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Stress and Strain Behaviour of Prefabricated Cage System

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Abstract

The columns are the most important structural members in a structure, and the strength and ductility of columns significantly influence seismic capacity of the structure. When reinforced concrete sections are subjected to large deformations typical of seismic motions, their ability to carry load depends primarily on the behavior of confined concrete. The strength and ductility of the structural members can be enhanced by confining the concrete by transverse reinforcement, commonly in the form of closely spaced steel or hoops prefabricated proposed by Halil to reinforce the columns can be used to confine the concrete in the structural members. The combination of concrete with high compressive strength and steel providing tensile strength lacking in concrete has made reinforced concrete a very common compound in construction of structural and non-structural members. In this experiment the different thickness of GI sheets is used to make the cage system and the openings varied in dimensions to make a set of experimentation. The prefabricated cage system is adapted to symmetrical mould which is having a dimension of 150mm diameter and 300mm height. The cylinders are casted using M 30 grade of concrete with locally available materials and are encased by fully confined, partially confined and unconfined cage systems. From the experimental results, we can observe that the axial load for confined and unconfined specimens gets failed due to local buckling or bulging effect. Due to the axial load the cracks will be formed inside the specimen and the cracks will propagate towards the surface by increasing the load. The propagation of cracks will gets arrested by the confinement of the specimen. The increase in load will leads to bulging of specimen and specimen will gets failed due to the formation of diagonal cracks. The partially confined specimens which is having 50 mm spacing of lateral ties will gives more compressive strength when compared to 100 mm and 150 mm spacing of lateral ties. The confined condition of specimen will increases the compressive strength of the specimen. The spacing of the lateral ties will influence the stress and strain behavior of concrete by implementing prefabricated cage system in the confined manner.

Keywords: Fully confined, GI sheets, PCS, partially confined, partially unconfined.

I.INTRODUCTION

Before modern engineering and the ability to manipulate concrete and steel, the world architecture consisted of wood and cave dwellings.

The first land mark building in reinforced concrete was built by an American mechanical engineer, William E. ward, in 1871 to 1875.

Many strong earthquakes occurred in regions high seismicity in the last decade resulted in significant loss of life and property and caused infrastructure damage. The columns are most important structural members in a structure, and the strength and ductility of columns significantly influence seismic capacity of the structure when reinforced concrete sections are subjected to large deformations typical of seismic motions, their ability to carry load dependsprimarily on the behavior of confined concrete. The strength and ductility of the structural members can be enhanced by confining the concrete by transverse reinforcement, commonly in the form of closely spaced steel or hoops. Prefabricated cage proposed by Halil to reinforce the columns can be used to confine the concrete in the structural members. The combination of concrete with high compressive strength and steel providing tensile strength lacking in concrete has made reinforced concrete a very common compound in construction of structural and non structural members.Since the use of prefabricated cage for confinement of concrete is a relatively a new approach. Conventional rebar reinforced concrete, concrete-filled tubular system, steel concrete composite system and welded wire fabric system are examples of such combinations used in structural members. The theoretical work in this area is still limited and the models originally developed for transverse steel reinforcement are not necessarily applicable to prefabricated cage reinforcement. The behaviour of concrete confined with prefabricated cage is different from concrete confined with regular steel reinforcement. In this paper, the stress strain behavior of prefabricated cage confined concrete cylinders, including experimental and analytical studies, is presented. The performance of concrete cylinders confined by prefabricated cage under uniaxial compression load and the effect of thickness of cage and compressive strength of concrete on confinement is included.

The prefabricated cage eliminates these difficulties and can play vital role in fast track construction against the time consuming conventional process. The prefabricated cages are produced by cutting out uniform rectangular openings on a cold form steel sheet or tube. The vertical continuous strips perform the function of stirrups, while the horizontal strips act as main longitudinal reinforcement. Since these cages are fabricated in industries using CNC cutting, better quality control can be maintained.

