IMPROVEMENT OF CONFINEMENT AND DUCTILITY OF CIRCULAR COLUMN

A

THESIS

Submitted in partial fulfillment of the requirements for the award of the degree

of

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With specialization in

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Under the supervision

of

Mr. Kaushal Kumar

(Assistant Professor)

by

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to

JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY

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May 2020

STUDENT'S DECLARATION

I hereby declare that the work presented in the Project report entitled **"IMPROVEMENT OF CONFINEMENT AND DUCTILITY OF CIRCULAR COLUMNS"** submitted for partial fulfilment of the requirements for the degree of Master of Technology in Civil Engineering at **Jaypee University of Information Technology, Wakhnaghat** is an authentic record of my work carried out under the supervision of **Mr. Kaushal Kumar Assistant Professor**. This work has not been submitted elsewhere for the reward of any other degree/diploma. I am fully responsible for the contents of my project report.

Signature of Student

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May 2020

CERTIFICATE

This is to certify that the work which is being presented in the project report titled **"IMPROVEMENT OF CONFINEMENT AND DUCTLITY OF CIRCULAR COLUMNS"** in partial fulfillment of the requirements for the award of the degree of Master of Technology in Civil Engineering with specialization in "Structural Engineering" and submitted to the Department of Civil Engineering, **JAYPEE UNIVERSITY OF INFORMATION TECHNOLOGY, WAKNAGHAT** is an authentic record of work carried out by **Awaz Dutt Sharma(182656)** during a period from JAN, 2020 to MAY, 2020 under the supervision of **Mr. Kaushal Kumar,** Assistant Professor, Department of Civil Engineering, Jaypee University of Information Technology, Waknaghat.

The above statement made is correct to the best of my knowledge.

Date: - ………………………

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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. So, one such material welded wire mesh (WWM) we have used in this project work in order to improve the confinement and ductility. This whole project aims to define how confinement and improvement in confinement will help compression members (Circular column) to increase their ductility. So, we used a welded wire mesh in addition to the previous reinforcement. Sample used were categorized in two categories, samples confined using conventional methods and others with improved confinement. Firstly, we prepared the samples using conventional methods, and then testing was done. Then we prepared the same samples by using additional reinforcement i.e. using WWM. A layer of welded wire mesh 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. After all this result of those in which confinement was improved were compared with that of samples made up by using additional WWM.

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CHAPTER 1
INTRODUCTION

1.1 COLUMN

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.

1.2 TYPES OF COLUMNS

Columns on the basis of different arrangement of steel reinforcement and concrete designs are classified into four different types:-

a) Columns with longitudinal reinforcement and lateral ties: - when no lateral ties are used with main bars and when load is applied on such a column, the concrete bulges out laterally. The bars themselves act as along slender columns and therefore tend to buckle away from the column's axis. Due to this, tension is caused in the outside shell of the concrete which opens out. The failure usually takes place suddenly. In order to check this tendency, the longitudinal rebars are tied transversely, at a suitable interval, with the help of ties. These ties check the bars from buckling and also restrain the concrete from bulging action.

b) Columns with longitudinal steel and spirals: - each of the tie has to be spliced by lapping or By bending its ends around the main bar, which is quite troublesome. In order to overcome this difficulty, the longitudinal bars are tied continuously together with the help of spirals. The spirals so provided serve an additional purpose of laterally supporting the concrete inside and thus has confining effect on it.

c) Composite columns: - Reinforced with a centrally placed joist and four or more longitudinal bars. Other steel sections may also be used. However, composite columns are used only for heavy loads.

d) Braced and unbraced Columns: - In the greater part of the cases the segments are exposed to level burdens like breeze, seismic tremor and so forth. In the event that sidelong backings are given toward the finish of the segments, the parallel burdens are borne totally by the horizontal backings. Such sections are known as supported segments, different segments, where the sidelong loads must be opposed by them, notwithstanding hub loads and end minutes are named as unbraced segments.

1.2.2 Functions of reinforcements in a column

Longitudinal and transverse reinforcements are provided in a column. Figure 1.1 shows the both type of reinforcements.

Figure 1.1 reinforcement

Functions of reinforcement are briefly discussed as follows: -

1) Vertical Reinforcement: -

a) To distribute the axial compressive stresses in column.

b) To avoid tensile stresses formed in compression member due to: -

i) Whimsical stress.

ii) Force acting at some point other than centre.

iii) Horizontal load.

c) To avoid sudden shattering of the column.

d) To provide certain amount of malleability to the column.

2) Horizontal Reinforcement: -

a) To avoid longitudinal shattering of vertical reinforcement.

b) Avoid inclined stresses formed by horizontal shear formed by moment.

c) Restricting vertical reinforcement in their position at the time of pouring of concrete.

d) Confine the concrete, thereby avoiding vertical bars to shatter.

1.3 CONFINEMENT

1.3.1 Introduction

A well known fact that why we use reinforcement in any structural member because to avoid sudden failure in concrete. And also, just adding reinforcement to the concrete won't help to increase the elastic property we also have to use some kind of later reinforcement so as to prevent reinforcement from shattering. Section imprisonment is essentially performed to improve their helper executions that can be associated using remotely associated transverse support plans. To improve the constrainment and flexibility of the solid different strands are utilized like steel filaments, manufactured strands, glass strands, artificial strands. Restriction in fortified solid sections is typically given by a blend of longitudinal bars attached with equal fortification as indirect circles or spirals, steel coats, fiber strengthened polymers, and material strengthened mortars, strands ropes and steel strengthened grout.

Figure 1.2 Confinements

Confinement is commonly consolidated into the type of shut circle ties, welded bands or consistent spirals so that as sidelong burden is associated with the essential system the level support contradicts the equal augmentation of the solid by giving equal insurance, thusly extending the breaking point and adaptability of the solid portion. This methodology is significant in limit plan procedures, in which originators ensure an adequate adaptable response of augmentation segment essential regions while maintaining a strategic distance from progress of vexatious dissatisfaction instruments all through the structure.

1.3.2 Types of confinement: -

a) **Passive confinement: -** The sort of restriction insinuates equal fortification reacting to concrete sidelong augmentation which causes a control pressure under stacking as a result of Poisson's effect and littler scope breaking.

b) **Active confinement: -** The binding weight associated with prestress the part at the edge going before stacking, applies a little sidelong weight on the solid with the result being an extension in as far as possible.

CHAPTER 2

LITERARURE REVIEW

2.1 HISTORICAL REVIEW

Kent. D.C. and Park. R. (1971) these two clarified about flexural individuals with restricted cement. So as to decide the snapshot of ebb and flow qualities of flexural part with limited part we utilize transverse steel bands or spirals. The pressure strain bend for this is spoken to as illustrative bend and a direct falling branch followed by a straight even line .the volume and dividing of the steel and the quality of cement is shaped as the slant of directly falling branch .flexural individuals have various degrees of resist the outrageous degree of pressure filaments and amounts of binding steel and this everything is found from the pressure strain chart .The assessment existing apart from everything else ebb and flow attributes of bars with kept cement indicated that the amount of keeping steel just significantly affects the conduct of individuals with a high pressure steel content and a low pressure steel content.

