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A REVIEW PAPER ON BEHAVIOUR OF R.C.C. BEAM UNDER PURE TORSION

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ABSTRACT

Many structural elements in building and bridge construction are subjected to significant torsional moments that affect the design. A simple experiment for the evaluation of the torsional strength of reinforced concrete beams as a one of this structural element is presented in this research. The goal of this experiment is to determine the effect of reinforcement type on torsion strength of concrete beams; therefore, bars with different types in each beam have been applied. It was observed that the ductility factor increases with increasing percentage reinforcement from the test results. It should be also noted that transverse bars or longitudinal bars lonely would not able to increase the torsional strength of RCC beams and both of them can be essential for having a good torsional behaviour in RC beams. This review paper presents the experimental investigation on the behaviour of RCCbeams subjected to pure torsion. The reported results include the behaviour curves, the failure modes and the values of the pre-cracking torsional stiffness, the cracking and ultimate torsional moments and the corresponding twists. The influence of the volume of stirrups, the height to width ratios and the arrangement and area of longitudinal bars on the torsional behaviour is discussed.

Keywords: pre and post -cracking, reinforcement, torsional strength, transverse and longitudinal bars, twist angle.

I.INTRODUCTION

Reinforced concrete is the most successful material used in construction industry. It is accepted as a structural material worldwide. Utility of reinforced concrete as a construction material is derived from the composite action that takes place between reinforcing bar and concrete. The bending, torsion and shear are inspirable effect in R.C. beams probably there is no structure subjected to only pure torsion or pure bending. When Beam is transversely loaded in such a manner that the resultant forces passes through the longitudinal shear centre axis the beam only bend and no torsion occurs but when the resultant acts away from the shear centre axis, then the beam subjected to combined bending and twisting effect.

Torsion on structural elements may be classified into two types; statically determinate, and statically indeterminate. Torsionresults from either supporting a slab or a beam on one side only, or supporting loads that act far away transverse to the longitudinal axis of the beam. Shear stresses due to torsion create diagonal tension stresses that produce diagonal cracking. If the member is not adequately reinforced for torsion, a sudden brittle failure can occur. Since shear and moment usually develop simultaneously with torsion, a reasonable design should logically account for the interaction of these forces. However, variable cracking, the inelastic behaviour of concrete, and the intricate state of stress created by the interaction of shear, moment, and torsion make an exact analysis unfeasible. The current torsion design approach assumes no interaction between flexure, shear and torsion. Reinforcement for each of these forces is designed separately and then combined. In this case study, we have put side faced reinforcement in R.C.C. beam and carried out test for pure torsion in comparison with the standard R.C.C. beam.

II. LITERATURE REVIEW

1. An Experimental Study On Combined Flexural And Torsional Behaviour Of RC Beams (Adheena Thomas[1], Afia S Hameed[2]) May,2018.

In this paper's experimental investigations states that, combined action of flexure and torsion is observed at between the lever arm. The inclination of these initial cracks was nearly 45° to the axis of the beam. The cracks propagated towards the top with increasing angle of inclination and bottom faces. The beam at the ultimate stage formed a hinge along the four faces, which is the compression face. This face is free from cracks. In reinforced concrete design, depending on the load transfer mechanism the torsion is classified as equilibrium torsion and compatibility torsion. In beams supporting lateral overhanging projections due to eccentricity in the loading, equilibrium torsion occurs. Torsion is induced in a structural member by rotations (twists) applied at one or more points along the length of the member in case of compatibility torsion. Statically indeterminate twisting moments are generally formulated and their analysis necessarily involves compatibility conditions. Therefore it is named compatibility torsion. The structural elements which are subjected to torsion show cracks if they are not designed properly. Beam subjected to transverse loading with the resultant force passing through the longitudinal shear centre axis, the beam bends and no torsion will occur. The beam is subjected to not only bending but also twisting when the resultant acts away from the shear centre axis.

2. Behaviour Of Fibre Reinforce Concrete Beam In Pure Torsion (C.Arvind Kumar[1], MadanMohan[2], D.V.S.P Rajesh[3], Prathik Kulkarni[4])May 2015.

Paper concludes that use of fibre has found very beneficial to increase the torsional strength of RC beam subjected to pure torsion. The cracking torsional strength of FR 1.5 increased up to 72.8% which is very significant increase in the strength of concrete compared to conventional RCCBeam. The ultimate torsional strength of FR 1.5 increased up to 40.56% which is very significant increase in the strength of concrete compared to conventional RCCBeam. The fibre reinforced concrete decrease in brittleness and increase in ductility can be observed. The fibre reinforcement has also succeeded to increase stiffness of the beam by decrease the angle of twist of strengthen beam compared to conventional RCC beam.The initial crack pattern has observed at higher loads in the fibre reinforced strengthen beams.

3. Torsional Behaviour Of Normal Strength RCC Beams With Ferrocement "U" Wraps(GopalCharanBehera, Manoranjan Dhal)June 2016.

In this paper two types of studies are carried out which are U wraps with plain type and reinforcement type .The paper conclude the following points by use of a Plain "U" Wrapped Beams A significant increase in torsional strength is observed with ferrocement "U" wrapped normal and high strength concrete beams over their plain concrete beams. Ultimate torque is dependent upon the core concrete, mortar strength, mesh layers and aspect ratio combinedly. The "U" wrap can increase the torsional capacity of a plain beam. This proves the effectiveness of "U" wrapped beams and also"U" Wrapped Reinforced Concrete Beams The increase in torsional strength over the number of layers for any state of torsion is very less. Single type of reinforcement either longitudinal or transverse reinforcement is ineffective in enhancing the torsional strength. Transversely over reinforced concrete beams showed overall increase in torque over longitudinally over reinforced beams. Soft computing model and the experimental results reveal that the torque twist response of a ferrocement "U" wrap beam is more influenced by the state of torsion than the amount of ferrocement reinforcement.

