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Effect of Stirrups on Shear Behaviour in an RC Beam

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Abstract: In this paper, Effect of stirrups on shear behavior in an RC beam has been discussed. Concrete is remarkably strong in compression but weak in tension. Hence, the use of plain concrete as a structural material is limited to situations where significant tensile stresses and strain do not develop. This weakness in the concrete makes it to crack under small loads, at the tensile end. To overcome this the reinforced cement concrete is used, RCC is strong in both tension and compression, hence it is widely used. In an RCC beam, shear is mostly occurred at the edges of the beam. In an standard RCC beam the stirrups are provided at equal spacing throughout the entire beam. In this experimental study, the stirrups are provided at the edges where the shear are occurred. The beam size is about 700mm X 150mm X 150mm. In the first beam specimen only 3stirrups are provided at both the edges, then the stirrups are reduced to two and one at the edges for the respective beam specimens. Flexural strength test is carried out to determine the strength of the RCC beam and the results are compared with one another. By reducing the stirrups, the cost can be minimized and the work time can be reduced.

Keywords: RC beam, Reinforced cement concrete (RCC), UHPFRC

I.INTRODUCTION

Concrete is a composite material containing cement, water, coarse aggregate and fine aggregate. The resulting material is a stone like structure which is formed by the chemical reaction of the cement and water. This stone like material is a brittle material which is strong in compression but very weak in tension. This weakness in the concrete makes it to crack under small loads, at the tensile end. These cracks gradually propagate to the compression end of the member and finally, the member breaks. The formation of cracks in the concrete may also occur due to the drying shrinkage. The formation of cracks is the main reason for the failure of the concrete. To increase the tensile strength of concrete many attempts have been made. One of the successful and most commonly used method is providing steel reinforcement. Steel bars, however, reinforce concrete against local tension only. Cracks in reinforced concrete members extend freely until encountering are bar. Thus, need for multidirectional and closely spaced steel reinforcement arises. Concrete is the most extensively used material in Civil Engineering and is the primary component in most infrastructures. Although strength of the concrete is most important, it is also necessary that concrete is durable, workable and possess a good service life. Concrete is remarkably strong in compression but weak in tension. Hence, the use of plain concrete as a structural material is limited to situations where significant tensile stresses and strain do not develop.

Concrete is acknowledged to be a relatively brittle material when subjected to normal stresses and impact loads, where tensile strength is only approximately one tenth of its compressive strength. As a result, for these characteristics, concrete member could not support such loads and stresses but usually takes place, majority on concrete beams and slab. Historically, concrete member reinforced with continuous reinforcing bars to with stand tensile stress and compensate for the lack of ductility and strength. Steel reinforcement adopted to over come high potential tensile stresses and shear stresses at critical location in concrete member.

Reinforced Cement Concrete (RCC) is an extremely popular in construction material. One major flaw of RCC is its susceptibility to environment attack. This can severely decrease the strength and life of these structures.
The majority of structural strengthening involves improving the ability of their structural element to safely resist one or more of the following internal forces caused by loading: flexure, shear, axial, and torsion. Strengthening is accomplished by either reducing the magnitude of these forces or by enhancing the member's resistance to them. Typical strengthening techniques such as section enlargement, externally bundled reinforcement.

The beam has the size of about 700mm X 150mm X 150mm. The flexural strength of the beam is tested in the Universal Testing Machine .The specimen were water cured for 28 days and tested with 2 point load

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subsequently. Concrete mix design is done for M20 grade of concrete.. The load was applied on two points according to shear span to depth ratio. In order to improve tensile strength, the reinforced steel bars are used and these bars are placed in position with the help of stirrups in beam and lateral ties in column. Flexural strength test is conducted to determine the tensile strength of the concrete beam. In a normal reinforced concrete beam, the stirrups are placed at an regular interval throughout the beam. In this case the stirrups are placed only at both edges of the beam where the shear are occur and compares these results with the normal RC beam. The RC beam with stirrups at the edges is widely used in the places where less loads acting on the structure.