2. Materials and methodology

Cement: Ordinary Portland cement of 43 grade ACC cement was used in this work and it meets the IS:8112-1989 recommendations.

Fine aggregates: Natural sand confirming to IS:383-1970 of zone 2 is used. Specific gravity, moisture content and absorption capacity of fine aggregate is calculated according to the procedure conforming to IS: 2386 and results obtained comply with code specifications

Coarse aggregate: Coarse aggregate passed through 20mm sieve and retained on 12mm sieve confirming to Indian standard specifications IS: 383-1970 was used for concreting.

Galvanized iron sheet:

Galvanized iron sheet of 1mm, 1.6mm and 2mm thickness were used as reinforcement cage for a cylinder of diameter 150mm and height 300mm. the width of prefabricated cage strips used in this study is 20mm.

Water:

Water fit for drinking is generally considered for making concrete. Water should be free from acids, oils, alkalies, vegetables or other organic impurities. Soft waters also produce weaker concrete. Water has two functions in concrete firstly; it reacts chemically with the cement to form a cement paste in which the inert aggregates are held in suspension until the cement paste has hardened. Secondly, it serves as a vehicle or lubricant in the mixture of fine aggregates and cement.

Casting of cylinders: Totally 39 cylinders were casted and studied by varying the parameters like centre to centre spacing of lateral ties, thickness of steel sheet. The casting of specimens involved two stages namely fabrication of prefabricated cage and casting of cylinders.

Fabrication of prefabricated cage for cylindrical specimens:

Width of the plate equal to depth and length of the plate which is equal to the perimeter of the cylinder is taken. The perforations were made to get the centre to centre spacing between the lateral ties of 50mm, 100mm and 150mm. then the plates were bent in the plate bending machine and two ends of the plates were joined by means of welding. Each series consists of one set of fully confined specimens, three sets of partially confined specimens along with one set of unconfined specimen.

3. Test on hardened state of concrete after 28 days of normal water curing:

Axially loaded compressive strength:

- One of the important properties of concrete is its strength in compression. The strength in compression has a definite relationship with all the other properties of concrete, these properties improved with the improvement in the compressive strength and the test procedure is as follows:

Fig: 3.1.compression testing machine

- After the completion of casting of the moulds and curing for 28 days. The specimen was tested for its compressive strength in compression Testing Machine. The bearing surface of the testing machine shall be wiped clean and any loose sand or other

- Materials removed from surface of the specimens contact with compression plate. The specimen is placed in the machine centrally in such a manner that the load is applied continuously on the cylinder.

- No packing shall be used between the faces of the test specimen and the steel plates of the machine

- The movable portion shall be rotated gently by hand so that uniform seating may be obtained. The load shall be applied without shock and increase continuously at a rate of approximately 40 kg/cm2/min until the resistance of the specimen to increasing load breaks down and no greater load can be sustained. The loading shall be continued until it reduces half on maximum load to obtain stress and strain curve. The maximum load applied to the specimen and the corresponding strain value shall be recorded.

- The graph shall be plotted between stress v/s strain values.

4. Results:

Table. No. 4.1: Showing the result for fully confined and unconfined cage specimens for different thickness of sheets.

Sl no	Specimen type	Sheet thickness in mm	Peak load in KN	Deformation(Δ)in mm	Stress in N/mm²	Strain Δ/L
1	Fully confined	1	667.08	4.20	37.74	0.014
		1.6	863.28	3.40	48.85	0.011
		2	941.76	3.05	53.29	0.010
2	Unconfined	-	372.78	2.6	21.09	0.008

Table. No. 4.2: Showing the result for partially confined cage specimens for 1mm thickness of sheet.