M. J. Negel Priestley, Wayne D. Gill (1982) worked on the ductility of square confined circular columns The experimental study showed the amount of hoops that are required by a column in the potential plastic hinge region of the reinforced concrete column in order to fulfill all the requirements of a seismic design code. Various parameters like cross sectional area, no of hoops in the rectangular columns were described. Four no. of columns of size 21.7 inches were tested. All the hoops were designed according to the New Zealand concrete design code. Results were like, ductility behavior of the columns increased by a factor 6 which therefore fulfilled all the requirements of the code and also, there was a wide difference in the flexural strength that was calculated theoretically and the one that was observed in the experimental testing. In any case, this expansion in flexural quality was represented the refined quality that additionally incorporated a type of strain solidifying impact of the longitudinal steel and lead to the increment in the malleability and quality of the segments. The compressive concrete strain that were recorded at their peak level ranged from 0.016 to 0.026 that lead to the maximum displacement.

FafitisA., and Shah, S. P. (1985) these three talked about fortification (parallel) for high quality solid segments. The fundamental way of thinking by these three was limiting cement in seismic tremor configuration to build the quality of the center of the section. The conditions given in the code depend on the suspicion that when a strengthened solid segment is exposed to uniaxial load the most extreme limit of the restricted center is arrived at when the unconfined spread beginnings spalling. It isn't evident whether this supposition that is pertinent for high quality cement. The endure which the spread concrete and bound solid will arrive at their most extreme limits will rely upon their particular pressure strain bends. In this paper, in light of a few arrangements of test information, investigative articulations are proposed for the pressure strain bends of limited and unconfined high-quality cement. Utilizing these scientific articulations, second ebb and flow connections are anticipated. The anticipated bends were contrasted and the test information of segments exposed to switched horizontal stacking. Raised on the palatable examination for ordinary quality solid sections, the hypothetical model is then applied to high quality cement.

J. B. Mander, Priestley, Fellow (1988) these four in this year considered exploratory and graphical investigation of the pressure strain chart of kept solid individuals Thirty-one almost full-size strengthened solid segments, of round-about, square, or rectangular divider cross region, and containing various plans of help, were stacked concentrically with critical compressive strain paces of up to 0.0167/s. The indirect sections contained longitudinal and winding help, the square territories contained longitudinal stronghold and square and octagonal transverse circles, and the rectangular divider regions contained longitudinal help and rectangular groups with or without gainful cross ties. The longitudinal weight strain lead of the bound concrete was assessed and differentiated and that foreseen by an earlier derived weight strain prototypes with considers the results of different arrangements of horizontal keeping fortress, cyclic stacking, and strain rate. The purposeful longitudinal concrete compressive strain when the transverse steel recently split was in like manner differentiated and that foreseen by looking at the strain imperativeness cutoff of the transverse help to the strain essentialness set aside in the strong due to the detainment.

Muguruma, Watanabe, and Komuro, T. (1990) These all learned about progress of flexibility of high quality solid segments with horizontal restriction. Eight section tests with limited sidelong fortifications having 328.8MPa and 792.3MPa yield quality were tried under switched cyclic stacking with consistent hub compressive burden rate 0.254-0.629. These were the compressive qualities of sections having yield quality as examined above 85.7 &115.8 MPa. Volumetric proportion of parallel fortification was 1.6 % in all the eight segments tried examined previously. Test outcomes indicated that by utilizing high return quality rebars an extremely enormous measure of flexibility can be accomplished.

A. I. Karabinis and P. D. Kiousis(1994) These two surely understand partner individuals from ASCE considered the impact of constrainment on the pressure part utilizing pliancy approach. So as to assess the plan of sidelong repression of solid sections a few speculations are utilized like hypothesis of versatility and the distortion similarity conditions and results resembled there was increment in quality and pliability of the pressure part. Plan of cement is finished utilizing a straightforward Drucker-prager a non-acquainted solidifying model. Where horizontal fortification is supplanted by a slight arrangement layer that covers the solid center. Also, that sheet is comprised of elastoplastic that covers the solid center, the support and the solid spread. Similarity of the distortions of the extending center and the support results into the parallel weight. n number of strategies were distributed because of analyses so as to foresee the reaction of the restricted pressure part. Be that as it may, this all trial study is only for rectangular imprisonment not for winding and roundabout ties.

Rodriguez and Park (1994) these two worked on the seismic load testing on the reinforced columns confined by jacketing. Columns had a cross section of 13.8 inches all the columns were square in shape and 4 no of units were designed these were typically less reinforced because these columns were of a typical building 1970s, that were subjected to repair and strengthening technique. That unit in which every set was divided was of mid heights of different stories. A space (stub) was present in every two consecutive columns of two stories. Two of the units were jacketed and reevaluated and other two were just jacketed and evaluated no reevaluation was done. Jacketing that was done in every case was having thickness of 100mm. All the transverse rebar was placed through the floor slab. Because of low amount of ductility in the previous columns due to low reinforcement these all were all redesigned, reinforcement was done in two arrangements, where the jacketing done showed the required amount of ductility.

Bilal M. Ayyub, Naji AI-Mutairi, and Peter Chang (1994) in this review paper it is expressed that bond quality of welded wire texture in solid decks were analyzed and 22 no of pullout examples for bond quality up to their definitive limit were tried. Handy examination demonstrated that considerably after the security among wires and cement fizzled, the examples despite everything opposed a few loads because of the jetty impacts of transverse wires and welded shear quality, this expansion in security quality differed from 16% to 771% contingent on the sort course of action of welded wire networks .in this way this indicated transverse wires and shear quality of the welds contribute a great deal to the security quality of the welded wire texture in solid extension decks.

Murat Saatcioglu, Amir H. Salamat, Salim R. Razvi (1995) these three tried limited sections under unusual stacking. Highlights of Confined solid segments under strain inclination were analyzed. Testing of twelve segments was led at two distinct degrees of end unusualness. This test included rudiments parameters like game plan, dispersing and volumetric proportion of control fortification. Sections with very much disseminated longitudinal fortification and furthermore along the side bolstered by firmly dispersed transverse support indicated incredibly malleable conduct, with no huge loss of solidarity it was building up an inelastic dislodging surpassing 4% of the float proportion. The ones with low volumetric proportion and extra wide dividing of transverse steel created quality rot after the use of pinnacle load. A kept solid model was created based on segment tests under unconventional stacking was to decide logical second ebb and flow connections of basic segment segments. Along these lines all the outcomes were contrasted and distinctive erraticism of stacking and parameters of constrainment .subsequently this inferred flexural conduct of kept solid sections can be registered sensibly precisely for solid model produced for concentric stacking, gave that the important parameters of imprisonment are consolidated in the model, and that strain solidifying in support is thought of.

S. M. Alcocer, J. A. Pineda and J.A. Zepeda (1996) Studied about re-fitting of reinforced masonry walls using WWM various observations were taken from the tests conducted that cracks and failure mechanism of the specimen was governed by shear deformation uniform distribution of inclined patterns of cracking were observed in specimens jacketed with welded wire mesh and 25mm thick concrete layer .The contribution of the welded wire mesh to strength depended on the amount of horizontal reinforcement ,deformation applied ,type of mortar quality and type of anchor .