Gedik et al. [1] proposed a new stirrup design for short deep beams by considering three-dimensional effects such as lateral deformations and spelling of concrete. Stirrups are placed laterally in the shear span along the beam height in order to prevent lateral deformations by confinement effect. Mohammad et al. [2] studied the behavior, design and analysis of high strength reinforced concrete (HSC) deep beam regarding the neutral axis variation and observed that, the strain distribution of deep beam is nonlinear before of tensile bars yielding state but it transforms to an almost linear state at ultimate condition due to horizontal steel bars behavior and crack progress. It was also evident that at the ultimate limit state, the stress distribution in compression area in the concrete is not parabolic as in the shallow beams. The intersection points of strain distribution decrease with the increase of the applied load. In other word the number of neutral axis depth will decreases after the yield point up to the ultimate load. Kim et al. [3] investigated structural behaviors of deep beams under combined axial and bending load. The deep beams are prepared to have different span-to-depth ratios from 0.5 to 1.5 and subjected to axial loads of 235kN and 470kN. When the shear span-to-depth ratio decreases with increased axial load the deep beam is failed due to concrete crushing before shear failure is occurred. These experimental results indicate that early failure of the beam is occurred due to concrete crushing when the deep beam is under axial load with relatively small shear span-to-depth ratio. Subhash V et al [4] suggest that the effect of stirrups orientation on flexural response of reinforced concrete (RC) beams with two different shear-span-to-depth (a/d) ratios is presented. For that purpose a lateral, vertical and inclined stirrup design with two different 'a/d' ratios is proposed. The test result of proposed lateral stirrup design indicated the increase of load carrying capacity. Venkatesh kodur et al[5] analyzes failure characteristics of ultra high performance fiber reinforced concrete (UHPFRC) beams under flexural and shear loading. The desired strength and durability properties of UHPC are achieved by adopting very low water- cement ratio, high cementations content and high packing density. prism were kept at room for 24hrs and then were cured in normal water for 28 days. 10-20% increase in load carrying capacity following yielding of steel reinforcement and this is facilitated from strain hardening effort in both tensile steel reinforcement.

II. MATERIAL STUDY

Concrete is the most widely used man made materials in the construction world. It contains following materials

1. Cement
2. Aggregate
3. Water

2.1 Cement:

Cement is used as a binding material in the concrete. Portland cement gets its strength from chemical reactions between the cement and water. The process is known as hydration. This is a complex process that is best understood by first understanding the chemical composition o1 cement.

Table 2.1 Test on cement

Test Conducted	Results
Initial setting time	35min
Specific gravity of cement	3.12

Portland cement is manufactured by crushing, milling and proportioning the following materials:

- Lime or calcium oxide, CaO: from limestone, chalk, shells, shale or calcareous rock.
- Silica, SiO2: from sand, old bottles, clay or argillaceous rock.
- Alumina, Al2O3: from bauxite, recycled aluminum, clay.
- Iron, Fe2O3: from clay, iron ore, scrap iron and fly ash.
- Gypsum, CasO4.2H20: found together with limestone

Unlike Ordinary Portland Cement, Portland pozzolana cement (PPC) is manufactured by combination of pozzolanic materials. Pozzolana is an artificial or natural material which has silica in it in a reactive form. Along with pozzolanic materials in specific proportions, PPC also contains OPC clinker and gypsum. These pozzolanic materials includes volcanic ash, calcined clay or silica fumes and fly ash which make around 15% to 35% of cement weight.

2.2 Fine aggregate

The sand passes through 2.36mm and retained on 900 micron sieve are used. The purpose of the fine aggregate is to fill the voids in the coarse aggregate and to act as a workability agent. In this work zone-III grade sand is used.

Table 2.2 Test on fine aggregate

Test conducted	Results
Fineness modulus of Fine aggregate	3.12
Specific gravity of Fine aggregate	2.65

2.3 Coarse aggregate

The Coarse aggregate used was broken crushed stone which of size pass through 40 mm sieve and retained in 20 mm sieve. It is well graded i.e, different particle size and cubical in shape

Table 2.3 Test on coarse aggregate

Test conducted	Results
Specific gravity of Coarse aggregate	2.8
Fineness modulus of coarse aggregate	4.01

2.4 Water

The water used for mixing and curing the concrete is the potable water available in the campus.

III. Beam specimen

3.1 Standard specimen

In the standard specimen, the stirrups are placed at an equal spacing of 80mm throughout the beam and an cover of 20mm is provided. In this beam,10mm diameter rod is used as an main reinforcement and 8mm diameter rod is used as an stirrups Fig shows the longitudinal and cross section of the standard specimen beam.

