EFFECT OF SPIRAL REINFORCEMENT IN BEAMS AND COLUMNS

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Abstract - *In reinforced cement concrete the replacement of main reinforcement into spiral form leads to increase the bending moment, torsional moment, shear, ductility with reduced deflection. This also leads to better earthquake performance.The main objective is to carry out the experiments and mathematical modeling on RCC beams and columns having main spiral reinforcement.*

KeyWords**:** RCC beams, RCC columns, Spiral reinforcement,Compression,UTM

1. INTRODUCTION

A concrete is a mixture of cement, sand, aggregate, and water with or without admixtures. Such concrete is having good compressive strength thereby it resist the compressive forces effectively, but it is very weak to resist the tensile forces and also it is brittle in nature. So the steel reinforcement is used in concrete to take the tensile forces by enhancing the ductility of the structure. Such reinforced concrete is in use for various constructions.

In the present theory and practice of design and construction of beams generally the shear reinforcement are provided in vertical forms of legs. But if we replace these vertical legs provided in the forms of rectangular stirrups by the spiral reinforcement, there may be increase in moment carrying capacity, shear carrying capacity along with increase in ductile behavior.

Also the construction and design of circular reinforced concrete columns the main steel is used in the longitudinal direction and to keep this main reinforcement in position the one spiral/helical reinforcement is used. If we replace the main reinforcement provided in the form of longitudinal steel by the spiral form in case of short axially/ biaxially loaded columns, there will be definitely better earthquake performance. So it is intended that to study first the effect of spiral main reinforced axially loaded short columns.

1.1 Present Theories and Practice

In the present theory and practice of design and construction of beams generally the shear reinforcement are provided in vertical forms of legs. But if we replace these vertical legs provided in the forms of rectangular stirrups by the spiral reinforcement, there may be increase in moment carrying capacity, shear carrying capacity along with increase in ductile behavior.

The construction and design of circular reinforced concrete columns the main steel is used in the longitudinal direction and to keep this main reinforcement in position the one spiral/helical reinforcement is used. The load in such columns is transferred through longitudinal steel reinforcement and concrete. The most of the load is carried by the longitudinal steel reinforcement. The load carried by the concrete is negligible. But if we neglect the load carried by the concrete then the role of concrete remains only to keep the main steel in position just to increase the moment of inertia so that it will carry the maximum load. The circular columns with helical reinforcement have greater ductility or toughness when loaded concentrically or with small eccentricity. So it should be noted that since the helically reinforced columns are very ductile as compared to columns with lateral ties, they are more desirable in highly seismic zone. Columns with one helical reinforcement take more load than that of tied columns due to additional strength of spirals in contributing to the strength of columns. Accordingly,(cl.39.4IS 456-2000) recommends a multiplying factor of 1.05 regarding the strength of such columns. The code further recommends that the ratio of volume of helical reinforcement to the volume of core shall not be less than 0.36 (Ag/Ac – 1) (fck/fy), in order to apply the additional strength factor of 1.05 (cl. 39.4.1. IS 456-2000).