S. T. Mau, John Holland and L. Hong (1998) performed pressure tests on little sections restricted with welded wire texture. Pressure tests were performed on tests with measurements (127*127*981) mm so as to examine the effectiveness of welded wire textures as keeping transverse fortification with close longitudinal separating. The dividing to width proportion shifted from 0.1 to 0.3. For every one of the five wires they utilized four distinctive s/d proportions, so by utilizing this they had twenty unique examples and every example was tried under same uniaxial stacking with three indistinguishable examples. Various charts were plotted; the welded wire texture in this way given a shifted level of repression to the solid, as found in the diagrams for improvement of solid quality and malleability. Thus, this all concluded that s/d ratio have more dominating character than amount of WWF. As a result of all this experiment a relationship between s/d ratio and the proportionate ratio in welded wire fabric was created as a boundary separating ductile behavior of confined concrete from brittle behavior. From this entire one more things were concluded that welded wire fabric is an effective confinement material to the concrete columns for construction purpose.

Michel Samaan, Amir Mirmiran (1998) these two worked on the concrete models that were confined by fiber composite. As from the studies it came into clearance that fiber jacketing of concrete in FRP makes an effective change in strength and ductility of the concrete columns. But designs of such structures need an accurate estimate and precision while designing due the confinement. conventional methods of confinement of reinforced concrete columns do not work in case of FRP confined concrete columns. Designs of such confined concrete were predicted on the basis of all the stress and strain results in both the directions i.e. in case of biaxial and lateral directions. Those models were proposed on some parameters or on the basis of the relationships between them and those parameters were expansion rate and strain hardening of concrete. Parameters of the FRP confinement and the unconfined concrete were having relations with each other. All the results like stress strain graphs were compared with unconfined concrete with that of the Fibre Reinforced Polymers confined with concrete.

Murat Saatcioglu and Mongi Grira (1998) these two made some exploratory arrangement identified with the restriction of solid sections utilizing welded fortified networks. Various arrangements of parameters were mulled over like volumetric proportions, separating and game plans of welded wire lattices for ten unique sections and those all were tried under consistent hub pressure stacking. This was a critical advance towards control of Strengthened solid sections, additionally there is an adequate increment in the flexibility of the segment and the welding done in the constrainment partition don't diminish the quality of the segment. More on it improved different basic property as required by the construction regulations it made a 3% of sidelong floats proportions as for the dividing and volumetric of the transverse fortified segment. Various changes after that additionally when no of cells was utilized in greater sum.

Stephen perrikin (2001) pivotal conduct of fortified solid segment bound with FRP coats. In these squares, round segments that were bound with FRP composite coats were exposed to mono driven pivotal stacking. Here upgrades or unjacketed solid individuals were contrasted and the jacketed solid individuals and results were produced. Axial stress strain behavior of FRP confined concrete was affected by factors like transverse dilation and effectively confined regions and areas that were confined and their relationships and inter-relationships of jackets of jacket properties were generated.

J.H. Shan, R. Chen, W.X. Zhang, Y. Xiao (2007) these all learned about the conduct of cement filled cylinders and kept cement filled cylinders under rapid effect. As we as a whole realize that in everyday developments like development of extension, structures concrete filled tubulars are increasingly used. Specialist named Xiao as of late developed new cement filled cylindrical segment framework that was a short time later named as bound cement filled rounded framework. What's more, increasingly after that he demonstrated those solid filled rounded sections has effective ones by indicating different stacking tests on it thusly basic properties like high burden conveying limit, malleability under static stacking and furthermore under seismic stacking were demonstrated right. Utilizing a gas weapon all the effect tests were continued cement filled steel tubes and the bound cement filled steel tubes. Different testing parameters were thought about like imprisonment subtleties and effect speed. Results demonstrated that so as to improve the dynamic effect conduct of cement filled sections efective horizontal imprisonment strategies were utilized. All the dynamic and static strain and the disappointment designs were talked about further in the diaries, examination was made in test results and the explanatory outcomes were completed utilizing LS-DYNA. Likewise, the engendering of the pressure designs was roughly same as anticipated before hypothetically.

Sami W. Tabsh (2007) in this diary stress strain model was proposed for high quality cement bound by welded wire texture. By utilizing legitimate imprisonment of the solid center we can accomplish expanded flexibility of sections made with high quality cement. So as to analyze the adequacy of welded wire texture as transverse rebars in high quality solid sections, an exploratory arrangement of made and 10 full scale segments were tried under pivotal pressure.

There after all the outcomes were contrasted and that of unconfined cement. Pivotal pressure strain outlines of the solid center from the trial tests indicated critical increment in the quality and malleability of sections horizontally strengthened with welded wire texture and this was conceivable if and just if volumetric proportion of transverse steel were more prominent than 3.5%.

Hadi and Hua Zhao (2011) these both did some research work on high strength reinforced columns confined with different types of mesh under different loading conditions. This whole experimental research found a new way of reducing flakes in the concrete columns. The whole idea is to use all the household sieves & steel meshes in the formwork of reinforced compression members. Fiber glass mesh, standard aluminum fly mesh and a galvanized steel mesh these all were the materials used for the experimental setup. Different no of loadings were applied like concentric, eccentric and pure bending stress. And sixteen no of sample were tested that were 925mm long, 205mm diameter. And the results showed that the wire mesh that we used had an effective increase in the load bearing capacity under eccentric and concentric loading but on the other hand it does not had that much increase in the ductility of column case. But on the other hand, fiber glass and aluminum fly ash increased the ductility of the column case but it does have had one drawback that there was an increase in the eccentricity.

S.M.Mourad, M.J.Shannag (2012) these both studied about the repair and strengthening of reinforced concrete square columns using ferrocement jackets. From a series of 10, 1/3 scale square reinforced concrete columns were casted, those all were preloaded under axial compression up to various levels of loading fraction. Repairing was done in two layers using ferrocement jackets of welded wire mesh and filled with high strength concrete and testing was done up till its failure stage. Some terms that were used to determine the actual response of the structure were the extent of stress bearing , amount of axial displacement, amount of axial load and amount of strain, amount of lateral displacement and amount of ductility. Overall experimental results showed there was an increase in amount of axial load bearing capacity and amount of axial stiffness of the square concrete columns by 33% in axial load bearing capacity and 26% amount of axial stiffness when compared with the normal as they were before. Also results showed that by using ferrocement jackets we can almost restore the original stress bearing capacity and ductility of the columns.

Soner Guler(2013) This paper presents a preliminary examination of indirect ultra-predominant concrete filled with steel tube areas under one center point tension. Somehow show documents, named strong duty extent (CCR), quality improvement list (SI) and pliability record, are examined tantamount due to the estimation of the girth extent (Dia/thickness) of the ultra-predominant concrete filled with steel tube fragments. critical impacting restrictions of the ultra-predominant concrete filled with steel tube areas got from the experimental results are differentiated and Eurocode-IV, ACI, ASAI of Japan arrangement codes. The experimental results shows that on increasing the steel tube girth from (0.25 cm to 0.36 cm) improves the DI value by 69%, yet the SI just by 5%. Regardless of the way that the Eurocode 4 arrangement code overestimates the center point bearing constraints of the ultra-predominant concrete filled with steel tube fragments, the ACI , ASAI of Japan codes are conventionalist.

