International Journal of Trend in Scientific Research and Development (IJTSRD)
Volume 6 Issue 5, July-August 2022 Available Online: www.ijtsrd.com e-ISSN: 2456 – 6470

Improvement in Properties of Circular Columns using Welded Wire Mesh (WWM): An Experimental Study

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ABSTRACT

Conventional steel tied reinforcement may not provide superior confinement for reinforced cement concrete columns (RCC). Based on different experimental observations and theoretical literature review many materials like FRP, WWF etc. were used as reinforcements to increase the load bearing capacity and ductility of the structural members. One such material welded wire mesh (WWM) is used in this project work to improve the confinement and ductility. This work aims to define how confinement and improvement will help compression members (Circular column) to increase their ductility. A welded wire mesh was added to the previous reinforcement. Sample used were categorized in two categories, samples confined using conventional methods and others with improved confinement. Firstly, the samples were prepared using conventional methods, and then testing was done. After this the same samples were prepared using additional reinforcement i.e., using WWM. A layer of WWM was warped on the outer periphery of the longitudinal reinforcement and then further casting and testing was done. The samples were casted in mould, de-moulded after a time interval and they were cured for a certain time interval and then were being tested under axial loading till failure. The results shows that properties of the samples made up by using additional WWM were improved than the conventional confinement samples.

KEYWORDS: *Conventional, Steel tied, Ductility, Wire mesh, Confinement, Reinforcement*

How to cite this paper: Abhishek Dubey | Dr. A. K. Jha | Dr. R. S. Parihar "Improvement in Properties of Circular Columns using Welded Wire Mesh (WWM): An Experimental Study" Published in International Journal of Trend in Scientific Research and Development (ijtsrd), ISSN: 2456-6470, Volume-6 | Issue-5, August 2022, pp.1764-1770, URL: www.ijtsrd.com/papers/ijtsrd51766.pdf

IJTSRD51766

I. INTRODUCTION

A compression member is an important component of reinforced concrete structures. Compression member such as column, in general, It can be defined as an element that carries direct axial stresses which result in compressive stress of such amount that these stresses largely have effect on its design. Both column & strut are compressive elements, the effective length of which is more than 3 times the least horizontal dimensions. When an element carries mainly axial stresses is vertical, it's called as a Column, while if it is inclined or horizontal, it's called as a 'Strut'. Depending upon structural or architectural requirements, Columns are mainly seen in shapes, i.e. (circular, rectangular, square, hexagonal, etc.). Concrete as we came to know through various experiments is stronger in compression. Therefore, mains bars or vertical steel rods are always provided in order to assist in carrying the direct loads. And there is set limit to provide that longitudinal steel in different shapes of column, whether it is taken into consideration of the type of load acting or not. And this is done to avoid tensile stresses formed due to some eccentricity of the loads acting longitudinal direction. Different sets of benchmarks that are listed in codes to provide the amount of maximum reinforcement, because reinforcement more than the upper limit may generate difficulties in pouring of concrete and compaction of the concrete. Vertical reinforcing bars are tied horizontally by ties or stirrups or welded joints at certain intervals so that the bars do not shatter or cause bulging.

TYPES OF COLUMNS

A. Columns with longitudinal reinforcement and lateral ties.

B. Columns with longitudinal steel and spirals.
C. Composite columns.
D. Braced and unbraced Columns.

Figure 1.1 reinforcement

II. LITRATURE REVIEW:

C. Mishra(2018) The use of metal in RCC sections has been generally being used from a long time like cement filled with steel tube (CFST) sections and so on. The paper is dependent on trialmix experimental work, it is planned to increase the hub pressure quality & parallel distortion attributes of round RCC segments kept with mellow steel (Mild) rings. The MS rings limited roundabout RCC sections were tentatively read for various cases (I) fluctuating % of segment steel (ii) changing girth of Mild steel circular rings (iii) shifting dividing of Mild steel circular rings, in various segment examples. It was discovered that the ring imprisonment adequately improved the hub compressive burden limit of round RCC segments and furthermore helped in lessening horizontal distortion of segment examples.

P. Sankholkar(2018) Constrainment of solid utilizing glass fiber–strengthened polymer (GFRP)spirals was assessed utilizing little scope concrete tube shaped examples with a 254-mm distanceacross and 762-mm tallness under concentric pivotal pressure. The commitment of longitudinal GFRP bars to constrainment was barred by utilizing wood dowels as longitudinal fortification to keep up a consistent winding pitch. In this manner, concrete control was given solely by the GFRP winding. An extreme loop strain of 1.0 to 1.5% was accomplished for the GFRP spirals of well confined little scope solid examples. Articulations were created for the limited compressive quality and extreme hub compressive strain of cement kept with GFRP spirals. The subsequent constrainment model is contrasted and hub section trial of strengthened cement segments with GFRP spirals and GFRP longitudinal bars from the current examination and the writing. An articulation is proposed for a definitive pivotal pressure limit of solid sections fortified with GFRP spirals and GFRP longitudinal bars.

