Irish Interdisciplinary Journal of Science & Research (IIJSR)
Vol.5, Iss.3, Pages 01-08, July-September 2021

Confinement of Reinforcement Concrete Using High Strength Concrete

Dhayasekar B.[1] & A. Sathiya Moorthy[2]

[1]PG Research Scholar, [2]Assistant Professor,
[1,2]Department of Civil Engineering, Bharathidasan Engineering College, Natrampalli, Tamilnadu, India.

Article Received: 10 April 2021 Article Accepted: 13 July 2021 Article Published: 02 August 2021

ABSTRACT

The installation of Helical Confinement in the Compression Zone of reinforced High Strength Concrete beams is also investigated in this study. Helical Confinement is more effective than the rectangular ties, Compression Longitudinal reinforcement and steel fibers in increasing the strength and ductility of Confined Concrete. A total number of 3 Specimens were casted. The Pitch distance for helical confinement of two specimens is 50mm, 60mm and the Pitch distance for normal confinement is 50mm. The Specimen is of a size of 600mm X 300mm X 300mm. It contains of 8 mm dia bar as longitudinal reinforcement and 6mm dia bar as transverse reinforcement. M 40 and Fe 500 Grade steels were used. After 28 Days of Curing. The Specimens were taken out and allowed to dry and tested under universal testing machine of capacity 1000 KN. The Effect of Yield strength ductility, were studied from Stress – Strain and Load – Displacement Curves. This Study Concluded the Helical Reinforcement is an effective method for increasing the Strength and Ductility of Reinforcement High Strength Concrete Beam.

1. Introduction

The concept of helical reinforcement of beams came after the demand of industry due to the improvement of stiffness factor; this improvement was associated with increasing of brittleness phenomenon in the tensile zone, having said that, it is significant to minimize this problem. For the last few years there was a remarkable increase in the tensile strength of structural concrete [1-3]. The brittle nature of high strength concrete is a major obstacle in its widespread use, as any benefit in terms of reduced member size are negated by the need for increased factor of safety to prevent brittle failure. Primarily long- and short-term advantages of high strength concrete are low creep and shrinkage, higher stiffness, higher elastic modulus, higher tensile strength, higher durability, higher shear resistance [4-8]. High strength concretes reduce the size of the member, which in turn reduces the form size, concrete volume, construction time, labor cost and dead load. Reducing dead load reduces the number and size of beams, column and foundation [9]. High strength concrete has definite advantages over normal strength concrete. It is generally accepted that helical confinement increases the strength and ductility of the confined concrete better than the rectangular ties. Helical confinement increases the strength of the concrete.

2. Objectives

The major objectives of the research are outlined below:

- To develop stress-strain models that's represents the behaviour of normal confined concrete and helical confined concrete.
- To increases a beam load capacity and reduces its cross section by using high strength concrete and high strength steel.
- To utilise the advantages of high strength concrete and high strength steel and to improve our understanding of how over- reinforced HSC helically confined beams behave.

3. Methodology

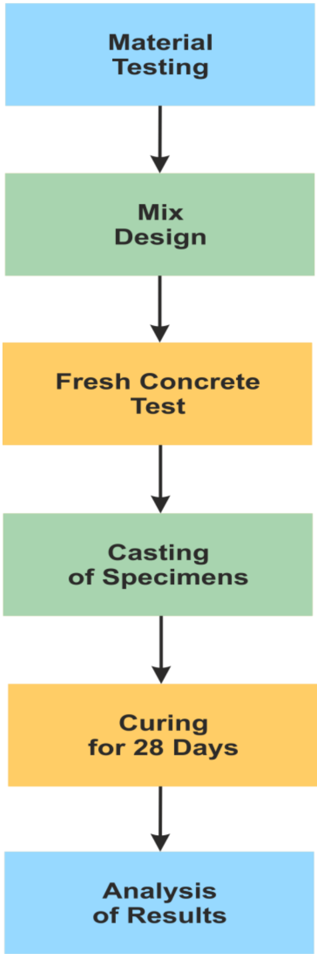

Fig.1. Methodology

4. Mix Design

4.1. Test Data for Materials

i. Grade designation	: M40
ii. Type of cement	: OPC 53 grade
iii. Maximum nominal size of aggregates	: 20 mm
iv. Maximum water cement ratio	: 0.45
v. Workability	: 75 to 100 mm (slump)
vi. Exposure condition	: Sevear
vii. Maximum cement content	: 395 kg/m3
viii. Chemical admixture	: Super plasticizers
ix. Specific gravity of cement	: 3.15
x. Specific gravity of coarse aggregate	: 2.72
xi. Specific gravity of Fine aggregate	: 2.65

4.2. Target Strength for Mix Proportioning

f'ck = fck + 1.65 s (1)

Where, f'ck = Target average compressive strength at 28 days, fck = Characteristic compressive strength at 28 days, s = Standard deviation From Table 1 standard deviation, s = 5 N/mm^2.