Xuedong Chen(2013) Number of investigations were led so as to discover the impact of l/d proportion on the quality Centers with breadths of 74 mm and length-to-width (l=d) proportions of 0.5, 1.0, 1.5, 2.0, 3.0, and 4.0, were expelled from solid bars. Compressive quality tests were led on 300 center examples (as demonstrated as follows). Through this trial it was inferred that more noteworthy the l/d proportion lesser is the quality. Examples with l/d=1 has 15% more quality than that of l/d with 2.

Rousakis and Tourtouras(2014) these two worked on the active and passive confinements with composite ropes of square sections of reinforced concrete. Fiber ropes were used as external confinement reinforcement rather than using normal reinforcement bars that have square sections and have a very less corner radius. Ropes are made up of polypropylene and come in either 3 layered or 4 layered. In order to apply pretensions on the ropes special mechanical instruments were used while doing the external wrapping of the columns and thereafter were compared with the columns without pretensions. Thereafter the specimens were subjected to an increasing order of compressive forces as in case of seismic actions. Up to a strain rate of 6.7% none of the column that was wrapped with polypropylene had any kind of fracture in the fiber. Normal pretension results were satisfactory while for higher pretension levels we will have to remove the friction between the ext. wrapping and the concrete columns. On removal of the wrapping results were like there was high cracking of the concrete part and also bulking was seen in the reinforcement part.

Mostafa Osman, Ata El-Kareim Shoeib Soliman(2015) discussed about different techniques of confinement and their behavior on columns. As columns are the most important elements of any structure, failure of any one column in a building may result in collapse or failure of the whole building. In order to reduce columns failures and to maintain the column capacity proper repair, maintenance and strengthening of columns is required. In this these took twenty columns with parameters (for example: -dimension, different w/c etc.) were tested. Eleven confined reinforced concrete columns using different confinement techniques were assessed, also four were tested using PVC (plastic tubes) these four were tested along with unconfined plain concrete and this technique of confined reinforced concrete is called mortar strengthening, steel rings strengthening, fiber reinforced polymer strengthening. All these columns were tested under uniaxial compressive loading and studied the effects of structural behavior on the columns. Behavior of each set of columns was represented in terms of stress strain curves and crack patterns. Results showed that the confinement of reinforced columns using different methods of strengthening resulted in significant improvement of behavior of the columns and can be used for construction purposes as well. Results also showed that reinforced columns with PVC tubes can be used for economical buildings as well. Theoretical models for predicted columns capacity is founded with some factors that depend on the methods of confinement and the strain reduction.

Osama Youssf(2016) An exploratory assessment was assesed to find out the possible using piece flexible concrete for essential portions by testing the use of fiber sustained polymer detainment by using as a techniques for crushing the ingredients insufficiencies (compression quality). 5 braced strong sections having 24 cm of estimation and 15 cm of shear extend were attempted by center point tension and steadily growing on opposite periodic stacking. 3 areas created out of Carbon detained with one, two and four stacks of CFRP and 2 were tested out of standard concrete with 0 and 2 layers of carbon FRP. Outcomes of all testing demonstrated that a comparable constrainment thickness, the apex nature of the FRP-kept CRC area was to some degree higher than that of the FRP-limited standard strong section, in spite of the way that the base concrete compressive quality was less. In any case, its complete buoy was hardly lower. Increasing the constrainment thickness extended of apex quality and an authoritative buoy of the

FRP-CFRC by 11.5% and 53.8%, independently. By using 2 layered FRP, the quality limitation ampleness of the traditionally made concrete and the CFRP were 1.1 and 1.3, independent, regardless, buoy detainment suitability was (1-0.02) and (1+0.07), independently. The assessment shows that CFRP gives earth cheerful choice as opposed to customary concrete in helper applications.

Ahmed M. EI- Kholy, Hany A.Dahish (2016) studied on the improved confinement of reinforced concrete compression members. Old school steel ties do not provide that much confinement in reinforced concrete compression members because of various imperatives on tie spacing and disturbances on concrete continuity. Here these both studied about the experimental setup of confining the reinforced concrete with the help of metal mesh layers in addition to the steel ties that we use. Expanded metal mesh sheet is wrapped above the ties. 16 numbers of short square columns were designed in two groups based on various parameters like different slenderness and ratios and different volumetric ratios of steel ties. All the examples were tried under concentric pressure till disappointment. Results resembled recently proposed plan of repression after their testing under pressure stacking demonstrated an extraordinary increment in quality and malleability. Also one more thing was observed reduction in the volumetric ratio of the steel ties in ultimate loading condition can be achieved by using expanded metal mesh sheets.

Alexander. D, Ramakrishnan.S. (2016) these both studied about the design of reinforced concrete beam with and without WWM (welded wire mesh) as a confinement material in flexural and shear behavior. These both figured out another method of reinforcement, here welded wire mesh was to act as transverse steel reinforcement in RCC Beams. Welded wires taken was ready made and were orthogonally aligned because these help in eliminating the problem of slower construction as in case of traditional reinforcement setups this is much faster, economical and has better quality than the traditional one. One of the main beams is having five other beams by its side with different welded wire mesh contents and all were tested under two point compressions loading. Results obtained were used to determine the flexural property of the beam also the members with continuous mesh and transverse rebars showed that they have maximum loading bearing capacity.

Rami Eid(2017) The advancement of seismic tremor opposition norms has prompted presentation of new plan conditions for the measure of transverse steel support (TSR) to guarantee flexible conduct of fortified solid segments. So as to follow the new codes' TSR prerequisites there is a need to fortify existing sections. One of the strategies to fortify fortified solid sections is by utilizing fiber-strengthened polymer (FRP) composites as restriction support. Basic surveys of existing examinations relating to the principal conduct and logical displaying of FRP-kept solid segments have shown that there are a few perspectives on which more research is required. These incorporate, among others, the cooperation between the interior transverse support constrainment and the outside FRP control, and non-uniform repression as found in FRP-limited square/rectangular areas. This paper presents the advancement of a bound together pressure strain model reasonable to speak to the hub conduct of round and square/rectangular fortified solid segments limited inside with TSR, remotely with FRP, or both inside and remotely with TSR and FRP, separately. Besides, trial investigation of six FRP-/TSR-bound square fortified solid sections under compressive pivotal stacking was directed. It is indicated that pressure strain bends anticipated by the proposed model are in acceptable concurrence with the introduced just as distributed exploratory outcomes.

Ahsan Parvez(2017) High-quality cement (HSC) offers points of interest as far as execution and economy of development. The utilization of HSC has gotten imperative in tall structure development, especially in segments. Be that as it may, HSC segments are increasingly fragile and have significantly less post-top deformability than ordinary quality solid sections. The malleability of fortified solid sections can be expanded by expanding volumetric proportion of keeping steel; regardless, higher volumetric proportions of tie strengthening bars are required for HSC segments to accomplish a pliability level like that of ordinary quality solid segments. The Australian Standard for Concrete Structures AS3600 manages the pliability issues of HSC segments by expanding the restricting weight applied deeply that is ordinarily accomplished by expanding the volumetric proportion and additionally course of action of tie support. It is normal that the utilization of high-quality steel tied in segments wiould give significant type of imprisonment needed to upgrade malleability & quality of that solid inside that center and will offer a decrease in steel blockage, improved solid arrangement, reserve funds in the expense of work and decrease in development time. This paper reports the aftereffects of a trial concentrate on the quality and malleability execution of HSC segments limited with steel attaches with a yield quality of 750 MPa, or more. The ampleness of AS3600 arrangements to decide the restriction furnished to center with HSS ties is explored and plan proposals are made.

