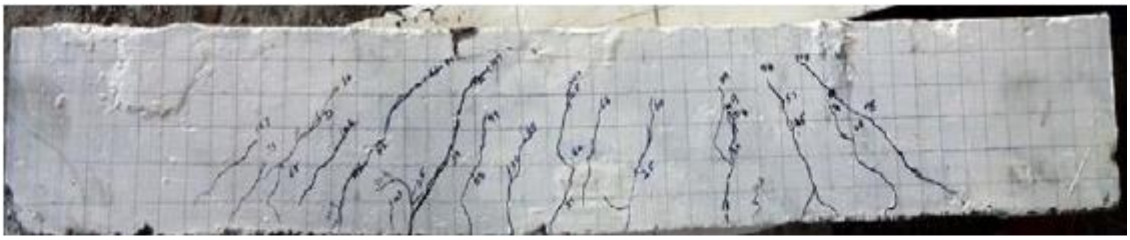

Fig. 6 Crack Propagation

VII CONCLUSIONS

The behaviour of shear critical beams were studied through monitoring the load – deflection behaviour, ultimate load values and crack propagation under four point bending test. Wire mesh when used as shear reinforcement in beam, enhanced the shear behaviour of the beam by distributing the shear forces along the section. The load carrying capacity of the beams slightly increases for the beams provided with WWM as shear reinforcement also the load carrying capacity of beams provided with channel shaped shear reinforcement is greater than the beams provided with rectangular cage shaped shear reinforcement. Beam using only wire mesh as shear reinforcement have performed better than any other specimen by having low deflection at peak load. By reducing the number of stirrups and increasing the number of layers the ductility of the specimen can be made marginally more than the control specimen. The use of wire mesh have made a significant effect on delaying the crack, increasing the number of crack and reducing the crack width. The percentage of increase for beams additionally reinforced in shear with one , two and three WWM layers was about 6.2% , 9.2% and 12.2 % over that of RC beam without WWM.

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