Therefore,

Target strength = 40 +1.65 x 5 = 48.25 N/mm^2 (2)

Fig.2. Test of cubes for compressive strength

4.3. Testing of Cubes for Compressive Strength

The cubes of dimensions, 150x150x150mm were casted. M40 grade concrete was poured in the mould and tempered properly so as not to have any voids. After 24 hours these moulds were removed and test specimens are put in water for curing. The top surface of this specimen should be made even and smooth. This is done by putting cement paste and spreading smoothly on whole area of specimen. These specimens are tested by compression testing machine after 28 days day curing. Load is applied gradually, till the specimens fail. Load at failure divided by area of specimen gives the compressive strength of concrete Cube = 42.59 N/mm2.

H1, H2 - Helical
reinforcement S1 - Square
reinforcement

Main reinforcement	=	4 no of 8mm dia
Hoops	=	For 50mm c/c spacing 13 no of 6mm dia hoops
	=	For 60mm c/c spacing 10 no of 6mm dia hoops
	=	For 50mm c/c spacing 10 no of 6mm dia hoops

4.4. Flexural Strength Test

Beams of dimensions (300 x 300 x 600mm) were prepared and tested under Universal testing machine to determine the flexural tensile strength. The rate of load application was 1.0 MPa/min in all cases. The flexural strength can be determined as PL/BD2, where P is the maximum node applied (N), L is the span length (mm) that is the distance between the line of fracture and the nearest support measured from the center line of the tensile side of specimen, B is the width of the specimen (mm), d is the depth of specimen (mm). (When L is greater than 200mm for 150mm specimen or greater than 133mm for 100mm specimen). Three beams were tested.

Fig.3. Flexural Strength Test

5. Result and Discussion

5.1. Load vs Displacement

Axial load-displacement response for various specimens was obtained. The measured axial compressive loads of wrapped specimens are slightly higher that the control specimen. Therefore, the confinement has increased the axial compressive strength of specimens. At that load tied columns fail suddenly due to excessive cracking in the concrete section followed by buckling of the longitudinal reinforcement between ties within the failure region, as shown in Fig 4.

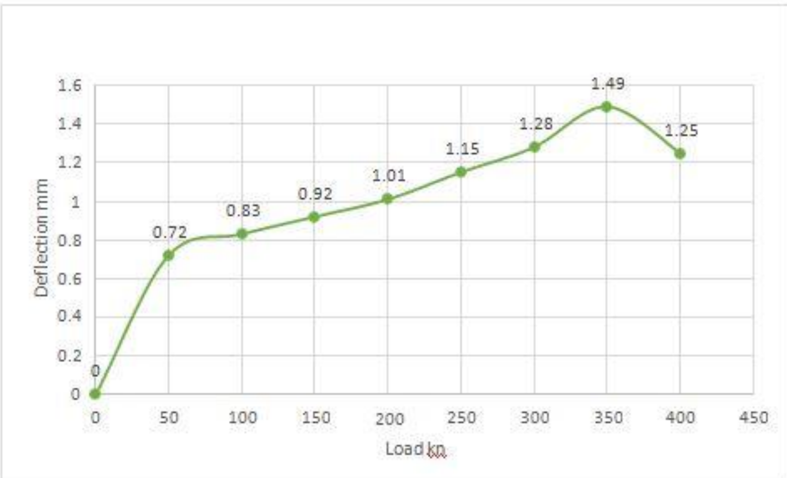

Fig.4. Load vs Displacement (60 mm spacing column H2)

5.2. Ultimate Load Carrying Capacity

The minimum load that in its last increment causes a physical breakdown in the specimen during strength test, according to computation, that cause breakdown. Load carrying capacity of specimens was reduced with spilling of the cover in compression zone, after reaching maximum load. The load carrying capacity of wrapped specimens increased slowly and steadily after yielding of tensile reinforcement steel. The ductile behavior were observed even for the specimens under higher constant axial load

Table 1. Ultimate load & flexural strength

Date of casting	Date of testing	Specimen	Ultimate load (N/mm2)	Flexural strength (N/mm2)
22.01.2019	20.02.2019	S1 (50mm spacing)	33.12	6.13
22.01.2019	20.02.2019	H1 (50mm spacing)	39.85	7.38
22.01.2019	20.02.2019	H2 (60mm spacing)	35.54	6.58