Lea Ghalieh(2017) Strong constrainment having Fiber confined polymers is a strategy extensively used now a days for increasing the strength and reclamation. Displacing the strands with ordinary wires or sheets is a phase to gain a viable turn of events. In this investigation, a preliminary examination results the sufficiency of the use of hemp fibre wires on the outer side of detainment for strong areas and the results of different physical quantities that may impact the assistant direct of strong segments constrained with that fibre polymer. The experimenal factors were: the amount of keeping differences between two materials, and areas slenderness extent . singly axially pressure was practiced for 30 models totally. critical weight amd change in original twists, fundamental flexibility assessed by break imperativeness and dissatisfaction modes were inspected. Similarly, the importance of existing tension models open in the composing is checked. It was found that the amount of restricting layers and segments slimness extent essentially influence the limitation feasibility and malleability. This examination gave promising results versus the use of trademark fibers as outside detainment disregarding the unbending nature of hemp FRP that are basically lower than that of designed FRP.

Francesco Micelli(2018) The use of external constrainment of strong fragments by using Fiber Reinforced Polymers (FRPs) composites has been extensively pondered and seen as a convincing advancement. The most bit of the preliminary examines that were coordinated are related to portions that were kept without a pre-stacking condition, which is the most notable situation that is met in the field. In order to extend the data, this assessment speaks to and discusses the preliminary outcomes that were gotten by testing strong chambers that were limited with Carbon FRP (CFRP) unidirectional sheets at five unmistakable pre-stacking levels. The strong chambers were prepared and poured all the while to restrict differentiate to start with properties of the strong focus. Five models were set up for each pre-load level. Thusly, 25 strong models having a separation across of 100 mm broadness and height of 200 mm have been attempted. In detail, 5 coupons were unconfined ("U"); 5 were CFRPconfined with invalid pre-load level ("P0"); and three courses of action of 5 models, named "P20", "P50" and "P80", were FRP-continued during the utilization of a pre-load level comparable to 20%, half and 80% of a conclusive unconfined cement compressive quality, independently. The test outcomes revealed the differing mechanical response depending of the pre-hurt state of the chambers identifying with different pre-load levels. Until a pre-load level of 20% the effects can be thought of for all intents and purposes insignificant, while for higher pre-load levels (half and 80%) it is critical to consider the loss of mechanical properties respect to an ideal un-stacked plan. The paper will discuss all the perspectives identified with the test outcomes, moreover showing a demonstrative technique to consider the effects of the pre-stacking conditions.

Qusay Al-Kaseasbeh , Iraj H. P. Mamaghani. (2018) Due to their excellent Steel tubular columns with conventional uniform circular sections and newly proposed graded-thickness circular sections then, the GC column with a size and volume of material equivalent to the C column is introduced, Thin-walled steel tubular columns with circular cross sections are widely used as cantilever piers in bridges. these have proved to have significant improvements in overall performance of column as compared with its counterpart C column.

Chau-Khun Ma, Nazirah Mohd Apandi (2018) Auxiliary specialists on the significance of guarantee solid structures to oppose Harmed structural elements are more expensive than the expense of Constructing a new structures. Is one of the mainstream & dominating fast fixing of harmed concrete. Of all constrainment fixing strategy in fixing effects solid sections or extension Size, harm degree, fix segment tallness, fix process, transverse support Dispersing, limit of hub stress, vertical bar proportion & yield quality.

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 trial mix 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 distance across 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 wellconfined 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 on arranged 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.

Chengxiang Xu, Sheng Peng, Chenfei Wang, Zuotao Ma(2019) Firmness of the examples and the CFRP sheets improved the malleability & vitality scattering of the examples, Carbon Fibre Reinforced Polymer sheets or ESJ didn't crumple in a reenacted solid quake and was like or even surpassed the Seismic exhibition of the first example; this outcome is significant and pertinent to building practice. Along these lines, the ESJ ingredient is ideal when just one kind of ingredient is utilized for reinforcing The seismic exhibition of the RCC shaft SRC segment outline joints fortified with the CFRP sheets.

2.2 SUMMARY OF LITERATURE REVIEW

1. Robert Park, M.J. Negel Preistley, Wayne D. Gill worked on the ductility of square confined and circular columns
2. Using diverse imprisonment materials like welded wire work, extended metal work, fiber fortified polymer, and carbon fiber strengthened polymer was motivated from the low volumetric proportion of control or absence of repression.
3. Xiong Performed confinement using ferrocement jackets in addition to the steel reinforcement in square columns. Did some experimental testing on both square and circular columns confining both with ferrocement jackets for strengthening and repair work. Using confinement materials like ferrocement jackets restrengthening of square columns was performed.
4. Specialists named Balguru, Singh and kaushik tentatively watched the conduct of plain solid short chambers that were kept with welded wire work and furthermore discovered in the case of throwing ought to be done in a couple for example right off the bat filling the center and afterward throwing the distorting.
5. Also, earlier studies related to materials like FRP were limited on being used as a material for confinement but these all studies brought up some empirical equations for dialations for FRP confined SSC and also results between the older method and new methods were compared.
6. Xiao Liang did some systematic computational practice on confinement in circular hollow reinforced concrete columns using key parameters like concrete dilation and confining pressure.

2.3OBJECTIVES

1. To find the strength of a circular column using traditional design for steel reinforcement.
2. To improve design for steel reinforcement of the traditional design used by: -
    a) Decreasing the number of steel ties.
    b) Using a welded wire mesh on the periphery of the steel reinforcement.
3. To find out whether strength of the two samples improved.
4. To compare the strength and axial displacement in all the samples on the 28th day.

CHAPTER 3

METHODOLOGY

3.1 MATERIAL & SPECIFICATIONS

Material used for experiments are listed below with brief specifications: -

a) **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 3.2 Mould

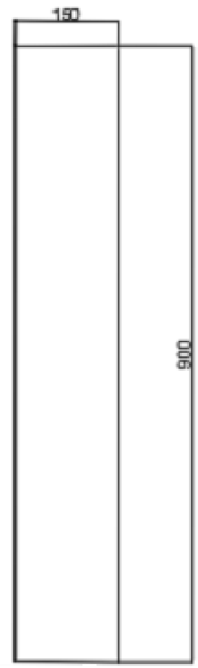

Figure 3.3 Font view of mould using AutoCAD

b) **Cement: -** For experimental work we used OPC 43 Grade. Before using it for experimental work we did some basic tests as mentioned below : -

i) **IST & FST: -** consistency test in a cement paste is defined as the minimum amount of water that is required to form the cement paste. And practically if we talk about this test then if it vicat's apparatus needle reaches a depth of 33-35mm from the upper end, then it defines the consistency of the cement at that amount of water. This is also known as Ordinary consistency. Apparatus is shown bellow in Figure 3.4. Through all this experiment we found out the IST and FST of cement. The IST is the time elapsed between adding water to the cement to the time cement paste starts loosing plasticity. It came out be 40 min as per the experiment conducted in lab (As per IS-4031 it should not. And the FST of the cement. Final setting period is the period from adding water to the cement to the time when cement paste completely loses its plasticity. It came out to be 310min (As per Indian standards it should not exceed 600min.

