iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 11 **Issue:** X **Month of publication:** October 2023

DOI: https://doi.org/10.22214/ijraset.2023.55914

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 11 Issue X Oct 2023- Available at www.ijraset.com

A Theoretical Analysis of Shear Failure of a Reinforced Self- Compacting Concrete Beam without Shear Reinforcement was Experimentally Validated

Meha Chaudhary[1], Dr. Ajay Singh[2]
Department of Civil Engineering, Roorkee Institute Of Technology, Roorkee, Uttrakhand, India

Abstract: Failures linked with reinforced concrete include axial, flexural, shear, torsion, and deflection (as well as cracking in the case of RC as a material) beyond specified allowed limitations. Failure due to shear (including shear related with torsion) is the most severe and can occur with little or no notice. To prevent the brittle character of shear failure with little or no forewarning, an examination was conducted to determine the size effect, and the diagonal shear failure of reinforced concrete beams without stirrups was analysed in terms of the effective depth of the section. The test beams are made of two types of concrete: conventionally vibrated concrete and self-consolidating concrete, both having nominal compressive strengths of 30, 60, and 70 at 28 days. Given the limitations of the laboratory, three beam sizes with overall depths of 200, 300, and 500 mm, a set shear span to effective depth ratio (a/ d) of 3.50, and a constant tensile reinforcement content of 3% are utilised as test specimens. The experimental results were compared to the acceptable shear stress requirements of IS 456 and ACI 318. The size, concrete type, and concrete strength were determined to have a substantial influence on beam shear strength.
Keywords: Shear failure, size effect, effective depth of a section, diagonal shear failure without shear stirrups, and self-consolidating concrete are all examples of shear failure.

I. INTRODUCTION

The structural design of any structure should allow for a sufficient margin of safety against any type of failure that may occur during its expected lifetime. Because of the larger fluctuation in mechanical properties associated with concrete, the required margin of safety for structures constructed of 'Reinforced Concrete' is substantially greater than for buildings made of 'Steel.' Failures occur when axial, flexural, shear, torsion, and deflection (as well as cracking in the case of RC as a material) exceed particular permissible limitations. Shear failure (including shear associated with torsion) is the most brittle and sudden, and it can occur without warning. Shear failure is delicate and can occur unexpectedly, thus much research has been conducted to understand how it occurs and how to prevent it.

Shear strength of reinforced concrete components, particularly beams, has been the subject of extensive research and controversy since the advent of reinforced concrete construction at the turn of the twentieth century. After more than a century of research, the bulk of concrete member shear design approaches still depend on practical data rather than merely theoretical principles. Concrete shear strength is a well-known complicated process involving several components, some or many of which are unknown. Despite all of the experimental study done thus far, this is correct.

The maximum permitted shear stresses for longitudinal steel anchoring were 0.060 fc, or a maximum of 1.240 MPa, or 0.120 fc, or a maximum of 2.480 MPa.

This shear tension was created to keep the stirrups from collapsing before the web concrete collapsed diagonally. Because of these code requirements, the nominal shear stress was estimated using the formula $v = V/bjd$.

This system, which served as the foundation for the future ACI standards, was in use from 1921 to 1951, with each iteration introducing more conservative design principles. Hooking all plain bars became necessary in 1951, while deformed bars had to correspond to ASTM A 305. It was also no longer required to distinguish between members that had mechanical anchoring and those that did not. As a result, the maximum permitted shear stress for concrete established by ACI 318-511 was 0.120 fc in web reinforced beams and 0.030 fc in unreinforced beams.

II. REVIEW OF BEHAVIOUR OF TRUSS ANALOGY FOR SHEAR REINFORCEMENT DESIGN

Between 1899 and 1902, the German engineer Mörsch and the Swiss engineer Ritter constructed the truss analogy12 separately. It is critical for designing shear reinforcement of reinforced concrete beams to develop a good mental model to portray the pressures operating on a cracked concrete beam. Figure 2.1(a) depicts a beam with inclined fissures. Because of these inclined fissures, the top and bottom of the beam suffer compressive and tensile loads, and the concrete "diagonals" in between the inclined cracks experience inclined compressive forces as well. As shown in Fig. 2.10(b), this highly unpredictable system of forces may be replaced with a simple truss without compromising accuracy.