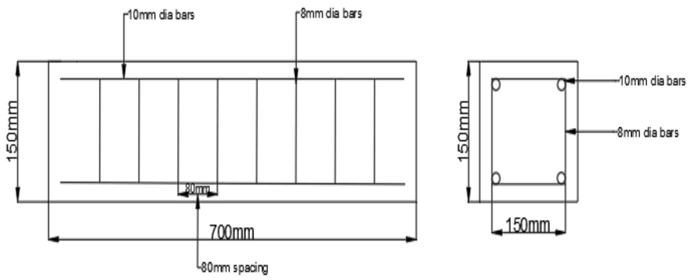

Fig 3.1 Standard specimen

3.1 Specimen 1

In the first specimen , there are only three stirrups are provided at both the ends of the beam where the shear is occurred with the cover of 20mm. In this beam,10mm diameter rod is used as an main reinforcement and 8mm diameter rod is used as an stirrups. Fig shows the longitudinal and cross section of the specimen - 1 .

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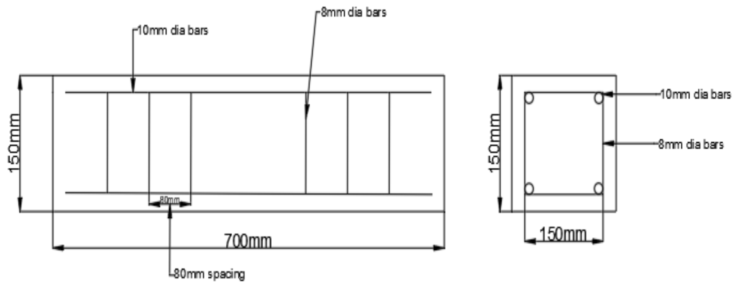

Fig 3.2 Specimen 1

3.2 Specimen 2

In the second specimen, the stirrups are reduced to two at both the ends of the beam where the shear is occurred with the cover of 20mm. In this beam, 10mm diameter rod is used as an main reinforcement and 8mm diameter rod is used as an stirrups. Fig shows the longitudinal and cross section of the specimen -2 .

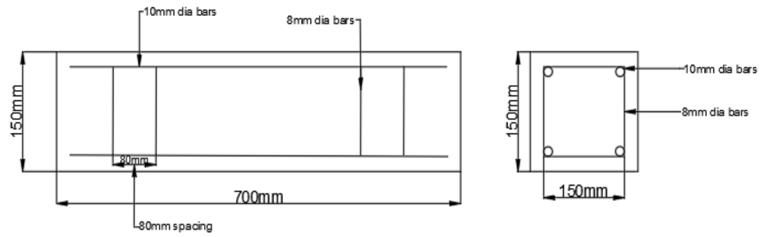

Fig 3.3 Specimen 2

3.3 Specimen 3

In the third specimen, the stirrups are reduced to one at both the ends of the beam where the shear is occurred and in the remaining portions the binding wires are used in the place of stirrups with the cover of 20mm. In this beam, 10mm diameter rod is used as an main reinforcement and 8mm diameter rod is used as an stirrups. Fig shows the longitudinal and cross section of the specimen -2 .

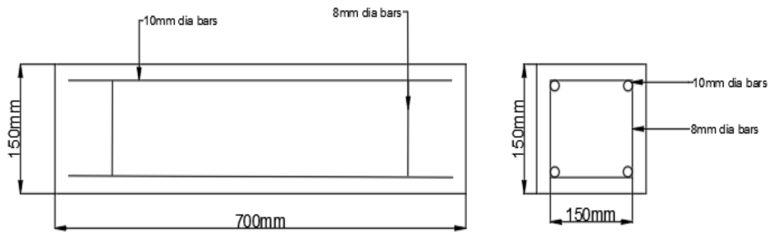

Fig 3.4 Specimen 3

IV. SPECIMEN PREPARATION

4.1 Mixing

Mix the fine aggregate and coarse aggregate on a water tight none-absorbent platform until the mixture is thoroughly blended and is of uniform color. Add cement with the line aggregate and foundry sand. Add the coarse aggregate and mix with until the coarse aggregate is uniformly distributed throughout the batch. Add water and mix it until the concrete appears to be homogeneous and of the desired consistency. Fig.5.2 shows the mixing of concrete.

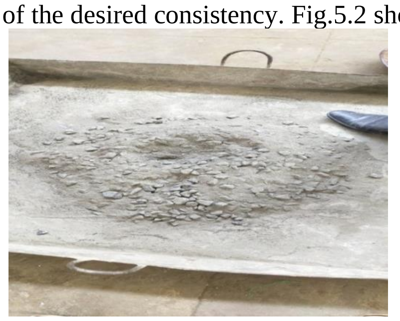

Fig 4.1 Mixing

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4.3 Compaction

Manual compaction of concrete specimen is carried out. It shall be a round, straight steel rod with at least the tamping end rounded to a hemispherical tip of the same diameter as the rod. Both ends rounded, if preferred. Tamping rod diameter is 16 mm and its length is 600 mm. Fig.5.3 Shows the manual compaction of concrete in their mould.