Accordingly, the governing equation of the spiral columns may be written as Pu=1.05(0.4 fck Ac + 0.67 fyAsc) Earlier observations of several investigators reveal that the effect of containing holds good in the elastic stage only and it gets lost when spirals reach the yield point. Again, spirals become fully effective after sapling off the concrete cover over the spirals due to excessive deformation. Accordingly, the above two points should be considered in the design of such columns. The first point is regarding the enhanced load carrying capacity taken into account by the multiplying factor of 1.05. The second point is maintaining specified ratio of volume of helical reinforcement to the volume of core, as specified in l.39.4.1 IS 456-2000. As the further increase in diameter of spiral reinforcement the load carrying capacity will further increase beyond 5%. And one stage will be reached the maximum load will be carried by the spiral reinforcement. In present theory and practice the main reinforcement in circular is designed and provided along the longitudinal direction along with one helical reinforcement. And in such cases as per code the increase in strength of such columns is 5%. But if the main reinforcement is designed and provided in two cross spiral/helical form with larger bar diameter along with one circular layers of smaller bar diameters along the longitudinal direction. The spirals are to be provided on either side of the longitudinal reinforcement will lead to improve its ductile behavior and such columns can be used in high seismic zone. The replacement of such main steel in to the two cross spiral/helical form leads to increase in its load carrying capacity by enhancing its ductility and earthquake performance. The main steel should be used in the two cross spiral form having bigger diameter spiral bars and just to keep this main steel in well position the vertical bars of smaller diameters can be used in between the two cross spirals so that it will carry the maximum load by increasing its load carrying capacity by the additional pipe action. The diameter of spiral reinforcement ranges from 12mm to 32 mm and the diameter of vertical bars may vary from 6mm to 8mm. Also the number of spirals may vary according to the requirement and provided cross to each other so that there will be additional truss action. Two cross spiral should consist of one layer of small diameter bars in between the two spirals along the longitudinal direction. The strength of such column can be further increased by the principle of fibrocement just by wrapping the welded mesh of diameter 1mm to 3mm.around the periphery of spiral reinforcement and replacing the concrete by mortar.

2. REVIEW OF LITERATURE

C.G.Karayannis studied about the behaviour of reinforced concrete beams with rectangular spiral Reinforcement under monotonic loading is experimentally investigated. In this direction, three beam specimens with ratio α/d= 2.67 were constructed and tested in monotonic shear loading. The first specimen had common stirrups, the second one spiral transversal reinforcement and the third one spiral transversal reinforcement with favourably inclined legs. Based on the experimental results and the behavioural curves of the tested beams it is deduced that the specimens with continuous spiral shear reinforcement demonstrated 15% and 17%, respectively, higher shear strength than the beam with closed stirrups. Further, the beam with spiral transversal reinforcement with favourably inclined legs exhibited enhanced performance and a rather ductile response whereas the other beams showed brittle shear failure.

Ioannis A. Tegos studied about the work is experimental and has to do with the behavior of circular cross-section (piles or columns) under axial compressive load. 10 column specimens having a diameter of 205mm and height 800mm were studied. The main parameters whose influence was examined are: Spiral reinforcement ratio, Density (step) of spiral reinforcement, the ductility of spiral reinforcement, The strength of spiral reinforcement and Opportunities for improving the mechanical behavior (strength and ductility) of these components by using either special ties or fiber reinforced concrete. Using experimental results, stress-strain diagrams σ-ε are constructed from which interesting conclusions emerged.

Dharane S. studied In reinforced cement concrete generally the main steel reinforcements are in use in horizontal form. But the replacement of this form of horizontal type of main reinforcement into spiral form leads to increase the bending moment, torsional moment, shear, ductility with reduced deflection which consider also considers the effect of reversal of loading as per substitute frame method. This also leads to better earthquake performance.

Jung-Yoon Lee Concrete columns confined with high-strength fiber reinforced polymer (FRP) composites can enhance the strength as well as the ductility of such structures. In recent years, the use of FRP composites to repair and strengthen existing reinforced concrete (RC) structures has been widely used. When the columns of existing RC structures are wrapped with FRP composites, the core concrete of such columns is confined not only by the FRP composites but also by the existing steel reinforcing ties (or spirals). Therefore, it is necessary to understand correctly the compressive response of concrete confined with both steel spirals and FRP composites in order to predict the behavior of such RC columns. Since the behavior of the reinforcing steel spiral ties and the FRP composites are different from each other, the behavior of concrete columns confined with both steel spiral and FRP composites is expected to be different from that of concrete columns confined with only steel spiral or FRP composites.