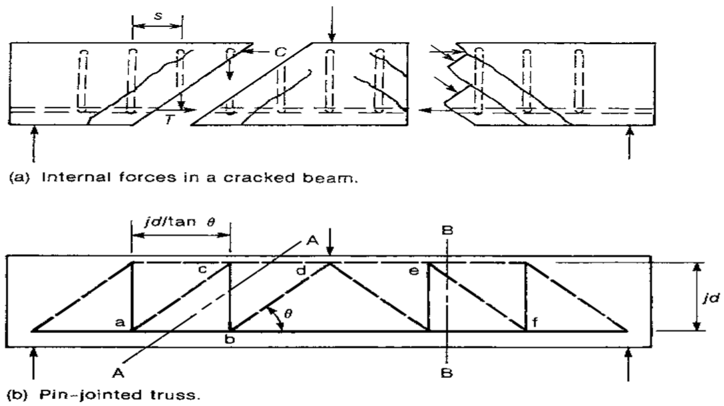


Fig. 2.10- Truss analogy

Unexpected seismic movement caused by an earthquake causes extensive damage to innumerable structures, either entirely or partially, and results in spectacular devastation. This structural damage has an immediate impact on both living and non-living things, as illustrated in Fig. 1.6. Pre-planned seismic evaluation and fortification of structures appear to be a better option than replacing structures to prevent this massive destruction and reduce construction costs. Global retrofit methods and local retrofit methods are the two primary strategies for seismic retrofitting and strengthening. In global retrofit procedures, a conventional method based on strengthening the seismic resistance of the existing structure and a non-conventional method based on lowering seismic demands are used. Kani13 developed the idea of internal arches, seen schematically in Fig. 2.2, based on stress trajectories that characterize the flow of internal forces in a homogeneous, isotropic, and elastic beam, in 1969. The emergence of internal arches that function to transfer the applied load to supports is depicted in Fig. 2.2, and two types of arches can be distinguished: (i) supported arch, which rests directly on the beam's external unyielding support, and (ii) hanging arch, which lacks direct supports but is suspended from the supported arch.

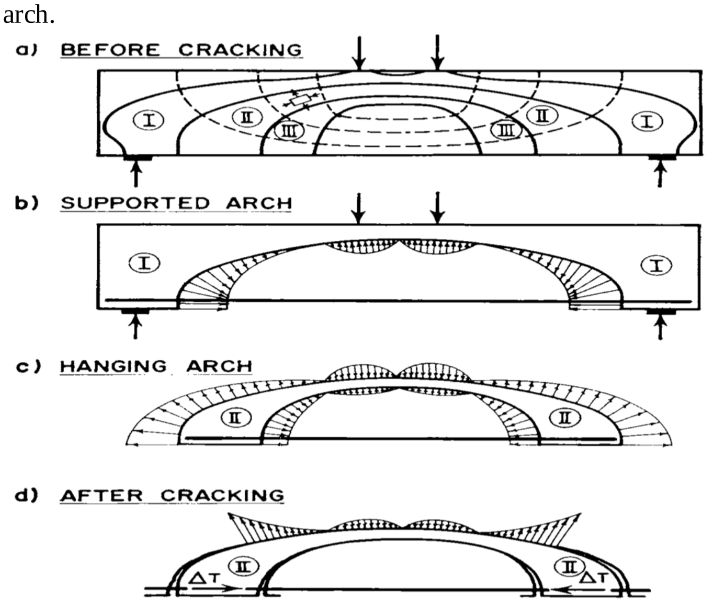


Fig. 2.2— Analogy of internal arches

III. FACTORS IMPACTING REINFORCED CONCRETE BEAMS' SHEAR STRENGTH

Currently, it has been discovered that the following factors have a significant influence on the shear strength of an RCC beam:

1) Compressive strength of concrete
2) Shear span/effective depth ratio
3) R/F (Longitudinal as a proportion of cross-sectional area)

Other factors found but thought to have only a slight impact include maximum aggregate size, flexural crack spacing, tensile reinforcing bar diameter, relative beam size when aspect ratio is retained, and others. If shear reinforcement is present, it is used to raise the overall resistance of the system to shear force rather than as a factor in and of itself.