4.4 Preparation of mould

Before casting of the specimen, the mould was cleaned and fully tightened. The inner side of the mould was coated with oil to prevent

4.5 Casting

During the casting of the concrete a large opening is needed. When the mold is filled, shake slightly to get rid of the bubbles. A compact size causes a high temperature. Its recommended to cover the mould with foil for one day to prevent their concrete from drying out. Fig 5.4 shows the casting of specimens. Concrete specimens of prism (700x150x1 50 mm). Specimens were cured for 28 days.

Fig 4.2 Casting of specimens

4.6 Demoulding

Test prism specimens should be demoulded in 24 hours after they have been made. If after this period of time the concrete has not achieved sufficient strength to enable demoulding without damaging the specimens then the demoulding should be delayed for a further 24 hours. When removing the concrete specimens from the mould, take the mould apart completely. Take care not to damage he specimens because, if any cracking is caused, the strengths may be reduced. Fig.3.3 Show the concrete demoulding.

4.7 Curing

The test specimens are stored in moist air for 24 hours and after this period the specimens are marked and removed from the molds and kept submerged in clear fresh water until taken out prior to test.

Flexural strength

Flexural strength is one measure of the tensile strength of concrete. It is a measure of an reinforced concrete beam or slab to resist failure in bending. It is measured by loading 6x6-inch (150×150 mm) concrete beams with a span length of at least three times the depth. Fig 6.3 shows the testing of prism specimen before and after failure. Cracking is due to diagonal tension but mostly due to restrained shrinkage and temperature gradients. Direct application of pure tension is difficult. The theoretical maximum tensile stress reached in the bottom of the test beam is as modulus of rupture.

F- PL/ (bd2)

Where,
F= Flexural strength of concrete (in MPa)
P= Failure load (in N)
L= Effective span of the beam (700 mm)
B= Breadth of the beam (150 mm)

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Prepare the test specimens in the standard manner size of the specimen in cm (70 x 15 x 15).Place the specimen in the machine in such a manner that the load is applied to the upper most surface as cast in the mould along two lines spaced 20cm a part. Align axis of the specimen carefully with the axis of the loading device. Apply load without shock and increase continuously at a rate of 0.4 t/min and it is increased until the sample fails. Note down the maximum load applied. Measure the distance between the line of fracture and nearest support.

V. TEST AND DISCUSSION

The beam is in the curing stage , the test is to be conducted after 28 days curing . after testing the beam the result is to be discussed and the graph is drawn for the flexural strength of the RC beam.

VI. CONCLUSION

- In the RC beam, the stirrups are provided at the edges of the beam where the shear is occur. By reducing the stirrups, the cost is reduced
- The usage of steel bars is reduced and less time required for reinforcement works
- This type of beam is used in the small buildings and low budget projects
- Based on the test result, the number of stirrups used can be obtained for minimum strength

REFERENCES

[1]. Subhash v. patankar , Atteshamuddin s. sayyad (2013). “Effort of stirrups orientation on flexural response of RC deep beams”, journal of structural engineering . vol.1(2013), pp: 107-111.
[2]. Venkatesh kodur, Roya solhmirzaei, Ankit agarwal, Esam m. aziz, parviz soroushian (2018).“analysis of flexural and shear resistance of ultra high performance fiber reinforced concrete beams without stirrups”, journal of structural engineering, vol.174(2018),pp: 873-884.
[3]. “Indian Standard Code of Practice for Plain and Reinforced Concrete (Fourth Revision) IS: 456:2000” (2000) Bureau of Indian Standards, New Delhi.
[4]. Unnikrishna pillai S., Devdas Menon (2009) “Reinforced Concrete Design”, published by McGaw Hill Education (India) Private Limited, Third Edition.
[5]. Gedik, Y.H., Nakamura, H., Ueda, N. and Kunieda, M. “A new stirrups design considering 3D effect in short deep beam,” Procedia Engineering, 14.2964-2971.2011.
[6]. Mohammed, M., Jummat, M.B. and Chemrouk, M. “An experimental investigation of stress strain distribution in high strength concrete deep beam,” Procedia Engineering, 14(2). 2141-2150.2011.
[7]. Kim, H.S., Lee, M.S. and Shin, Y.S. “Structural behavior of deep RC beam under combined axial and bending force,” Procedia Engineering, 14. 2212-2218.2011.