Sl NO	Specimen type	Spacing of stirrups	Sheet thickness in mm	Peak load(l) in KN	Deformation(Δ) in mm	Stress in N/mm²	Strain (Δ/L)
1	Partially confined	50	1	716.13	4.2	40.52	0.014
		100		608.22	5.4	34.41	0.018
		150		421.83	6.6	23.87	0.022

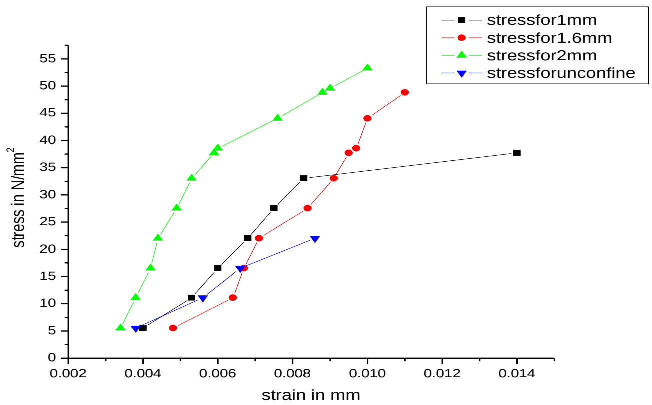
Table. No. 4.3: Showing the results for partially confined cage specimens for 1.6mm thickness of sheet.

Sl NO	Specimen type	Spacing of stirrups	Sheet thickness in mm	Peak load (l) in KN	Deformation(Δ) in mm	Stress in N/mm^2	Strain (Δ/L)
1	Partially confined	50	1.6	519.4	3.65	29.39	0.012
		100		490.23	4.08	27.74	0.013
		150		461.07	3.4	26.09	0.01

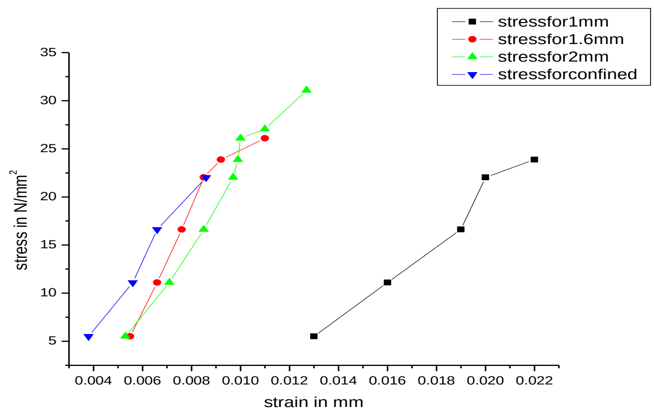
Table. No. 4.4: Showing the results for partially confined cage specimen for 2mm thickness of sheet

Sl NO	Specimen type	Spacing of stirrups	Sheet thickness in mm	Peak load(l) in KN	Deformation(Δ) in mm	Stress in N/mm^2	Strain (Δ/L)
1	Partially confined	50	2	706.32	3.2	39.96	0.0100
		100		647.46	3.7	36.63	0.0120
		150		549.36	3.83	31.08	0.0127

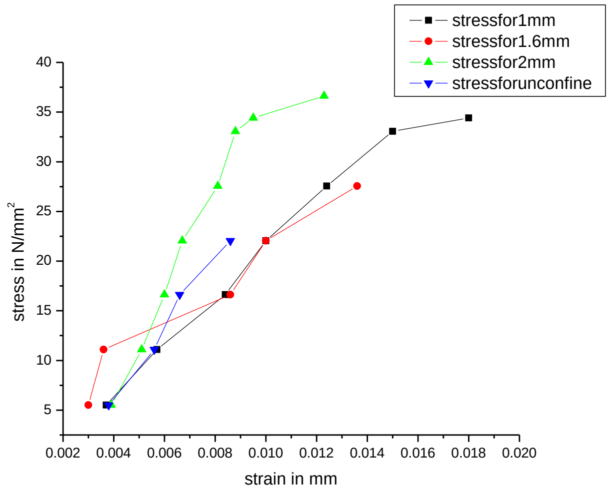
GraphNo. 1: showing stress v/s strain behaviour of fully confined cage system of thickness 1, 1.6 and 2mm