Huang Yuan (2018) the steel tube-fortified cement (ST-RC) segment is comprised of solid filled steel hollow bars implanted in strengthened cement. As an inventive sort of composite structures,there is as yet an absence of data on the conduct and flexibility of ST-RC segments, especially onarranged development steel tube-fortified solid (ST-SC-RC) segments. This paper contemplated the component of two sorts of ST-RC sections in a 15 story building. A limited component (FE) model with legitimate material constitutive relationship was proposed for ST-SC-RC sections exposed to consolidated hub compressive power and parallel stacking. The material nonlinearity and the cooperation between steel cylinder and cement were thought of. The proposed FE model had the option to anticipate the horizontal solidness, quality and distortion limits of ST-SC-RC segments with a sensible degree of exactness. At that point, the impacts of various parameters on removal pliability were talked about in detail. At long last, a rearranged recipe for ascertaining the removal pliability of ST-SC-RC sections was created dependent on the parametric investigation, the forecasts of the proposed equation fitted well with countless test outcomes. Using the proposed equation, the interest of removal flexibility under various seismic plan grade in current ST-RC detail was introduced, which may give a valuable reference to the seismic structure of the ST-SC-RC structures.

Prashant O Modani et al, [2020]: Today researches all over the world are focusing on ways of utilizing either industrial or agricultural wastes as a source of raw materials for the construction industry. These wastes utilization would not only be economical, but may also help to create a sustainable and pollution free environment. Sugar-cane bagasse is one such fibrous waste-product of the sugar refining industry, along with ethanol vapor. Bagasse ash mainly contains aluminum ion and silica. In this paper, untreated bagasse ash has been partially replaced in the ratio of 0%, 10%, 20%, 30% and 40% by volume of fine aggregate in concrete. Fresh concrete tests like compaction factor test and slump cone test were undertaken along with hardened concrete tests like compressive strength, split tensile strength and sorptivity. The result shows that bagasse ash can be a suitable replacement to fine aggregate.

Jayminkumar A. Patel[2021] India is a second country in major sugar producing countries after Brazil. Due to that many of the time there is increase in bagasse as a byproduct from the sugar mill. Bagasse is the fibrous residue of sugar cane after crushing and extraction of juice. Sugar cane bagasse ash is the waste by product of the combustion of bagasse after the complete burning process, for energy in sugar factories. Sugar cane bagasse ash is disposed of in landfills and is now a days becoming an environmental burden. In this experimental research study concrete cubes, beams prism and cylinders of M25 grade were casted and tested to examine various properties of concrete like workability, compressive strength, split tensile strength, modulus of elasticity and flexural strength. Sugar cane bagasse ash was partially replaced with cement at that is 2, 4, 6 and 8 % by weight of cement in concrete. From the results we can conclude that optimum amount of sugar cane bagasse ash that can be replaced with cement is 6% by weight without any admixture.

III. EXPERIMENTAL PROGRAM:

Mould: - for the experiment we used a circular mould that was having a height of 900mm and diameter 150 mm. Pictorial representations and front view of Auto-cad are shown below in figure 3.1 and 3.2 respectively.

Figure 3.1 Mould

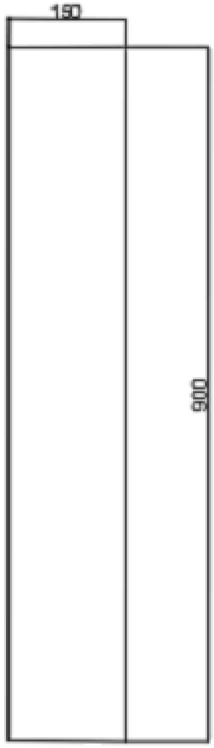

Figure 3.2 Font view of mould using AutoCAD

In this part we will experience through the entire tests we experienced till now. So fundamentally entire test work comprised of three cases (Let it be case 1, case 2 and case 3).And after when all the specimens were ready, we put every specimen for curing for 7, 14 and 28 days. Then we on every 28th day of the three specimen we tested it under universal testing machine, we compared the results of three specimen using data we recorded from the data blogger in the forms of graphs. All the three cases have been briefly discussed below.