Figure 3.4 Apparatus for IST and FST.

ii) Soundness Test: - According to IS-4031, soundness value should not exceed 10mm else the cement is termed as unsound. Sound cement is one retains its volume expansion up to some extent. For this experiment we used Le-Chateiler apparatus. The new Expansion value was 5mm.

iii) Specific Gravity: - For specific gravity of cement we used Le-Chateiler's flask (As shown in Figure 3.4). By using the formula given below we found the specific gravity with respect to known kerosene oil.

$$\text{Specific gravity of cement} = \frac{W2-W1}{(W2-W1)-(W3-W2)*0.79}$$

Where, W1= weight of empty bottle

W2= weight of bottle +cement

W3= weight of bottle + cement + kerosene

0.79 is the S.G. of kerosene oil

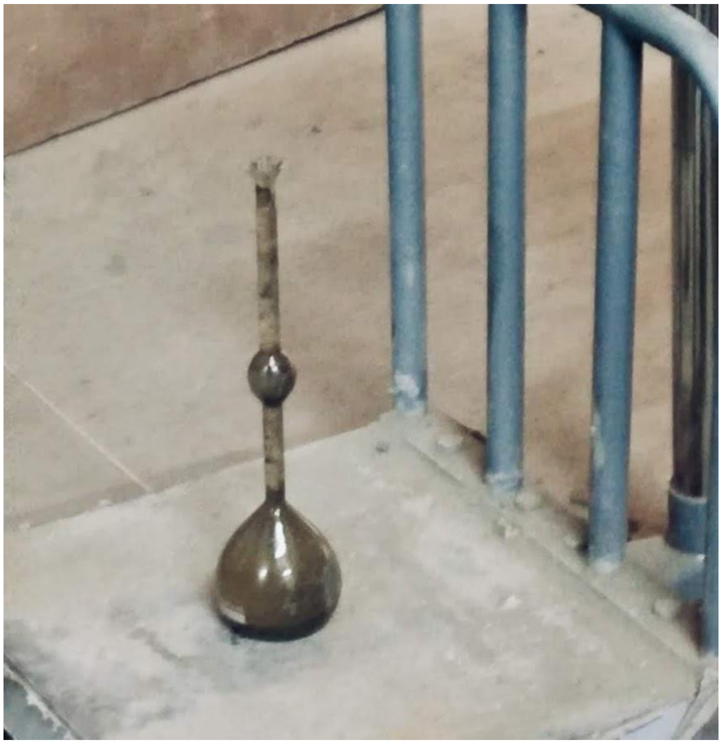

Figure 3.5 Density bottle.

iv) Fineness Test: - Fineness test of cement was carried out by sieving in through 90 micron sieve. Lumps due to moisture were crushed using trowel (As shown in Figure 3.5). Percentage retained on the sieve was approximately 4%.

Figure 3.6 fineness test of cement

v) Cement's compressive strength: - This is one of the most important properties of Cement. So here we took sand and cement mixture. For compressive quality we don't utilize straightforward concrete glue in light of the fact that exorbitant shrinkage and breaking quality tests are not done on concrete paste. Mix proportion and strength of the cube is shown in table 3.1 and below that Figure 3.6 of a tested cube specimen tested under compression testing machine.

Table 3.1 Compressive strength of cement

Mix proportion	Days	Compressive strength (MPa)
1:3	7	38
1:3	28	45

Figure 3.7 Crushed cement specimen

c) Coarse Aggregate: - For the experimental study we used coarse aggregate of size 12.5mm and 20mm (As shown in figure 3.7). Having following specifications as listed in table 3.2.

Table 3.2 Coarse Aggregate specifications

Properties	Specifications
Water absorption	1.4%
Specific gravity	2.78
Bulk density	1437 kg/m^3

Figure 3.7 Coarse Aggregate

d) Fine Aggregate: - For all the experimental work Zone II Sand was used (As shown in figure 3.8). Basic specifications of the fine aggregate have been listed below in the table 3.3.

Table 3.3 fine aggregate specifications

Properties	Specifications
Water absorption	6%
Fineness modulus	2.47
Specific gravity	2.65

Figure 3.8 fine aggregate

e) Reinforcement: -For the experiment were used two types of steel reinforcements of diameter 6mm and 8mm both of Fe 500 grade as circular ties(Figure 3.9) and main reinforcement(Figure 3.10) As shown respectively. Design of Reinforcement used in the experiment is explained in design part 3.2.

Figure 3.9 Circular ties

Figure 3.10 Main reinforcement

f) Mixer: - we used a tilting mixer (as shown in figure 3.11), having 40 kg capacity at one time use.

Figure 3.11 Tilting mixture

g) Needle vibrator: - This is generally used at places where trowels or other compaction instruments cannot reach easily, so by using this needle vibrator compaction can be easily done with mould having smaller dimensions . Figure 3.12 represents the use of needle vibrator.

Figure 3.12 Needle vibrator

h) Wire mesh: - we used a galvanized iron wire mesh with square mesh for the confinement part as well. Thickness of the wire mesh was 2mm and mesh size was 2*2 inches. As shown in figure 3.13 below.

Figure 3.13 Galvanized wire mesh

i) Data logger: - this is a device that shows us the data that is receives from the universal testing machine through different channels. It shows the data in the form of load values in kN, deflection in terms of mm etc. figure 3.14 shows the image of data logger.

Figure 3.14 UDAS

3.2 DESIGN MIX FO CONCRETE AND REINFORCEMENT

3.2.1 Preparation of Design Mix

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

Table 3.4 Material specification

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

A) Target Strength for Mix Proportioning

Target strength of the M30 grade concrete is denoted as f'_{ck} and after calculating it came out to 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 ratio of 0.45.

D) Water Content Selection

From table 4, for 50mm slump water content is 186 Kg.

Therefore, for 100mm slump water content is 193.44 kg

E) Calculation of Cement Content

0.45 w/c ratio is the present case.

Content of Cement =193/0.45

Amount of cement per cubic meter is 428 kg.

F) Extent of proportion of Coarse and Fine ingredients

Table 5of IS: 10262 say that the proportionate w/c ratio for 20mm coarse aggregate and Zone II fine aggregate is 0.622.

0.45 w/c ratio is the present case. In order to decrease the proportion of fine aggregate there is a need to increase the proportion of coarse aggregate. Here the w/c ratio is decreased by 0.14; 0.028 is the new increased proportionate volume of the coarse aggregate.

Therefore, corrected proportion of coarse aggregate for the w/c ratio of 0.45 is 0.650.

Proportion of fine aggregate content is 0.350.

G) Mix Computation

- Entire volume = 1 cubic meter.
- Proportion of air in the voids of wet concrete = 0.01 cubic. Meter.
- Proportion of cement = 0.138 cubic meter.
- Volume of water = 0.193 cubic meter.
- Total amount of all aggregate = 0.659 cubic meter.
- Proportion of coarse aggregate = 1187.14 kilogram/cubic meter.
- Proportion of fine aggregate = 614.7 kilogram/cubic meter.

H) Design-Mix Proportions For M30

Mix Proportion for all the ingredients has been tabulated below (Table 3.5).

Table 3.5 Mix proportion

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

3.2.2 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 in table 3.6.

