An Experimental Study on Shear Strength of Flexural Member Using 2-side Inclined Continuos Stirrups

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***Abstract*— A beam is a horizontal flexural member which provides support to the slab and vertical walls. A normal beam(simply supported) consist of two zones generally arise, compression zone at top and tension zone at bottom. Our aim is to reduce the shear failure of the structure and reduction in cost and time for make a stirrup without losing its strength and serviceability in the structural design. In this paper, an experimental Study on shear strength arrested concrete has been done to create reduction in shear crack and savings in materials. Hence we are comparing a 2-side inclined reinforced Stirrups(RC-2S) with a reinforced concrete Conventional beam (RC-CB) in terms of flexural strength. The beam is investigated in terms of crack load and deflection curves.**

Keywords—2S (2-Side inclined stirrups), flexural strength, deflection, beam, compression zone, tension zone

I. Introduction

A beam is a structural element that primarily resists load applied laterally to the beam's axis. Its mode of deflection is primarily by bending. The loads applied to the beam results in reaction forces at the beam's support points. The total effect of all the forces acting on the beam is produce shear forces, bending moments and deflections of the beam. Beams are characterized by their manner of supports, profile (shape of cross-section), length and their materials Beams must also have an adequate safety margin against some type of failures such as shear, which may be more dangerous than flexural failure. The shear forces create additional tensile stress that must be considered. Shear failure of reinforced concrete beam, more properly called *diagonal tension failure* is difficult to predict accurately. In spite of many years of experimental research and the use of highly sophisticated computational tools, it is not fully understood. If a beam without properly designed for shear reinforcement is overloaded to failure, shear collapse is likely to occur suddenly. With no shear reinforcement provided the member failed immediately. So shear reinforcement should be provided to resist these shears which created on the beam. A flexural member designed to carry uniform or concentrated line loads. A beam may act as a primary member in beam-column frames, or may be used to support slabs. A beam is a structural element that is capable of withstanding load primarily by resisting against bending. The bending force induced into the material of the beam as a result of the external loads, own weight, span and external reactions to these loads is called a bending moment. It is equal or slightly larger than the failure stress in tension. Flexural strength, also known as modulus of rupture, or bend strength, or transverse rupture strength is a material property, defined as the stress in a material just before it yields in a flexure test. Stirrups are a reinforcement, that are provide to resist the shear which induced on beams. The use of stirrups is needed to prevent the columns and beams form buckling. Stirrups are sometimes placed diagonally and often vertically as well. This is done to prevent shear failure which is usually diagonal in case of cracks in beams. The primary reason for the diagonal shear is due to compression and tension caused by transverse and vertical tension. Eventually diagonal tension occurs since concrete is stronger in compression as compared to tension. This tension is bound by steel stirrup which holds the cracked surface together. The spacing of the stirrup along the beam is important and should ideally be specified by the designer. This will help the stirrups to be manufactured accordingly. They are usually placed in places where there are high chances of shearing such as beneath large load and bearing points. Concrete is made strong by running bars of steel through them. However, stirrups are used to keep everything in a straight line. Stirrups help keep order and also add strength to the structure at critical points of probable vulnerability from use over time. Steel rebar are stronger than stirrups. However, often it is seen that stirrups are used along with rebar. While rebar act as the bones of the concrete, the stirrups aid the rebar to remain straight and provide enhanced backing to the column of concrete inside which it is placed. Stirrups help secure much needed resistance. When the pressure from above comes down on the column, the stirrups act like tendons. They help the rebar and concrete provide sustainable support for the extreme amounts of load. Stirrups are an essentially high strength steel wire which helps the concrete columns just as the windows are held together by metal wires.

2. LITERATURE SURVEY

This Experimental study was conducted on RCC beams to investigate the strength and shear resisting capacity of various shear reinforcements such as traditional shear reinforcements, inclined shear reinforcements, combination of vertical and inclined shear reinforcements and vertical shear reinforcements with inclined cross bracings. The various parameters like load deflection characteristics, strength characteristics, shear cracks and failure mode of concrete were investigated. It was found that the shear reinforcement configuration influence the strength characteristics of the beam.

