# Alternating Design of Transverse Reinforcement With New Design For Concrete Beams

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***Abstract*- In this study, a testing on beams has been performed to compare the shear resisting capacities between old shape two leg stirrups and new design stirrups. Resisting the shear force is one of the important features of shear reinforcement. The shear reinforcement represent function of it. The reinforced concrete beams with two leg vertical stirrups and new designed stirrups are tested. The beams are tested under single point load (flexural strength test).**

***Index Terms:*  Shear Reinforcement, Reinforced concrete beam, New Design, Flexural Strength, Testing   .**

## I. INTRODUCTION

Shear reinforcement is designed to resist shear force in excess of the shear strength of concrete. They are provided in forms of vertical or inclined stirrups or longitudinal reinforcement bent up at 45 degrees at locations where they are no longer needed to resist bending. And we design new shear reinforced stirrups for comparison between new design and old two leg vertical stirrups.

Reinforced concrete beams are important structural elements that transmit the load from slab, to columns. Beams have sufficient safety margin against bending and shear forces, so that it will perform effectively during its service life. The purpose of shear reinforcement is to prevent failure in shear and to increase beam ductility and subsequently the likelihood of sudden failure will be reduced. In building construction, stirrups are most commonly used as shear reinforcement, for their simplicity in fabrication and installation. Normally, spacing between stirrups is reduced to resist high shear stress. Congestion near the support of RC beams due to the presence of the closely spaced stirrups increase the cost and time required for installation. Due to difficulties in construction, bent-up bars are rarely used. In beams with small number of bars provided, the bent-up bar system is not suitable due to insufficient amount of straight bars left to be extended to the support as required by the code of practice.

The experimental results show that the shear capacity for beams with identical shear reinforcement ratios increases significantly when the spacing of the stirrups are increased.

A well-designed reinforced concrete structure, if subjected to extreme overloads, should fail in flexure rather than shear. Such structures are tough, give warning of approaching failure, and are often capable of resisting surprisingly large loads. Unlike flexural failures, reinforced concrete shear failures are relatively brittle and, particularly for members without stirrups, can occur without warning. Because of this, the prime objective of shear design is to identify where shear reinforcement is required to prevent such a failure, and then in a less-critical decision, how much is required. Shear reinforcement, usually called stirrups, links together the flexural tension and flexural compression sides of a member and ensures that the two sides act as a unit. Shear failures involve the breakdown of this linkage and, for members without stirrups, typically involves the opening of a major diagonal crack in the manner.

## II. FLEXURAL STRENGTH

Flexural strength is one measure of the tensile strength of concrete. Typically, flexural strength is thought to be the measure of the highest tension suffered by the concrete at its moment of rupture. It is an indirect way of determining the tensile load at which the concrete will fail to stretch and develop cracks.

### a. Shear Strength of Concrete

The shear strength of concrete is defined as its ability to resist forces that cause the material's inner structure to slide against itself. This can be measured either horizontally or vertically by seeing if a force causes the object's layers to slide in a horizontal or vertical direction.

### b. Design of 2 Leg Shear Reinforcement and New Design Transverse Reinforcement


Fig 1: Normal Stirrup


Fig 2: New Design Stirrup

**c. Experimental Setup and Testing Setup**

In the experimental program carried out, reinforced concrete beams is designed as under

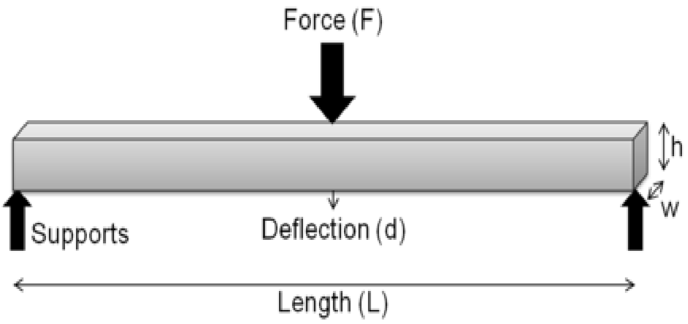



Fig 3: Experimental Setup

Reinforced section using m20 grade concrete and fe500 grade steel. Six reinforced concrete beams were prepared for the test, B1 to B3 are with two leg vertical stirrup and NB1 to NB3 are with new design stirrups. All of the same dimension 700 mm length, 150 mm width and 150 mm depth. These beams were designed with 2 bars at bottom and 2 at top with 8 mm diameter and shear reinforcement of 6 mm diameter at 100 mm c/c.