Figure 3.3 Case I-5RS

IV. METHODOLOGY:

Preparation of Design Mix

Here design mix prepared was whole as per the guidelines provided by IS: 10262-2019. Basicmaterial used and some material specifications has been listed below in table.

Material	Specification
Grade of concrete	M30
W/c Ratio condition	Severe
Grade of cement	OPC 43 Grade
Specific gravity of cement	3.10
Workability	100mm(slump)
Maximum size of CA	20mm
Specific gravity of CA	2.78
Water absorption of CA	1.4%
Aggregate Type used	Crushed stone angular aggregate
Type of fine aggregate used	Zone II Sand
Specific gravity of sand	2.47
Water absorption of fine aggregate	0.6%
Method of pouring	Hand pouring using Trowel

Table 3.1 Material specification

A. Target Strength for Mix Proportioning

Target strength of the M30 grade concrete is denoted as f'_{ck} and after calculating it came outto be 38.25 MPa. Therefore, the target strength of the concrete is 38.25 MPa.

B. Approximate Air Content

As we used maximum size of coarse aggregate 20mm so according to table 3 the expected to be 1% for 20mm ostensible most extreme size of total.

C. Determination of Water-Concrete Proportion

As per table 5 from IS: 456, we assumed severe exposure condition so here we consider w/c ratioof 0.45.

Ingredients	Mass/cubic meter
Water-cement ratio	0.45
Cement	428
Water	193
Fine aggregate	614
Coarse aggregate	1187

Table 3.2 Mix proportion

Trial mix testing For M30

For verifying whether the prepared design mix is correct or not we prepared three circular column samples with the same mix of diameter 100mm and height 200mm and kept them for curing for 7,14,28 days. after every interval every interval we tested every sample under CTM(compression testing machine as shown in Figure 3.15) with an strain rate of 1.8 and results has been displayed.

Figure 3.1 Testing under CTM

Days	Strength of mix (kN)
7	431
14	637
28	695

Table 3.3 strength of trial mix

Case I: - 4 vertical bars of diameter 8 mm and 5 ties of diameter 6mm tied at a spacing 217mm.

Case II: - 4 vertical bars of diameter 8 mm and 4 ties of diameter 6mm tied at a spacing of290mm.

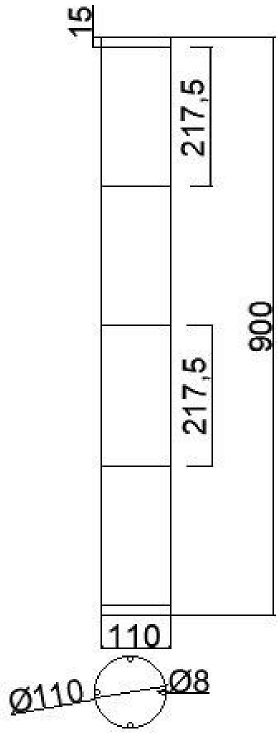

Figure 3.2 5RS-design

V. RESULT AND DISCUSSION

On testing all the samples under axial loading under the universal testing machine we found the compressive strength and deflection of each sample. Compressive strength values of each sample with respect to days has been tabulated below and graphical representation of load with respect to deflection value of each sample on the 28th day has been graphically represented.

The compressive strength value in kN of each sample (Case I, Case II and Case III) has been tabulated in table 5.1 with respect to time period. And graphical representation of data is shown in Figure 5.1 in the form of bar graph

Specimen name	Compressive strength (kN)		
	7 DAYS	14 DAYS	28 DAYS
Case I – 5RS	430	597	663
Case II- 4RS	418	579	643
Case III-4RWS	465	644	716