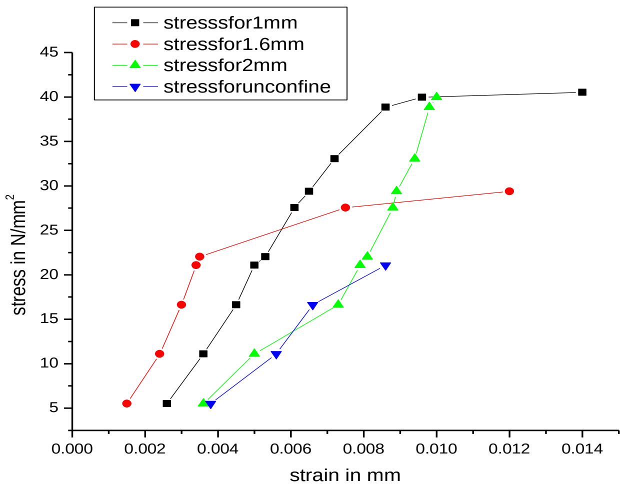
Graph No.2: Showing stress and strain behavior of partially confined cage system with thickness 1, 1.6 and 2mm thickness with 150mm spacing



Graph No.3: Showing stress v/s strain behaviour of partially confined cage System for 1, 1.6 and 2mm thickness with 100mm spacing



Graph No. 4: Showing stress and strain behaviour of partially confined cage system for 1, 1.6 and 2mm thickness and 50mm spacing



5. Discussion:

Experimental results showed about, we can observe that axial load for confined and unconfined specimens get failed due to local buckling or bulging effect. Due to axial load the cracks will be formed inside the specimen and the cracks will propagate towards the surface by increasing the load. The propagation of cracks will gets arrested by confinement of specimen. The increase in load will leads to bulging of specimen will get failed due to the formation of diagonal cracks. The failure of specimen by bulging of steel sheets started at 70%-80% of maximum load.

The spilling of concrete has been occurred at 95% of maximum load. The compressive strength of confined specimen will be greatly increased for axial load compare to unconfined specimen.

The partially confined specimens with different spacing of lateral ties get failed due to diagonal formation of cracks. The partially confined specimens which is having 50mm spacing of lateral ties will gives more compressive strength when compared to 100mm and 150mm spacing of lateral ties.

6. Conclusion:

The experimental results showed about, we can observe that axial load for confined and unconfined specimens get failed due to local buckling or bulging effect. Due to axial load cracks will

- The behavior of concrete by influence of confinement cannot be captured clearly u8sing the standard compressive strength. It shows that the concrete under axial compressive test gives low compressive strength in unconfined form due to the early crack failure.
- The confined condition is used to prevent the brittle collapse and slowdowns the crack from occur.
- The confined condition of specimen will increase the compressive strength of specimen.
- The spacing of lateral ties influences the stress and strain behaviour of concrete specimen.
- The thickness of sheet will greatly influence the stress and strain behaviour of concrete by implementing prefabricated cage system in confined manner.
- Overall conclusion is that we can improve stress and strain behavior of concrete by implementing prefabricated cage system in confined manner.
- It is also observed that minimum spacing of lateral ties will gives more compressive strength and stability due to buckling when compared to 100mm and 150mm spacing of lateral ties.
- By the observation of graphs showing stress v/s strain, the fully confined cage specimen will withstand more stress due to maximum load but the cage system will gets failed by increasing the stress in the fully confined specimen.
- The thickness of sheet for prefabricated cage system will affect the stress and strain behavior of specimen. If the thickness of sheet is more the stress absorption capacity of specimen will gets reduced because of sudden failure of specimen will occur due to bulging.

7. References:

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