4. Behaviour Of RCC Hollow Beam Under Pure Cyclic Torsion(Gajipara J M[1], Patel P.V[2], Raiyani S.D[3])Dec 2015.

This paper attempts to evaluate the effect of main reinforcement and shear reinforcement on the behaviour of RC hollow beam under pure cyclic torsion and also studied the crack pattern. In present experimental study total 12 RC hollow beams were casted with different amount of longitudinal and shear reinforcement and tested under pure cyclic torsion. The parameters studied were cracking torque, angle of twist, energy dissipation, crack pattern and failure mode. It has been found that in pre cracking mode, reinforcement are ineffective for resisting the torsion moment but in post cracking mode all the torsional moment are resisted by the main reinforcement. It was over served that longitudinal reinforcement increases the torsional flexibility of beam, for the same amount of transverse reinforcement. It was also found from the experiment that optimum spacing of transverse reinforcement is equally important parameter while designing for the torsional reinforcement.

5. Enhancement of Torsional Strength of Reinforced Concrete by Application of Steel FibresPatilPremachand J, KanaseJayant SApril 2016.

Experimental program of this paper consists of casting 4 reinforced concrete beams of size 150mm X150 mm and length 2m. One of them was cast without fibres to make a comparative study with the remaining 3 beams; one beam was cast with 0.5% fibre by weight, one beam 1.0% fibre by weight in the rest one beam 1.5% fibre by weight added. The longitudinal reinforcement, spacing of shear stirrups was kept constant. The results concluded that the cracking torsional strength and ultimate torsional strength goes on increasing as the percentage of Steel fiber goes on increasing.

6. Behaviour model and experimental study for the torsion of reinforced concrete members(C. E. Chalioris)

The results of an experimental investigation on the behaviour of 15 reinforced concrete beams subjected to pure torsion are also presented in this paper. The reported results include the behavioural curves and the values of the initial torsional stiffness, the cracking torque moment and the ultimate torque capacity of the beams. Analyses for the torsional behaviour of the tested beams using the proposed approach were performed and analytical curves are produced and compared with the experimental ones. A good agreement between predicted and experimental results is observed.

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CASE STUDY

7. Behaviour of composite beams under combined bending and torsion (J.Thivya1, R. Malathy2, D Tensing)Tamilnadu, India:

The crack first appears on the top face of the beam and then vertically both down.For those beams tested under combined bending and torsion, in the initial stages the angle of twist and twisting moment increase linearly. However after the formation of cracks, the behaviour is nonlinear. The length of the linear portion of the torque-twist relationship decreases when the twisting moment value increases. When failure occurs the sheets are separated from concrete and the bracing at the top delays the failure and consequently the crack are widen appreciably at failure shown in fig 1. Rotation of beam at failure occurred at an axis near the top face. In some beams, upward deflection is well prominent.

Fig: 1 Failure Patten in pure torsion

Table 1Values of torque, ultimate bending moment and twist moment

Sr. No	Beam ID	Dimensions	Spacing of bracing (mm)	30% Ultimate Torque (kNm) average	Ultimate Bending Moment (kNm) average	Angle of twist (θ) (radians) X
1	A	150 X 230 X 2300	75	13.41	26.18	0.032
2	B	150 X 230 X 2300	100	15.45	29.97	0.037
3	C	150 X 230 X 2300	125	19.57	37.69	0.047
4	D	150 X 230 X 2300	150	13.41	26.18	0.032

From the readings of table 1, the values of torque, ultimate bending moment and twist moment are found. This is drawn as a graph figures, they are shown in fig.2.More resistances to twist are provided by the closely spaced

bracing. This is because the brass acts as ties and carries combined bending and torsion that resist the torsional deformation. Thus, the bending and torsion carrying capacity of the beam have been enhanced.

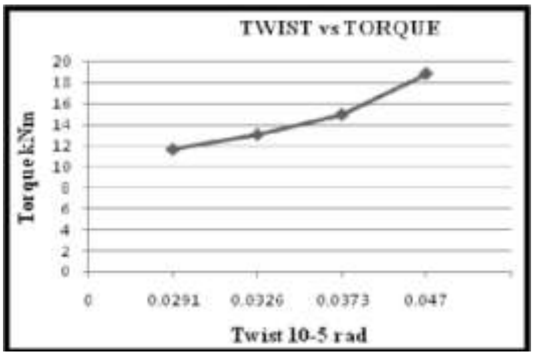

Fig 2Twist Vs torque

III. CONCLUSION

1) From case study it can be observed that crack pattern under pure combined bending and torsion Follows the principal stress trajectories. At first cracks are observed at the middle of the longer side. Following that, cracks are observed at the middle of the shorter side. When the cracks connect, they circulate along the periphery of the beam. In case of structures, a beam is generally not subjected to pure combined bending and torsion. Along with torsion, it is also subjected to flexure and shear.

2) After extensive literature study it can be concluded that torsional strength can be increased by various ways such as applying U warps, Fibre reinforcement, Steel reinforcement, hollow beams and steel fibres etc.

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