3. METHODOLOGY

1.Mix design
The mix design will be carry out for M20 grade of concrete by IS – code method

2.Casting and testing of conventional RCC beams
The beams of size 150mm X 150 mm X 700 mm will be casted in the laboratory for following cases and will be tested after 28 days of curing for shear and flexure separately.

a)The conventional RCC beams with minimum shear reinforcement.

b)The RCC beams with spiral shear reinforcement

3.The conventional short RCC columns and RCC columns with main spiral reinforcement will be casted in the laboratory and tested after 28 days of curing for axial loads only

4.The theoretical work consists of mathematical modeling by ANSYS of following cases a)The conventional RCC beams with minimum shear reinforcement

b)The RCC beams with spiral shear reinforcement

c)The conventional short RCC columns

d)RCC columns with main spiral reinforcement

5.Comparison of experimental and theoretical results obtained by ANSYS.

Universal testing machine

Procedure
1.Insert the specimen in position and grip one end of the attachment in the upper portion and one end in the lower portion.

2.Switch on the main switch of universal testing machine.

3.Bering the drag indicator in contact with the main indicator.

4.Select the suitable range of loads and space the corresponding weight in the pendulum and balance it if necessary with the help of small balancing weights.

5.Operate (push) The buttons for driving the motor to drive the pump.

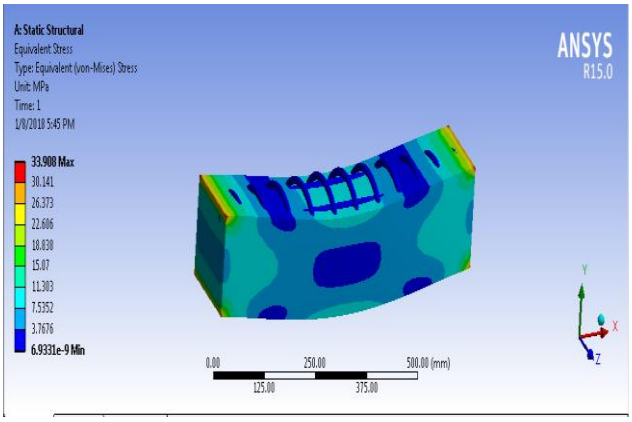
6.Gradually move the head control level in left-hand direction till the specimen cracks.

7.Not down the load at which the specimen crack.

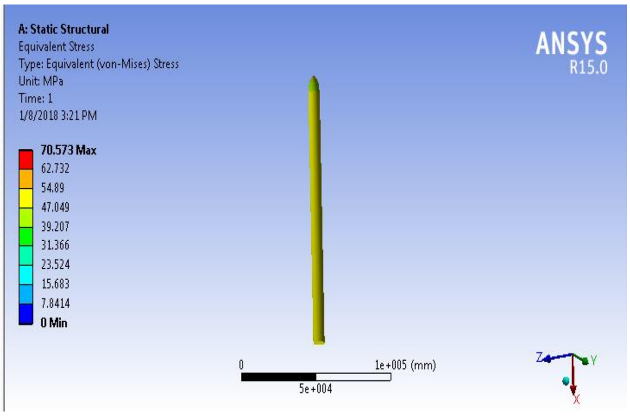
8.Stop the machine and remove the specimen.

4. MATHEMATICAL MODELING BY ANSYS

1. The RCC beams with spiral shear reinforcement



2. RCC columns with main spiral reinforcement



4. RESULT AND CONCLUSIONS

Experimental results

1)Compressive yield strength of conventional RCC beams with minimum shear reinforcement is 30MPa

2) Compressive yield strength of RCC beams with spiral shear reinforcement is 38MPa

3) Compressive yield strength of RCC columns with main spiral reinforcement is 60MPa

Theoretical results

1)Compressive yield strength of conventional RCC beams with minimum shear reinforcement is 29.431MPa

2) Compressive yield strength of RCC beams with spiral shear reinforcement is 33.908MPa

3) Compressive yield strength of RCC columns with main spiral reinforcement is 70.573MPa

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