This literature state that there was an improvement in the shear resistance and stiffness was observed in inclined stirrup system in comparison with traditional stirrup system.

This paper presents an experimental investigation to clarify shear cracking behavior of reinforced concrete beams. The effects of the various influential parameters on the spacing between shear cracks and the relationship between shear crack width and stirrup strain at the intersection with shear cracks were carefully investigated. It was found that the shear crack width proportionally increases with both the strain of shear reinforcement and with the spacing between shear cracks.

This paper explains that the shear failure of reinforced concrete beam is often sudden and catastrophic. This sudden failure, due to, shear, made it necessary to explore more effective ways to design reinforced concrete beam for shear. The reinforced concrete beam show different behavior at the failure stage in shear compare to bending, which is considered to be unsafe mode of failure. The shear cracks progressive rapidly without sufficient advanced warning, and the diagonal cracks that develop due to excess shear forces are considerably wider than the flexural cracks. The cost and safety of shear reinforcement in reinforced concrete beams led to study of other alternatives. Bent-up bars have been used in the past. New form of bent-up bars will be used. Cross bars will be welded to these bent-up bars making rectangles capable of resisting shear in a plane compare to single bar performance. The main purpose is to identify the most efficient shape to carry shear forces at the lower cost. Several reinforced concrete beams were carefully prepared and tested in the lab. This literature explains the deflection of each beam is measure at applied load. The propagation of shear cracks was also closely monitored. This literature explains the shear cracking behavior in reinforced concrete beams with shear reinforcement clearly.

This paper explains test results of six large-size concrete beams reinforced with either conventional- or high-strength steel and tested up to failure. The beams were constructed without web reinforcement to evaluate the nominal shear strength provided by the concrete. The shear behavior, ultimate load-carrying capacity, and mode of failure are presented. The applicability of the current ACI design code to large-size concrete beams constructed without web reinforcement is discussed. The influence of the shear span depth ratio, concrete compressive strength, as well as the type and the amount of longitudinal steel reinforcement is investigated. The study shows that using high-strength steel alters the mode of failure from diagonal tension to shear compression failure and results in higher shear strength compared with using conventional steel. It was also found that the current ACI shear design provisions are unconservative for large-size concrete beams without web reinforcement. This literature clearly explains the shear behavior of large concrete beams that reinforced with high strength steel.

The shear transfer mechanism greatly depends on the diagonal compressive field in case of such loading condition, so concrete would be significant in the shear resistance. The past proposed equations of shear strength of reinforced concrete members are derived from the test results in the above mentioned loading condition. But there are member that are subjected to shear with the diagonal tension like as footing beams in high rise building, and the members should be designed considering the shear transfer mechanism depended on the diagonal tension field. The experimental study was carried out to investigate the shear behavior of such members. This literature clearly explains the influence of the loading condition in RC beams on the shear resistance and strength in presented.

3. METHODS AND MATERIAL PROPERTIES

3.1 Methodology:

Mix design of M40 concrete was done with various type of reinforced stirrups beam. The curing was done for 7, 14 and 28 days, after that the hardened tests of compressive, flexural and tensile were made on specimens for the strength test.

Material	Test	Result
Cement	Specific gravity	3.15
	Consistency	35%
	Fineness	1.00g for 100g of cement
Fine aggregate	Specific gravity	2.61
	Fineness modulus	0.592
Coarse aggregate	Fineness modulus	0.45
	Impact	18.2%

4. RESULTS AND DISCUSSION

Compressive strength is most important property of the hardened concrete. The concrete cubes were casted, cured and tested accordance with the IS standard and 7 & 28 days. Compressive strength result of concrete are listed in Table4.1. The highest compressive strength value is 42.08 $N/^{mm2}$ which is obtained at 28 days

