Shear Capacity of RC Beams with Different Patterns of Spiral Reinforcements

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***Abstract*— Shear failure in reinforced concrete beams is one of the most undesirable modes of failure due to its rapid progression. This sudden type of failure made it necessary to explore more effective ways to design these beams for shear. All reinforced concrete beams require shear reinforcement, calculated or minimum ratio. Most commonly used stirrups are provided to hold the main reinforcement rebars together in an RCC structure. The length of two end hooks for each closed stirrup is an extra amount of material that increases steel weight and total cost. The cost and safety of shear reinforcement in RC beams led to the study of other alternatives. Thus reduction of cost by the use of continuous spiral reinforcement is considered as an important benefit. A systematic procedure is presented for comparing the relative performance of RC beams with different patterns of continuous rectangular spiral reinforcement using ANSYS software.**

Keywords*— *RC beam, shear stress, steel shear reinforcement, spiral reinforcement

INTRODUCTION

In building constructions, stirrups are most commonly used as shear reinforcement, for their simplicity in fabrication and installation. Generally small diameter bars are used for stirrups and are formed to fit around main longitudinal rebars with a hook at end to provide enough anchorage against pullout of the bars. 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. If a beam without properly designed shear reinforcement is overloaded to failure, shear collapse is likely to occur suddenly with no advance warning. Therefore, concrete must be provided by special shear reinforcement to insure flexural failure would occur before shear failure. This sudden type of failure made it necessary to explore more effective ways to design reinforcement for these beams for shear.

All RC beams require shear reinforcement, calculated or minimum ratio. The calculated shear reinforcement is only required when the externally applied shear force exceeds the design shear resistance of the member without shear reinforcement. By whichever standard or method calculated, shear reinforcement is necessary in the majority of the RC beams. Stirrups are provided to hold the main reinforcement rebars together in an RCC structure. Stirrup bending and installation is a time consuming operation, contributing to a significant part of the ultimate cost. Any reduction of that cost is favourable and a possible method is the use of a spirally shaped stirrup arrangement. Research on the substitution of traditional stirrups by continuous spirals is sparse, except for the use in columns especially in earthquake sensitive locations.

Fig.1 Conventional stirrups

Fig.2 Continuous rectangular spiral reinforcement

I. OBJECTIVES

- To compare the shear capacity of RC beams reinforced with different patterns of shear reinforcement with conventional stirrups.

II. METHODOLOGY

Methodology employed is response spectrum method of analysis.

A. Modelling

The models are created using ANSYS software. Then the different models should be analysed. After analysis the results obtained are evaluated to find out which type of shear reinforcement is most effective in resisting shear. From the literature survey helps to catch the knowledge about spiral reinforcement in beams.
Here the study is to be carried out for the behaviour of shear reinforcement in RC beams. Different patterns of spiral reinforcements are provided in RC beams and compared with the traditional stirrups. An RC beam which is simply supported at both ends is modeled using ANSYS

software with the design procedure. And both longitudinal and transverse reinforcements are provided.

B. Dimensional Details

RC beam with conventional stirrups is coded as ST and those with spiral reinforcements are SP1, SP2, SP3 and SP4. The specifications of the beam are as follows:

Table 1
Dimensional details of RC beam

Depth of the beam	300 mm
Width of the beam	150 mm
Length of the beam	1500 mm
Longitudinal reinforcement	4#12mmϕ
Transverse reinforcement	6mmϕ @ 140mm c/c

C. Material Properties

In concrete beams, steel reinforcements are provided. The material properties of both concrete and steel are given below:

Table 2
Material properties of RC beam

PROPERTIES	CONCRETE	STEEL
Density(kg/m^3)	2400	7850
Young's modulus (MPa)	25000	2×10^5
Poisson's ratio (μ)	0.15	0.3
Yield strength (MPa)	3.5	415