Figure 3.15 Testing under CTM

Table 3.6 strength of trial mix

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

3.2.3 Design for Reinforcement

As per ACI guidelines for design of structure and also as per IS: 456 we designed the reinforcement part of the column. For whole reinforcement part we use main bars of diameter 8mm and circular steel ties of 6mm diameter both of Fe500 grade, also we used a welded wire mesh of diameter 2mm and size 2*2 inches as shown above in the material section.

3.2.3.1 Design for longitudinal reinforcement

As per IS456 (table 16) if the longitudinal reinforcement used is other 12mm then nominal cover can be less than or equal to 25mm(As per Exposure conditions).

Here the total area of concrete without reinforcement is 17678 mm^2.

Area of steel reinforcement is compression is 201 mm^2.

According to Seems to be: 456 conditions 26.5.3.1 says longitudinal fortification ought to be between (0.8% to 6%) of the gross zone of cross-segment of the section. Hence, we can use 4 bars of 8mm as longitudinal reinforcement (As shown in figure 3.16).

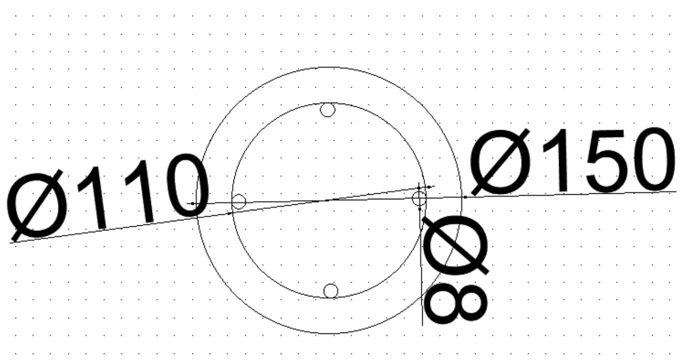

Figure 3.16 top view of mould and reinforcement

3.2.3.2 Design for Transverse Reinforcement

According to IS: 456 Clause 26.5.3.2 says that the dispersing between the horizontal reinforcement will be not more than and least of the accompanying: -

1) Least lateral dimension of the column.
2) 16 times the dimension of the longitudinal bar
3) 300mm.

So after calculating all the spacing we were to apply those spacing in three cases(two of the cases are shown in figure 3.17 and 3.18 respectively): -

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 of 290mm.

Case III: - in addition to Case II we'll be adding welded wire mesh around the periphery of main reinforcement.

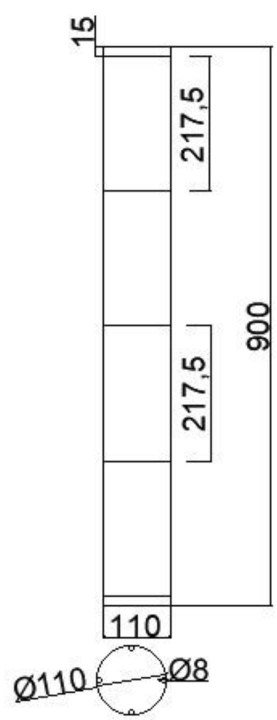

Figure 3.17 5RS-design

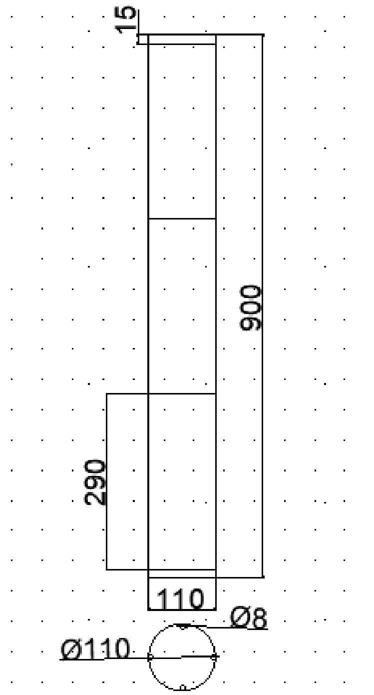

Figure 3.18 4RS-design

CHAPTER 4

EXPERIMENTAL WORK

4.1 INTRODUCTION

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 28^{th} 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.

4.1.1 Case I- 5RS

In this case we took traditional design reinforcement for while casting the specimen. Four longitudinal bars of diameter 8mm and length 900mm and 5 circular ties were used of diameter 6mm at spacing of 217mm from each other (As shown in figure 4.1).

Figure 4.1 Case I-5RS

4.1.2 Case II-4RS

In this case we decreased one of the circular tie reinforcement while casting the specimen. Four longitudinal bars of diameter 8mm and length 900mm and 4 circular ties were used of diameter 6mm at spacing of 290mm from each other (As shown in figure 4.2).

Figure 4.2 Case II-4RS

4.1.3 Case III- 4RWS

Reinforcement design in this case is same as that Case II but in addition to that design we used one extra galvanized welded wire mesh around the outer periphery of the main reinforcement (As Shown in Figure 4.3).

Figure 4.3 Case III-4RWS

4.1.4 Casting of sample

a) Casting: - Casting of samples of samples was taken out for three stages firstly we prepared Case I samples then case II and then case III. While casting we used clay between the walls of mould where possibility of leakage was observed, and then did oiling of the inside wall of the mould. Compaction in every case was carried out by using needle vibrator and tamping rod (As shown in Figure 4.4 and 4.5).

Figure 4.4 Compaction by needle vibrator while casting

Figure 4.5 casted samples

b) Failure while casting: - The only failure while casting samples can be due to unproper compactions. While casting sample due smaller cross-section area and large aggregate size(as compared to the radius of the mould). Gaps between the circular ties can get generated(As shown in figure 4.6).

Figure 4.6 Failure due to improper compaction

c) De-molding and curing of samples: - De-Molding of samples was done after 24 hours and curing was done after the same for respective days (7, 14 and 28 days). Figure 4.7(a & b de-molding) and figure 4.8(curing).

Figure 4.7 (a) de-molding of sample

Figure 4.8 (b) de-molded sample

Figure 4.8 curing of sample in curing tank

d) Testing of samples: - testing of samples was done after 7, 14 and 28 days respectively. Under the universal testing machine (UTM). Using Data logger we measured all the load and deflection values. Testing under UTM is shown in figure 4.9. Failure of sample due to crushing is shown in figure 4.10.

Figure 4.9 Compression testing under UTM

Figure 4.10 Failure of 4RWS

CHAPTER 5

RESULT AND CONCLUSION

5.1 INTRODUCTION

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.

5.1.1 Compressive strength values

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.