**d. Casting of Beam**

Six beams were casted for this experimental test program.in this two were control beams and series B and series NB beams. Series B contain 3 beams with stirrups and Series NB contain 3 beams with new design stirrups. The dimensions of all the specimens are identical. The cross-sectional dimensions of the both the set of beams is 150 mm X 150 mm and length is 700 mm. In all beams, 8 mm bars are provided as the main longitudinal reinforcement and 6 mm bars as stirrups at a spacing of 100 mm center to center.

## III. TESTING PROCEDURE

1) Measure the cross-sectional dimensions of the test specimen.
2) Place beam assembly on lower cross head of UTM.
3) Fix point load attachment on middle cross head of UTM.
4) Adjust the required span (300 mm) and place the specimen on roller supports.
5) Lower the middle cross head so that point load just touches the beam at midspan.
6) Apply the load at the center of specimen at constant rate till the specimen fails. Note down the load of failure.
7) Repeat the test with remaining specimen.
8) Calculation of flexural strength.

## IV. OBJECTIVES

- To investigate new Transverse design of stirrups
- Investigate the effectiveness.
- Performance of the new design stirrups.
- Shear strengthening.
- To enhance the shear strength of the beams.

## V. FLEXURAL TEST ON BEAM

Standard beam of size 150 x150 x 700 mm were supported symmetrically over a span of 700 mm and subjected two points loading. In shear test, the beam specimen was placed in the machine in such a manner that the load was applied to the upper most surface as cast in the mould. All beams were tested under Single-point loading in Universal Testing Machine. The load was increased until the specimen failed and the failure load was recorded.

### a. Testing Setup for Flexural Test on Reinforced Concrete Beams

Fig 4: Testing Setup


## VI. SPECIFICATION OF BEAM AND RESULT OF FLEXURAL STRENGTH

| Beam | Size of Beam | Reinforcement Detail | | | Load |
|---|---|---|---|---|---|
| | | Main Steel | | Shear Reinforcement | |
| | | Top | Bottom | Steel & Spacing | |
| Beam With Vertical 2 Leg Stirrups | | | | | |
| B1 | 700 X 150 X 150 | 2 Bars of 8mm | 2 Bars of 8mm | 6 mm @ 100 mm c/c | 24 KN |
| B2 | 700 X 150 X 150 | 2 Bars of 8mm | 2 Bars of 8mm | 6 mm @ 100 mm c/c | 25 KN |
| B3 | 700 X 150 X 150 | 2 Bars of 8mm | 2 Bars of 8mm | 6 mm @ 100 mm c/c | 24 KN |
| Beam With New Design Transverse Stirrups | | | | | |
| NB1 | 700 X 150 X 150 | 2 Bars of 8mm | 2 Bars of 8mm | 6 mm @ 100 mm c/c | 31 KN |
| NB2 | 700 X 150 X 150 | 2 Bars of 8mm | 2 Bars of 8mm | 6 mm @ 100 mm c/c | 32 KN |
| NB3 | 700 X 150 X 150 | 2 Bars of 8mm | 2 Bars of 8mm | 6 mm @ 100 mm c/c | 31 KN |