IV. SIMULATION RESULT

According to the study, high-strength steel had a substantial impact on shear behaviour in concrete beams lacking web reinforcing. It would be paradoxical to neglect the material's high strength qualities, which might lead to erroneous predictions of the load-carrying capacity, which is the final failure mechanism. After diagonal fracture, a high-strength steel reinforced beam revealed a considerable strength reserve. Because it was crushed at significantly higher weights than standard steel-reinforced beams, the diagonal concrete strut disintegrated. Despite a 40% drop in reinforcing ratio, RCC beams with high-strength steel showed significantly higher shear strength than RCC beams with Grade 420.0 MPa steel. Stress along the diagonal, on the other hand, causes the first entirely formed inclined fracture in long beams ($a/d > 2.5$) to develop and spread. Because total shear failure occurs almost immediately after the first significant diagonal fracture begins, this failure mechanism is highly sudden. This is caused by the roughly similar magnitudes of the ultimate and breaking shear strengths (vc and vu) in thin beams.The structure should be strong enough to withstand any loads that may be placed on it over the course of its life. Due to various types of loads, a structure may experience stress, displacement, and displacement, which can cause issues with the structure and possibly increase the likelihood that it will fail. As a result, an accurate calculation of the total load expected in the structure is made, and structural components should be adequately built. The various types of loads that can affect a structure include dead load (DL), live load/imposed load (LL/IL), wind load (WL), and earthquake load (EL). Indian Standard (IS) codes for structure design provide information on all types of loads. According to the authors, a crack failure is caused by a breakdown in the ability of aggregate interlock, which is the major means by which shear is transferred in slabs and beams designed without shear reinforcing. Experiment evidence refutes the generally held belief that the whole force in shear is transferred in the zone of compression. As a result, aggregate interlock should be carefully considered in shear design guidelines in order to correctly recreate experimental results. The size effect given in this work is explained by fracture width/spacing, which predicts the size impact in shear.

.