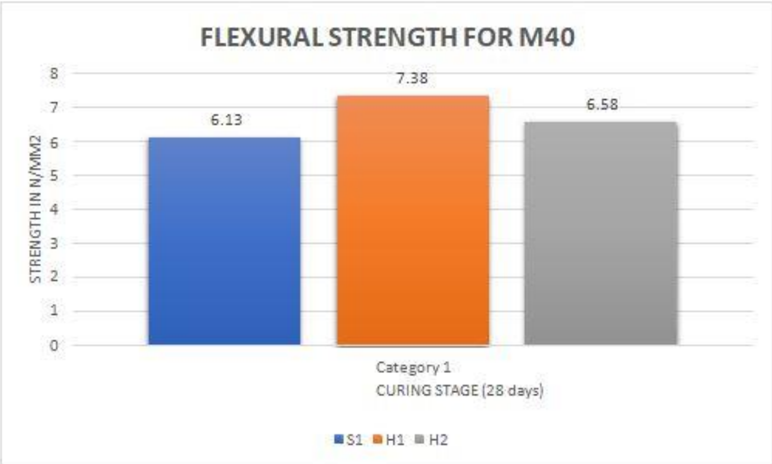

Fig.5. Flexural Strength

5.3. Stress vs Strain

5.3.1. Determination of Stress Strain Test for M 40

Table 2. Stress Strain

STRESS = Load/area (N/mm2)	Strain =deformation/original length
0	0
2.829`	0.00083
4.527	0.00016
5.658	0.00025
6.2	0.00033
7.92	0.00041
9.62	0.00058

11.31	0.00083
12.44	0.00100
13.60	0.00125
14.71	0.00141
16.97	0.00167
19.80	0.00200
21.50	0.00250
22.63	0.0030

5.3.2. Failure Modes

The initial curves were developed during yield load. They are classified as short columns. The expected failure pattern is crushing failure.

Fig.6. Failure Mode of S1 (50mm) **Fig.7.** Failure modes of H1 (50mm)

Fig.8. Failure modes of H2 (60mm)

The failure was not sudden. It was observed at the control specimens that the load carrying capacity reduced with spalling of the cover concrete in tensile zone after reaching the maximum load. However, the load carrying capacity of the specimens increased slowly and steadilyafter yielding of tensile reinforcement steels, and the ductile failure mode was observed. The wrapped specimens, bulging of the jacket in the transverse direction and wrinkle near the bottom of the jacket were observed. Before carbon jacket completely fractured, partial fractures were observed at the wrinkled area without any reduction of the load carrying capacity.

6. Conclusion

High Strength Concrete that consistently meet requirements for workability and strength development places more stringent requirements on material selection than that for lower strength concrete. Using steel helices to enhances concrete in the compression zone increase ductility and improves overall performance of HSC beams. The interval between the longitudinal steel and failure depends on the helical confinement especially helical pitch. The reduced ductility, due to the increase in tensile steel and the use of high strength concrete was overcome through the use of helical reinforcement in the compression region of the beam. The Compression test of the Precast Specimen will be carried out by Universal Testing Machine. Through the test results, end concept will be analysed with Load Vs Displacement, for 50mm and 60mm Spacing Columns. And also the Ultimate load Carrying Capacity of the designed specimen was compared with normal Reinforced Concrete Specimen. Ductility, and Stress Vs Strain analysis, failure modes, was also investigated. When the helical pitch was reduced, then the strength of the beams becomes higher. The use of helical reinforcement was effective due to the lateral confinement of the concrete. The results from this study show the strength and ductility of over-reinforced beams can be increased by using helical reinforcement.

Declarations

Source of Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Competing Interests Statement

The authors declare no competing financial, professional and personal interests.

Ethical Approval

Not Applicable.

Consent for publication

Authors declare that they consented for the publication of this research work.

Availability of data and material

Authors are willing to share data and material according to the relevant needs.

References

1. AS3600, Australian Standard for Concrete Structures, Standards Assoc. of Australia, North Sydney, 2001.

2. Sargin M. Stress-Strain Relationships for Concrete and the Analysis of Structural Concrete Sections. Solid Mechanics Division Study, University of Waterloo, No. 4, 1971, pp. 167.

3. Richart FE, Brandtzaeg A, Brown RL. A Study of the Failure of Concrete under Combined Compressive Stresses. University of Illinois Engineering Experimental Station, Bulletin, No. 185, 1928, pp. 104.

4. Hatanaka S, Tanigawa Y. Lateral pressure requirements for compressive concrete, Proceedings of 10th World Conference on Earthquake Engineering, Madrid, 1992, pp. 2603-2608.

5. Chan WWL. High-strength concrete: The Hong Kong experience, Magazine of Concrete Research, No. 21, 7(1955) pp. 121-32.

6. Kwan A, Ho J, Pam H. Effect of concrete grade and steel yield strength on flexural ductility of reinforced concrete beams, Australian Journal of Structural Engineering, No. 2, 5(2004) pp. 119-38.

7. Hadi MNS, Schmidt LC. Use of helixes in reinforced concrete beams, ACI Structural Journal, No. 2, 99(2002) pp. 191-98.

8. Whitehead PA, Ibell TJ. Deformability and ductility in over-reinforced concrete structures, Magazine of Concrete Research, No. 3, 56(2004) pp. 167-77.

9. Ross J, Hadi MNS. Effect of confinement shapes on over-reinforced HSC Beams, Proceedings of World Academy of Science, Engineering and Technology, Paris, France, 2008, pp. 268-293.