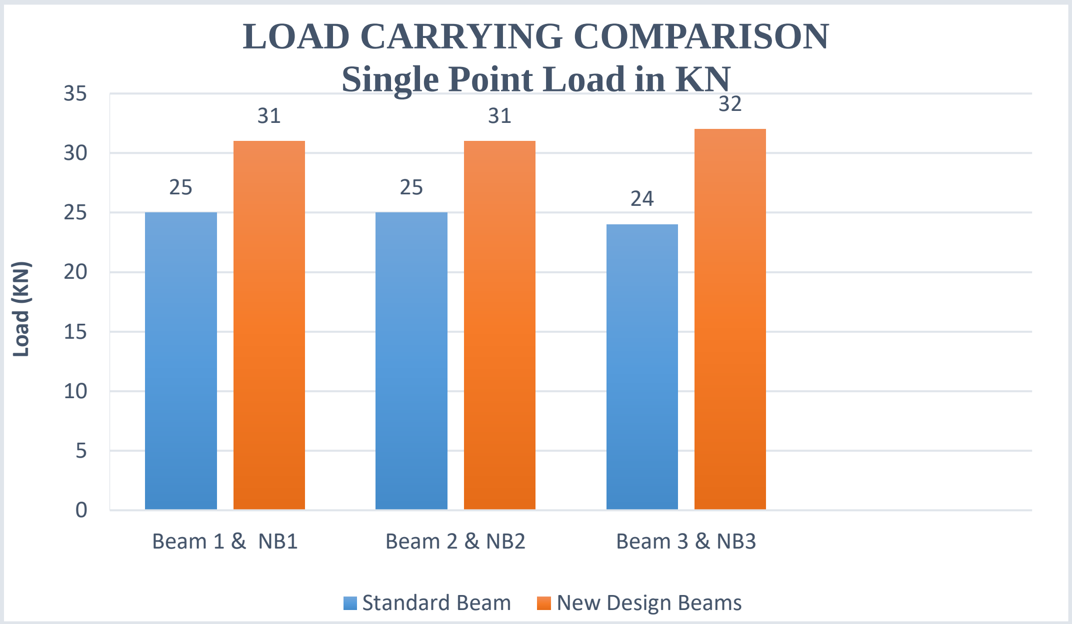
Table 1: Specification of Beam

## VII. CALCULATION OF FLEXURAL STRENGTH

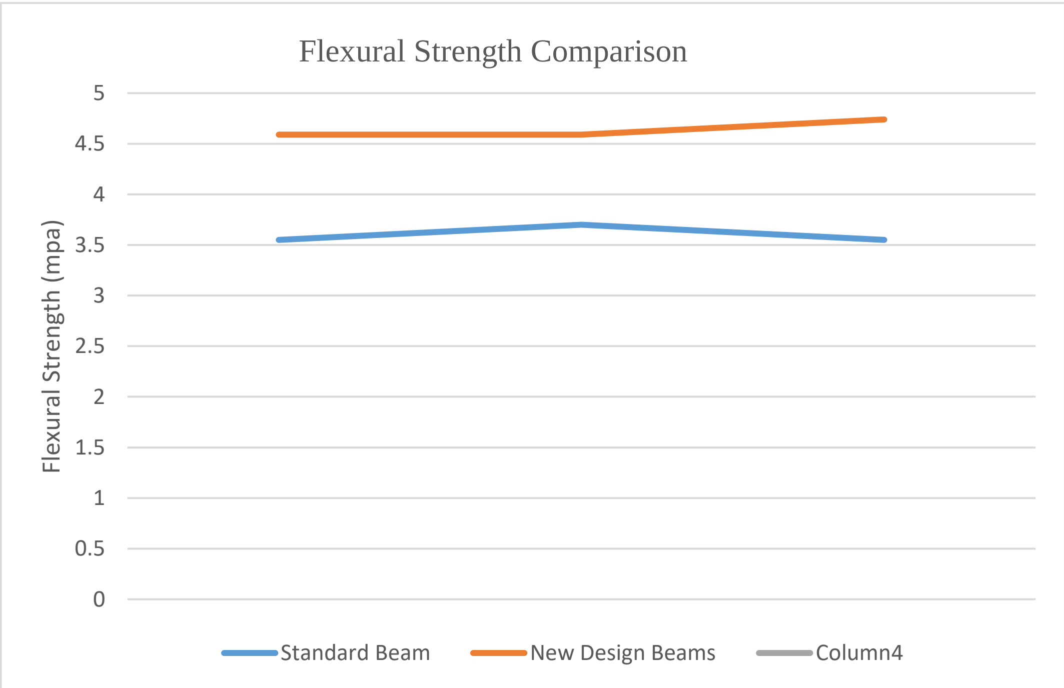
| Beam series | Size of beam | Load Carried | Flexural Strength (N/MM) |
|---|---|---|---|
| Beam With Vertical 2 Leg Stirrups | | | |

| | | | |
|---|---|---|---|
| B1 | 700 X 150 X 150 | 24 KN | 3.55 |
| B2 | 700 X 150 X 150 | 25 KN | 3.7 |
| B3 | 700 X 150 X 150 | 24 KN | 3.55 |
| Beam With New Design Transverse Stirrups | | | |
| NB1 | 700 X 150 X 150 | 31 KN | 4.59 |
| NB2 | 700 X 150 X 150 | 32 KN | 4.74 |
| NB3 | 700 X 150 X 150 | 31 KN | 4.59 |