Table 4.1Compressive Strength

SPECIMEN	7 DAYS (N/mm^2)	28 DAYS (N/mm^2)
CONVENSIONAL	27.26	42.08

4.2 Flexural Test for beam:

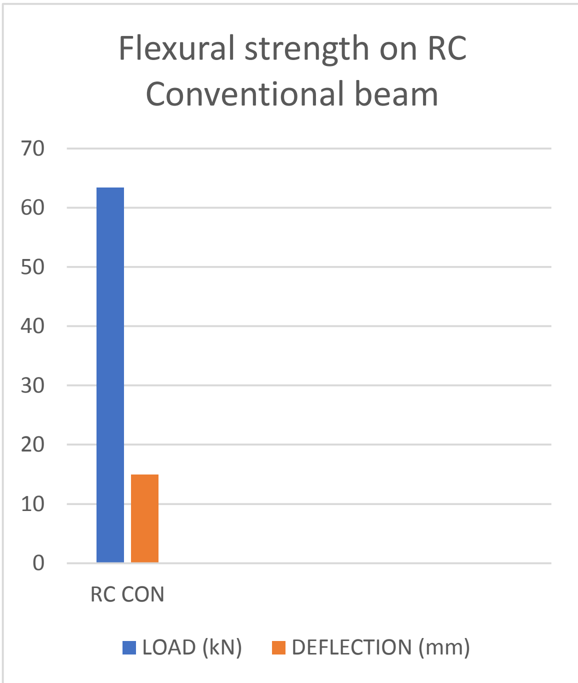
The flexural test were carried at 28 days beam

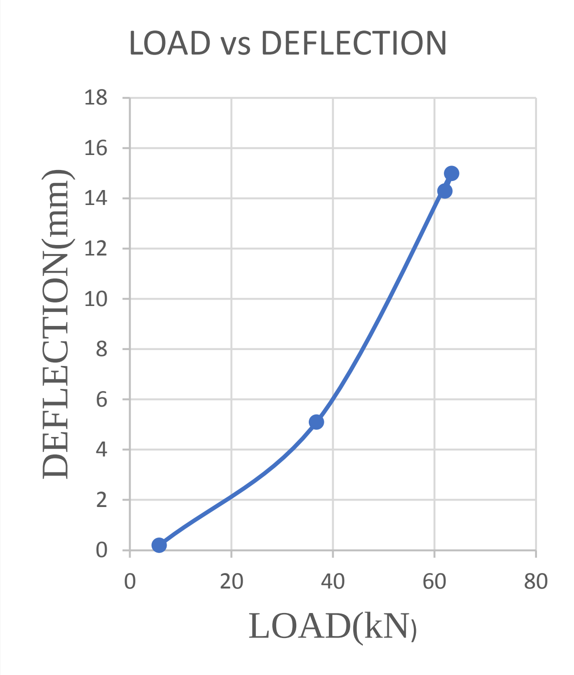
4.2.1 Flexural Test for Conventional beam:

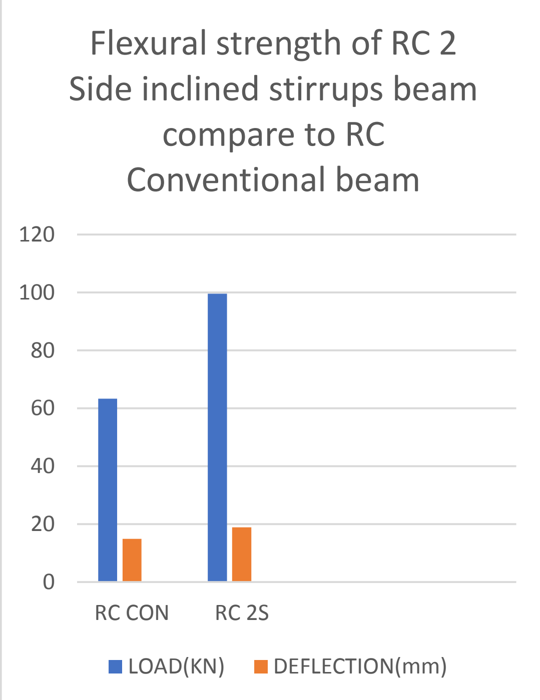
Load cell = 0

Channel (LVDT) = 9

SI.NO	LOAD(kN)	Deflecion (mm)
1	5.8	0.2
2	30.3	2.6
3	36.8	5.1
4	63.4	15.0





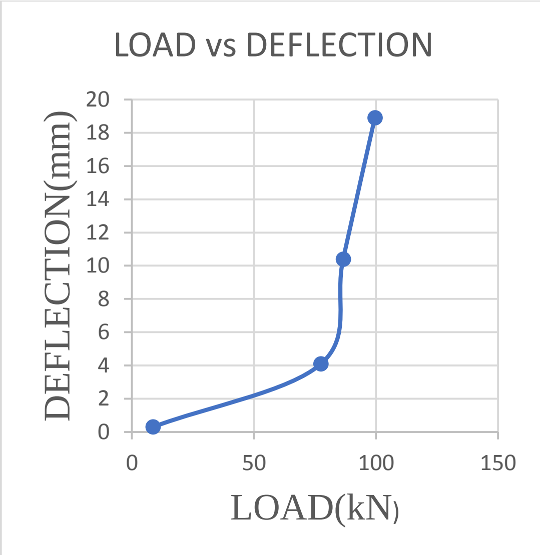


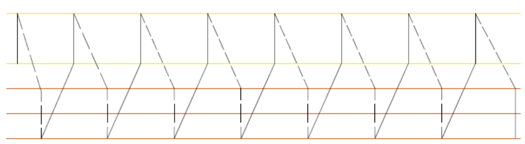
4.2.2 Flexural Test for RC-2S beam:

Load cell = 0

Channel (LVDT) = 9

SI.NO	LOAD(kN)	Deflecion(mm)
1	8.6	0.3
2	77.5	4.1
3	86.6	10.4
4	99.6	18.9





2- sides inclined

5. CONCLUSION

- The conventional reinforced concrete beam has the ultimate load carrying capacity of 63.4kN and deflection maximum of 15mm.
- The two side inclined reinforced stirrup concrete beams has a ultimate load carrying capacity of 99.6kN and a deflection maximum of 18.9mm, while comparing this with the previous two beam specimen it carried a huge amount of load and resist the shear in a massive way.

6. REFERENCES

[1] Park, R. & Paulay, T., Reinforced Concrete Structures, John Wiley & Sons, 1975.
[2] Saatcioglu, M. & Razvi, S., Strength and ductility of confined concrete, Structural Engineering, ASCE, 118(25), pp. 1590-1607, 1992.
[3] Sheik, S. & Toclucu, M., Reinforced concrete columns confined by circular spirals and hoops, ACI Structural, 90(5), pp. 542-553, 1993.
[4] Hellenic Aseismic Code 2000 (in Greek).
[5] Essawy, A.S. & El-Hawary, M., Strength and Ductility of Spirally Reinforced Rectangular Concrete Columns, Construction and Building Materials, 12(1), pp. 31-37, 1998.
[6] Karayannis, C.G., Sirkelis, G.M., Chalioris C.E. & Mavroidis, P.D., External RC Joints with continuous spiral reinforcement - Experimental investigation, Proc. of 14th Greek Concrete Conf., Vol. A, (in Greek), Kos,Greece, pp. 343-353, 2003.
[7] ASS Shahul Hameed M., Sekar, V Saraswathy Arabian Journal for Science and Engineering volume 37 , issue 3, pages 561-574 Strength and permeability characteristics atudy of self-compacting concret using crusher rock dust and marble sludge powder.
[8] Karayannis, C.G. & Sirkelis, G.M., Response of columns and joints with spiral shear reinforcement, Proc. of 12th Int. Conf. on Computational Methods and Experimenta Measurements (CMEM 2005), Malta, 2005.
[9] Karayannis, C.G. & Chalioris, C.E., Experimental Investigation of the Contribution of Bonded C-FRP jackets to Shear Capacity of RC Beams, Proc. of the Int. Symposia Celebrating Concrete: People and Practice, Vol. Role of Concrete in Sustainable Development, Dundee, Scotland, UK, pp. 689-696, 2003.
[10] Zararis P.D., Concrete Shear Failure in Reinforced Concrete Elements, Structural Engineering, ASCE, 122(9), pp. 1006-1015, 1996.
[11] S HAMEED M. Self concrete high performance green concrete for sustainable development 1 2009 National conference on “Recent advancements in construction materials