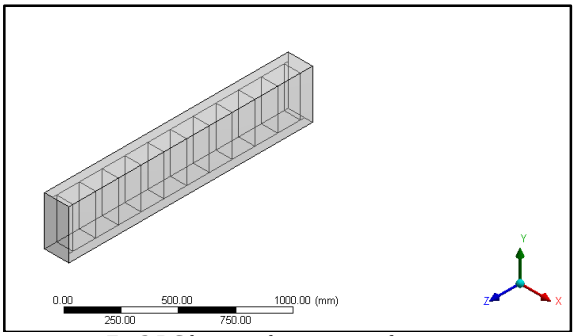

Fig.3 RC beam with conventional stirrups

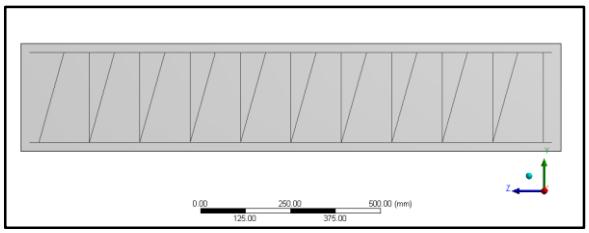

Fig.4 RC beam with spiral reinforcement SP1

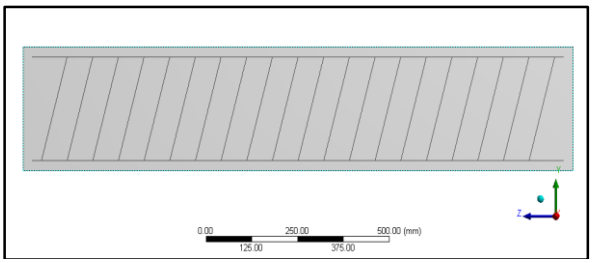

Fig.5 RC beam with spiral reinforcement SP2

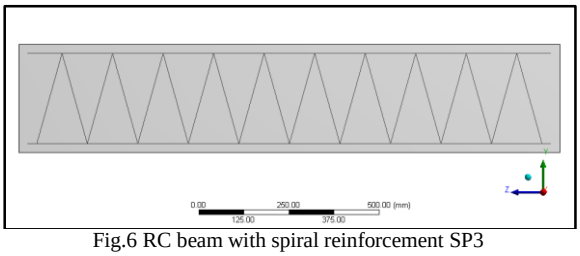

Fig.6 RC beam with spiral reinforcement SP3

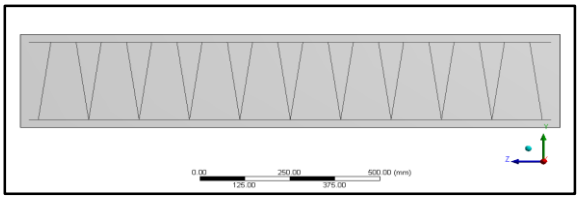

Fig.7 RC beam with spiral reinforcement SP4

D. Meshing and Loading

Quadrilateral mesh with medium size is provided. Two point loading is provided with 100 kN. Pinned supports are provided on both ends.

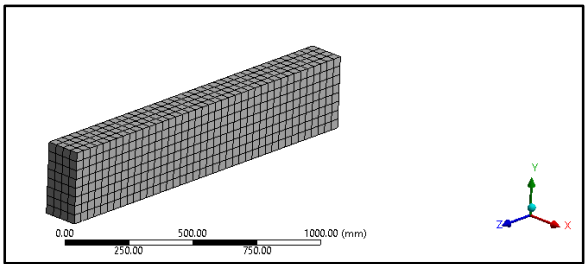

Fig.8 Meshing of RC beam

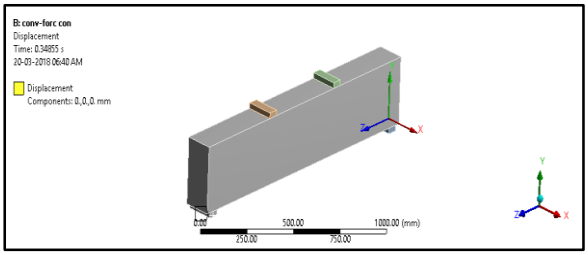

Fig.9 Support condition of RC beam

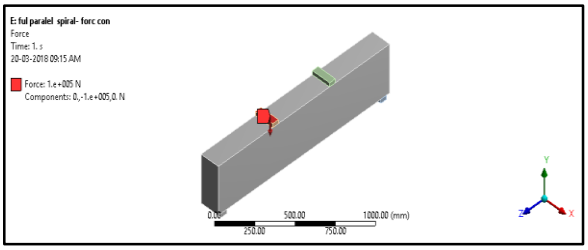

Fig.10 Loading on RC beam

E. Analysis of RC beam

Analysis was done using ANSYS software. Non liner static structural analysis is carried out in this work.

III. RESULTS AND DISSCUSSION

- *Shear Stress*

Shear capacity of RC beams with different patterns of spiral reinforcements are compared with beams of conventional stirrups. Beams with spiral reinforcement has high shear stress compared to beams with traditional stirrups.

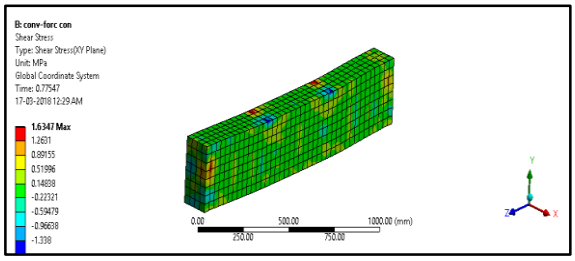

Fig.11 Shear stress diagram of control beam

Table 3
Shear Stress of RC Beams

MODELS	SHEAR STRESS (MPa)
ST	2.15
SP1	1.96
SP2	1.63
SP3	1.907
SP4	1.826

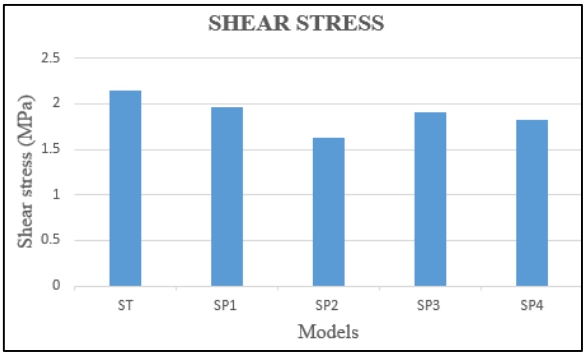

Fig.12 Comparison of shear stress of RC beams

IV. CONCLUSIONS

RC beams are analysed in ANSYS software and the results where compared. Conclusions obtained when RC beams with different patterns of spiral reinforcement are compared with beams of conventional stirrups are: based on shear capacity, spiral reinforcement shows low shear stress. Among different patterns of spiral reinforcement, SP2 shows lower shear capacity.

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