Table 2: Calculation of Flexural Strength




Graph 1; Load Comparison




Graph 2: Flexural Strength Comparison

## VIII. CONCLUSION

1. **Effectiveness of Transverse Reinforcement**: The presence of transverse reinforcement significantly enhances the shear strength of RC beams. It helps to resist shear forces and improve the overall performance and load carrying capacity of the beams.
2. **Shear Crack Control:** Transverse reinforcement effectively controls the formation and propagation of shear cracks in RC beams. It helps to distribute the shear forces and prevents the formation of large, brittle cracks that can lead to failure.
3. **Ductility and Energy Dissipation:** The inclusion of transverse reinforcement promotes ductility in RC beams subjected to shear forces. This ductility allows the beams to undergo larger deformations before failure, improving their energy dissipation capacity.
4. **Shear Capacity Prediction:** The experimental study provides valuable data for predicting the shear capacity of RC beams with transverse reinforcement. These data can be used to develop analytical models and design guidelines that accurately estimate the shear strength of such beams in practical applications.
5. **Optimum Transverse Reinforcement**: The study helps in determining the optimum amount and configuration of transverse reinforcement required for RC beams to achieve the desired shear strength. This information can guide designers and engineers in optimizing the reinforcement design for specific structural requirements.
6. **Load Redistribution:** Transverse reinforcement facilitates the redistribution of shear forces within RC beams. It helps in redistributing the loads from the heavily stressed regions to adjacent areas, thus increasing the overall load-carrying capacity of the beams.
7. **Structural Safety:** The use of transverse reinforcement significantly enhances the structural safety of RC beams, particularly in regions prone to high shear forces. It improves the structural integrity and reduces the risk of shear-related failures.

## REFERENCES:


1. M. Zakaria, T. Udea, Z. Wu, L. Meng, "Experimental Investigation on Shear Cracking Behavior in Reinforced Concrete Beams with Shear Reinforcement" Feb 2009, Vol. 7.
2. N. Subramanian, "Alternate Transverse Reinforcement in Beams" Dec 2012.
3. A. Najmi, A. Lebdeh, "The Use of Swimmer Bars as Shear Reinforcement in Reinforced Concrete Beam" Jan 2013.
4. R. Vollum, L. Fang, "Shear enhancement near supports in RC beams" Dec 2014.
5. P. Colajanni, L. Mendola, G. Mancini, A. Recupero, N. Spinella, "Shear Capacity in Concrete Beams Reinforced by Stirrups with Two Different Inclinations" Aug 2014.
6. Z. Aljazaeri, J. Myers, "Strengthening of Reinforced-Concrete Beams in Shear with a Fabric-Reinforced Cementitious Matrix" Oct 2017.
7. S. Javidmehr, "Shear Capacity of Concrete Members under Monotonic and Cyclic Loading" Aug 2019.
8. H. Naderpour, M. Mirrashid, "Shear Strength Prediction of RC Beams using Adaptive Neuro-Fuzzy Inference System" 2020.
9. X. Yang, N. Liang, H. Yang, R. Feng, "An Experimental Study of Shear Resistance for Multisize Polypropylene Fiber Concrete Beams" 2021.
10. F. Autrup, H. Joergensen, "Experimental Investigation of the Influence of Stirrup Spacing on the Shear Capacity of Reinforced Concrete Beams" Sep 2022.

**IS Codes Used**

1. IS 516 – 1959 for Flexural Strength of Concrete
2. IS 456 – 2000 for Reinforced Concrete Beams
3. IS 10262 – 2009 for Concrete Making
4. IS 4990 for Specification for Plywood Formwork for Concrete
5. IS 456 for Removal of Formwork