Table 5.1 Compressive strength Results

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

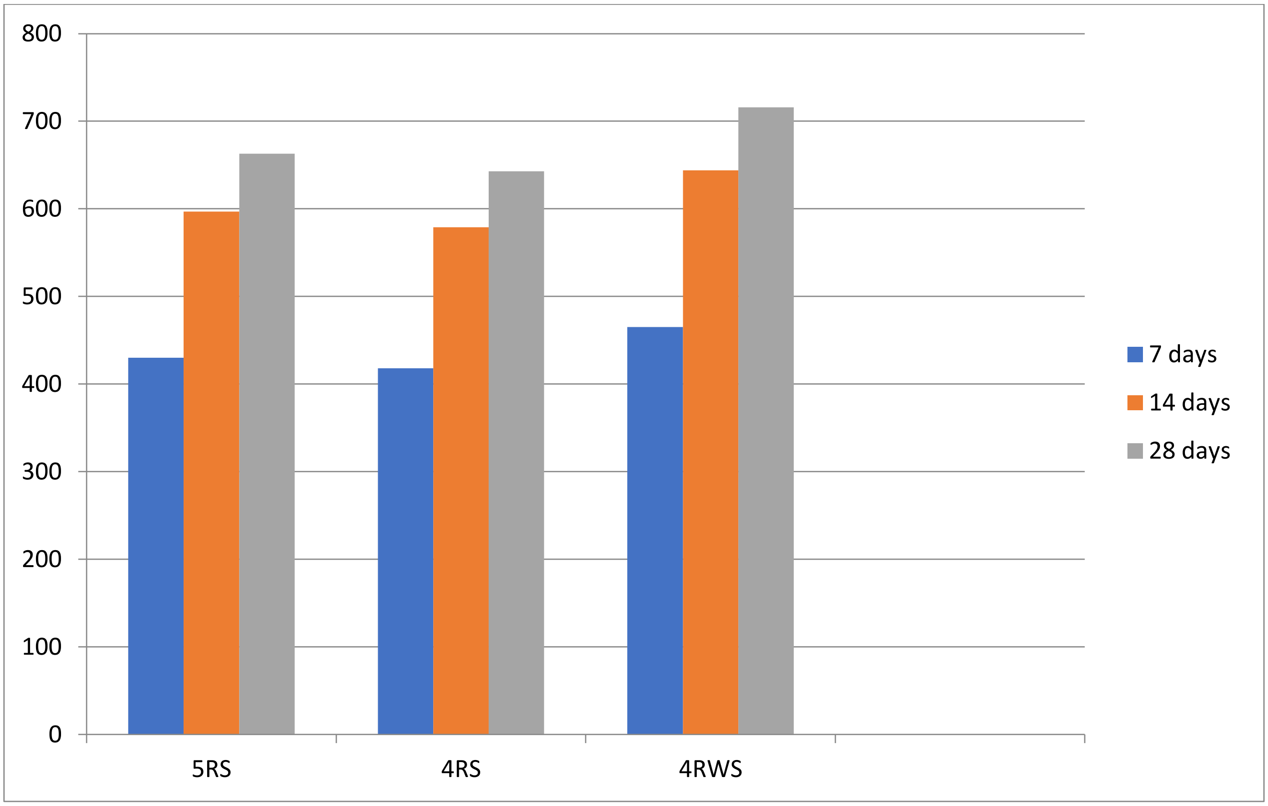

Figure 5.1 Compressive strength (kN)

5.1.2 Axial Displacement

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(As shown in Table 5.2).

Table 5.2 load vs. displacement

Axial displacement (mm)	Load(kN)		
	5RS	4RS	4RWS
0	0	0	0
0.1	23	20	27
0.2	39	37	52
0.3	55	50	82
0.4	71	65	88
0.5	87	77	110
0.6	103	85	138
0.7	119	99	147
0.8	135	110	179
0.9	151	121	190
1	167	135	210
1.1	183	150	235
1.2	199	175	255
1.3	215	181	263
1.4	231	193	287
1.5	247	202	298
1.6	263	206	309
1.7	264	222	330
1.8	276	249	353
1.9	290	261	369
2	310	277	380
2.1	319	291	395
2.2	359	301	409
2.3	375	318	430
2.4	391	330	446
2.5	407	350	461
2.6	423	372	479
2.7	439	391	491

2.8	455	407	505
2.9	471	430	515
3	487	466	531
3.1	503	491	555
3.2	519	532	568
3.3	535	560	580
3.4	551	591	593
3.5	567	608	594
3.6	583	625	595
3.7	589	643	597
3.8	598	635	599
3.9	607	631	608
4	636	626	610
4.1	663	619	616
4.2	660		620
4.3	651		625
4.4	644		629
4.5	637		633
4.6			638
4.7			641
4.8			647
4.9			651
5			664
5.1			677
5.2			690
5.3			703
5.4			716
5.5			701
5.6			695
5.7			680

5.1.3 Discussion of results

a) Load bearing capacity: - As from the above table 5.1 of compressive strength results we clearly concluded that the compressive strength in case of 4RWS sample (4 circular ties and wrapped with welded wire mesh) is more as compared to other cases (say 5RS and 4RS). As 4RSW had 716kN load bearing capacity than that of 5RS and 4RS i.e. 663kN and 643kN respectively. So it is seen that on including welded wire work it expanded the heap conveying limit of example by 7% when contrasted with 4RS example.

b) Axial Displacement: - with the help of data logger we observed the displacement with respect to change in load. In all specimens different designs were used so it was observed that the 4RWS (sample with wrapped welded wire mesh) had more ductility than the other two 5RS and 4RS as shown in the figure 5.3.

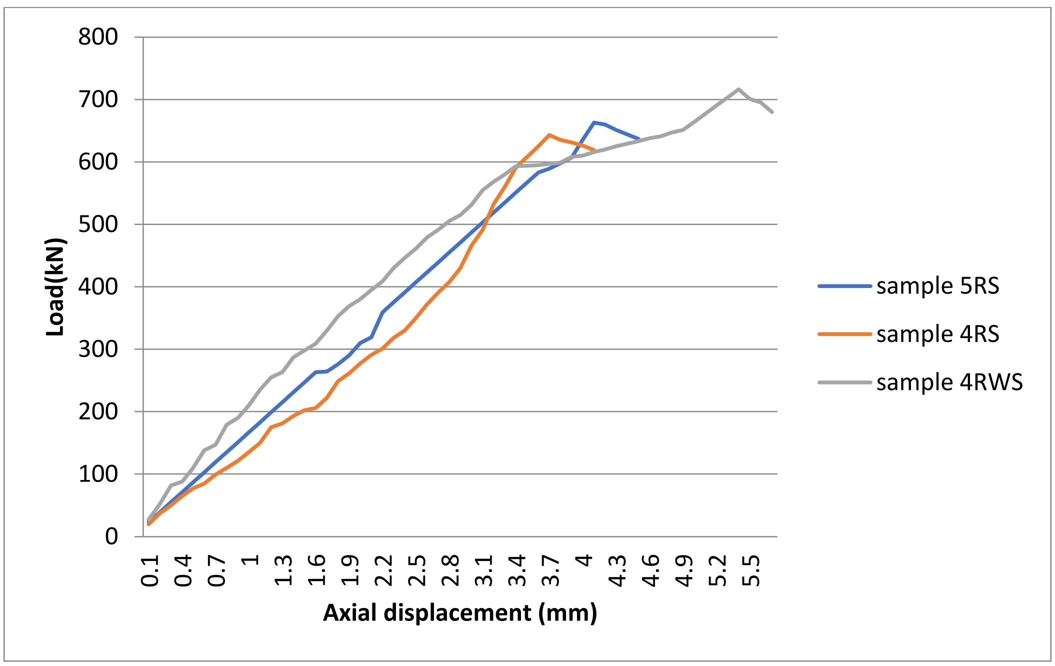

Figure 5.2 load and axial displacement curve

5.2 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.

5) Basically after all these results it can be concluded that the confined sample with welded wire mesh has more ductility and load bearing capacity so somehow such reinforced structures can play a better role in earthquake resistance structure.

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