Table 5.1 Compressive strength Results

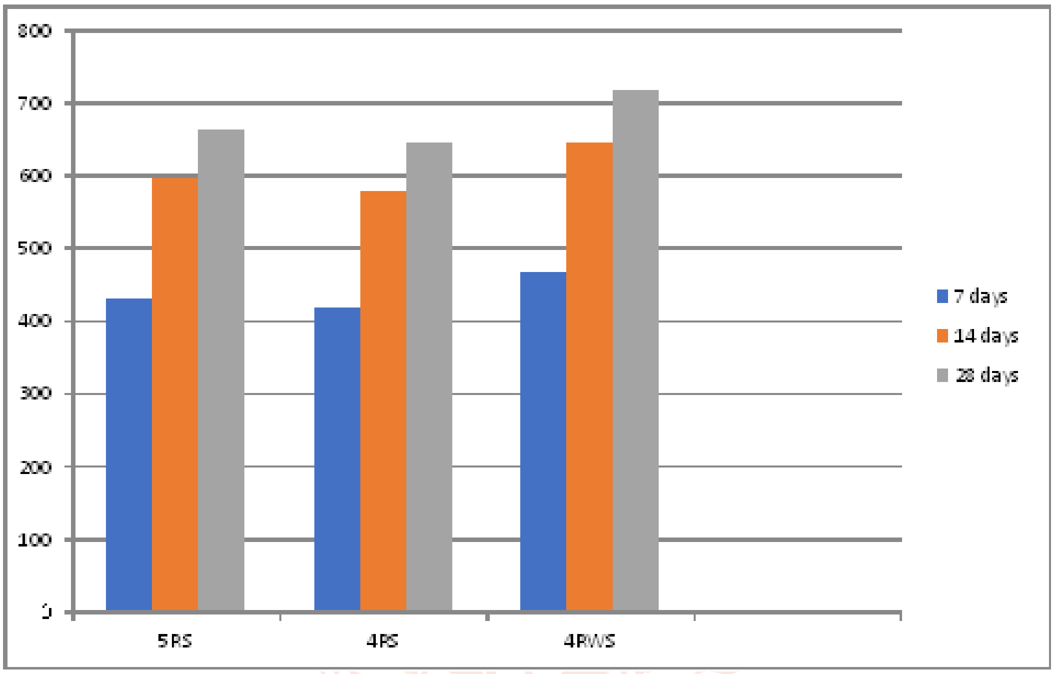

Figure 5.1 Compressive strength (kN)

Axially loading was applied by using universal testing machine on each sample on the 28th day and using data logger we measured load Vs axial displacement values of each sample and this data was created from the data logger.

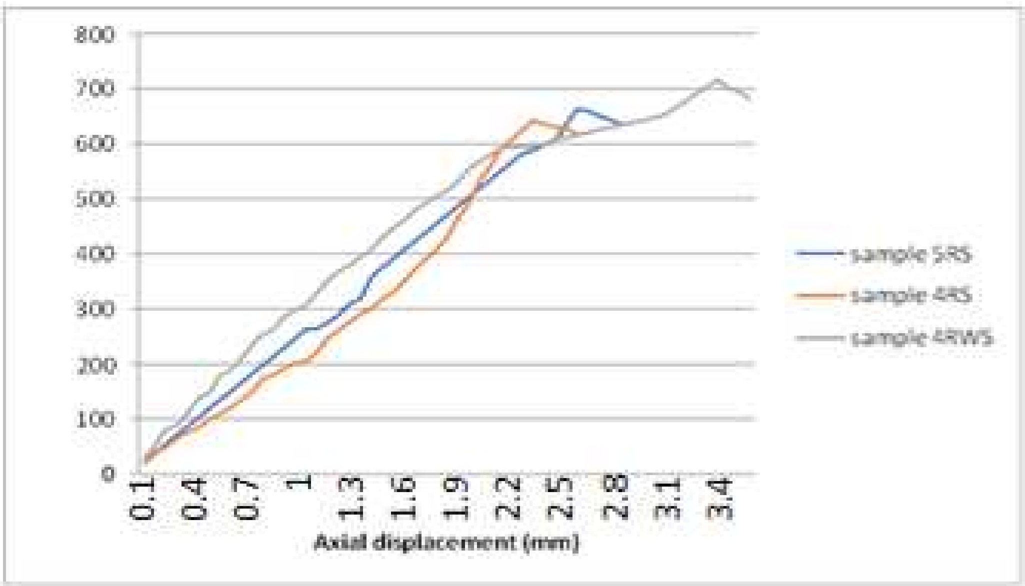

Figure 5.2 load and axial displacement curve

VI. CONCLUSION:

Based on the test results some conclusion listed are as follows: -

1. The load carrying capacity or we can say compressive strength of the sample that was wrapped with the welded wire mesh on the outer periphery of the major reinforcement of the column has 7% more compressive strength than that of the other two samples named as 4RS and 5RS.
2. The ductility of the column confined with welded wire mesh is more than conventionally or traditionally reinforced samples.
3. The axial load carrying capacity load carrying capacity was not having much difference.
4. Cracking pattern was more observed in case of in case of samples confined the welded wire mesh than in case of the other two was less as compared to the welded wire mesh sample.

VII. SCOPE FOR FURTHER STUDY

1. welded wire mesh on the outer periphery of the major reinforcement of the column.
2. Cracking pattern was more observed in case of in case of samples confined the welded wire mesh.
3. Concluded that the confined sample with welded wire mesh has more ductility and load bearing capacity

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