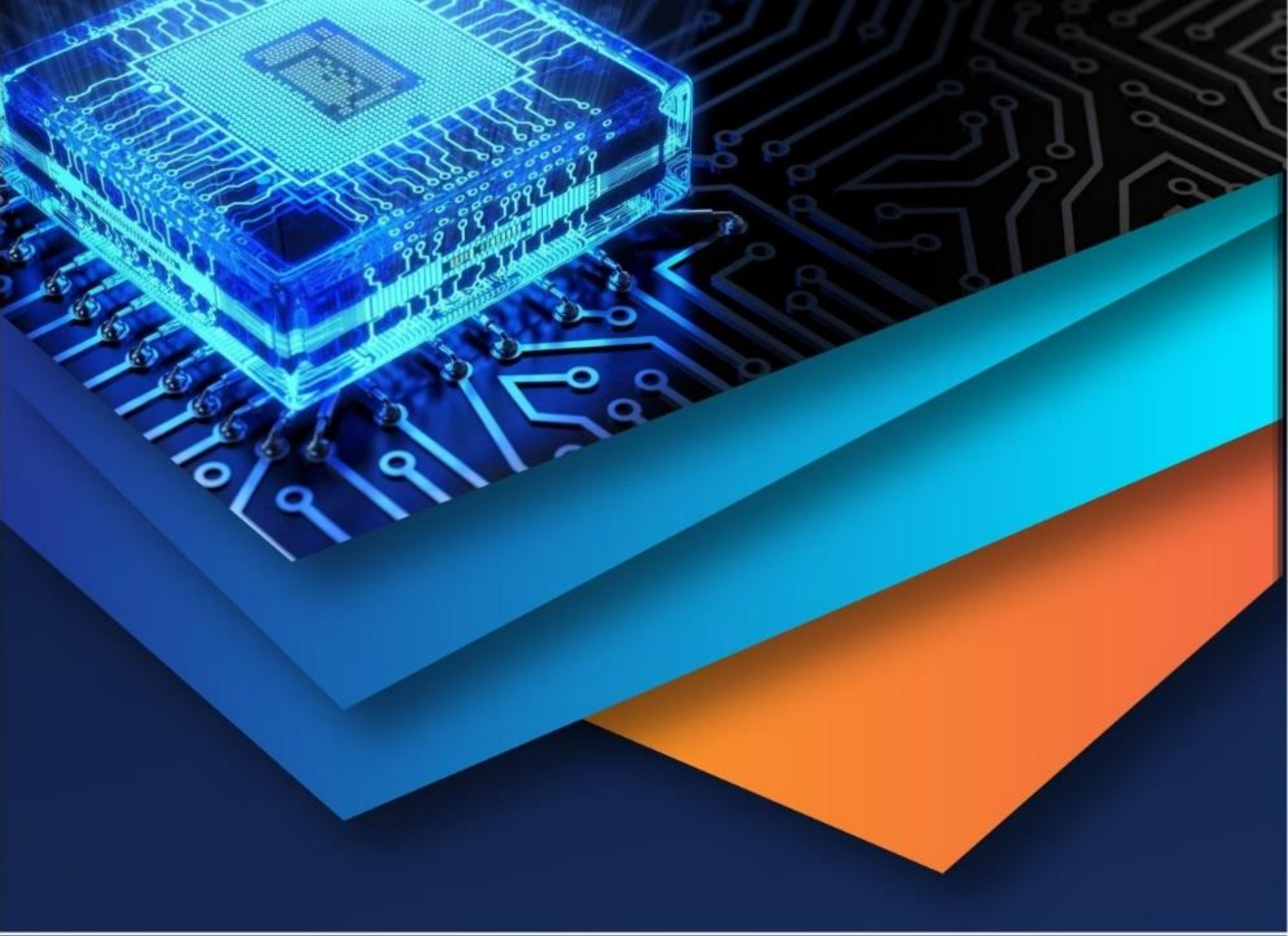
V. CONCLUSION

According to a review of a few important research, until the late 1950s, it was believed that the compressive strength of concrete was the only factor influencing the strength in shear of RCC beams. Later, it was found that the ratio of shear span to depth (or slenderness of beam) and tension R/F % also had a significant influence on the shear and diagonal tension strength of concrete beams without web reinforcing. These discoveries led to the identification of additional factors that may also impact the shear strength of concrete components, such as the maximum aggregate size, the spacing of flexural cracks, and the diameter of tension reinforcing bars. The influence of reinforced concrete beam size is a relatively new addition in recent analytical research28 has focused on the size effect in longitudinally reinforced beam shear failure using fracture mechanics ideas and probabilistic models. In addition to shear failure, there has been interest in the experimental investigation of the size effect phenomenon.

REFERENCES

[1] In 2017, Abhishek K. K. and R. S. The impact of the bracing systems on the seismic performance of a typical RC tall building. Journal of Scientific and Technical Innovation. Smith, A. C. Bryan Stafford (1991). Design and Analysis of Tall Building Structures. An article published by Wiley-Interscience.
[2] (2017) Dr. S. B. Shinde, N. Shear wall thickness and height variations have an impact on the stiffness, story drift, and deflection of multistory buildings. Journal of Advanced Science and Engineering Research International.
[3] In 1998, Taranath, B.S., "Structural Analysis and Design of Tall Building", McGraw-Hill Book Company
[4] Park, R. and Paulay, T. (1974), “Reinforced concrete structures", John Wiley & Sons.
[5] Ferguson,” Reinforced concrete fundamentals”, fifth edition, John Wiley & Sons.
[6] "Earthquake Resistant Design of Structures", Prentice-Hall of India Pvt. Ltd., New Delhi, India, 2006, P. Agrawal and M. Shrikhande.
[7] Rosenblueth, E. and Holtz, I. (1960), "Elastic analysis of shear walls in tall buildings", Journal of the American Concrete Institute, Vol.31, June, pp. 1209-22.
[8] Beck, H. (1962), "Contribution to the analysis of Coupled Shear Walls," Journal of the American Concrete Institute, Vol.59, August, pp. 1055-70.

[9] In 1964, Khan, F.R., and Sbarounis, J.A. published "Interaction of Shear Walls and Frames" in Journal of Structural Division, ASCE, Vol. 90, June (ST3), pp. 285-335.
[10] Building Science, Volume 7, Pages 121–125, 1972. Macleod, LA. "Simplificd Analysis for shear wall-frame interaction."
[11] IS 1893 (Part 1): 2016, Criteria for Earthquake Resistant Design of Structure.
[12] IS 875 (Part 1):1987, Code of Practice for Design Loads (other than earthquake) for Buildings and Structures, Part-1 dead loads - Unit weights of building materials and stored materials.
[13] IS 875 (Part 2):1987, Code of Practice for Design loads (other than earthquake) for Buildings and Structures, Part 2 Imposed loads.



10.22214/IJRASET

INDEX COPERNICUS
45.98

ISRA JIF
IMPACT FACTOR:
7.129

TOGETHER WE REACH THE GOAL
IMPACT FACTOR:
7.429

ISI

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY