ANALYSIS OF CONFINED CIRCULAR COLUMN

A PROJECT

Submitted in partial fulfillment of the requirements for the award of the degree
of
BACHELOR OF TECHNOLOGY

IN

CIVIL ENGINEERING

By

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CERTIFICATE

This is to certify that the work which is being presented in the project report titled **"Analysis of confined column "** in partial fulfillment of the requirements for the award of the degree of Bachelor of Technology in Civil Engineering and submitted to the Department of Civil Engineering, Jaypee University of Information Technology, Waknaghat is an authentic record of work carried out by **Harsh Chauhan (151616)** during a period from January 2019 to November 2019 under the supervision of **Dr. Ashok Kumar Gupta (Head of Department),** Department of Civil Engineering, Jaypee University of Information Technology, Waknaghat.

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

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DECLARATION

This is to declare that this report has been written by us. No part of the report is plagiarized from other sources. All information included from other sources have been duly acknowledged. We aver that if any part of the report is found to be plagiarized, we are shall take full responsibility for it

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ABSTRACT

Traditional steel ties reinforcement cannot provide superior confinement for reinforced concrete (RC) columns due to the constraints on tie spacing and disturbance of concrete continuity. This project presents a practical confinement configuration consisting of single welded wire mash (WWM) layer in additional to regular tie reinforcement. The WWM layer is warped over the longitudinal reinforcement and under the longitudinal reinforcement. The proposed transverse reinforcement, with various volumetric ratios of ties, was investigated in sixty four ciccular short RC column specimens categorized in two groups according to their warping. The specimens were cast in vertical position simulating the construction field and they will be tested under concentric compression till failure. The results indicated that the columns, confined with proposed lateral reinforcement, revealed significant improvement in the strength and ductility. Also, high reduction in ties volumetric ratio with no loss in ultimate load could be achieved by installing the WWM layer.

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1.1 INTRODUCTION

Strengthened cement (RC) is generally utilized for development everywhere throughout the world. Segments move the heaps from pillars and chunks to establishment. Segments bolster high compressive powers in uber structures, for example, long-range structures and tall structures. In addition, segments may endure harm due to over-burdening and cataclysmic events, for example, seismic tremors and flames in view of the constrained quality and pliability of cement. Disappointment of at least one segments may prompt the breakdown of the structure have filled in so far another update that seismic development can impact particularly populated areas of the world. In these locale, a great deal of structure exists and their continuance and handiness is fundamental in the post-shake response of emergency vehicles and personnel similarly as money related impact to the consistently life. report bases on the examination of kept section. The present example in the arrangement of system in most of these zones is to ensure that the structure can withstand such a huge event without experiencing breakdown, yet they may not be functional after the shudder A key part in achieving this kind of design in strong structures is to all the almost certain fathom the impact of detainment support in the essential areas of a structure so consequent poorconstraints.

The sort of solid disappointment delineated in Figure is ordinarily forestalled using sufficient repression fortification. The measure of repression support required in a given plan, depends on the structure approach, yet in addition on different factors, for example, pivotal burden proportion.

The sort of solid disappointment delineated in Figure is ordinarily forestalled using sufficient repression fortification. The measure of repression support required in a given plan, depends on the structure approach, yet in addition on different factors, for example, pivotal burden proportion, concrete compressive quality, zone of longitudinal steel, size of keeping fortification and numerous others. In any case, not these factors are commonly remembered for the conditions utilized in the foundation of the binding support. Right now, in any case, it is proper to express that a set agreement doesn't exist with regards to the fitting measure of level steel expected to enough bind concrete in segments. This is on the grounds that the run of the mill imprisonment support prerequisites don't utilize bend or dislodging requests expected in the framework as a necessity, which would better characterize the measure of constrainment fortification. Or maybe, verifiable methodologies dependent on trial tests are ordinarily utilized that depend on the material properties and section geometry, however no factor that speaks to the interest.

Fig.1.1 Failure of column

1.2 Overview

This examination centers around the basic limited solid squashing stature of the limit zone restricted cement in a well-nitty gritty strengthened solid horizontal burden opposing divider where the longitudinal gentle steel fortification inside the kept center yields and builds up a plastic pivot at the base of the divider. As shows an unbounded post-tensioned cast set up solid extraordinary basic divider. It shows a divider example tried by Rivera (2013). The test examples in this proposal speak to the limited solid pulverizing stature of limit zone kept cement of this parallel burden opposing divider. Along these lines, the material properties, solid restriction geometry, and stacking method for the test examples are illustrative of the limit zone bound cement of the unbounded post-tensioned cast set up solid extraordinary auxiliary divider framework. In this examination, two indistinguishable 10 in. x 15 in. cross-area bound solid examples were concentrated to watch the impacts of two distinct scopes of semi static inelastic elastic cyclic stacking of the longitudinal gentle steel support bars on the conduct, quality, and pliability of the limited cement under pressure stacking. Figure 1-2 shows an unbounded post-tensioned cast set up solid uncommon basic divider exposed to sidelong stacking with the basic limited solid smashing tallness of the limit zone constrainment. It shows base pressure reaction in an unbounded point. Solid extraordinary auxiliary divider exposed to horizontal burdens. Kept cement is frequently utilized in limits of a sidelong burden opposing divider. The constrainment is alluded to as limit zone solid control. Longitudinal gentle steel support bars are implanted in the bound cement to give flexural solidarity to the divider, and for vitality scattering, these bars respect disseminate seismic vitality. When the bars yield, a plastic pivot creates at the base of the divider. Unbounded post-tensioning, which gives natural focal points to the seismic exhibition of the dividers, is used in some horizontal burden opposing dividers. The post-tensioning ligaments add to sidelong obstruction and furthermore give a versatile reestablishing power to take out post-tremor perpetual distortions. In such dividers, the pressure and pressure cycling stacking extents will surpass the flexible furthest reaches of the longitudinal gentle steel support inside the bound solid center under the structure tremor load. It is misty whether current solid control models detailed in the writing precisely anticipate the conduct and quality of restricted cement under pressure after inelastic malleable cyclic stacking is forced on the longitudinal gentle steel fortification bars of the bound solid center. These models were created for various stacking conditions (i.e., just pressure or cyclic pressure loadings) and littler ductile stacking ranges (i.e., in the pliable flexible range). As announced by most analysts, the monotonic pressure stacking pressure strain bend shapes an envelope to the cyclic pressure stacking pressure strain reaction. Themodels try not to incorporate inelastic pliable distortions of the longitudinal mellow steel support of the kept solid center, alongside the related solid splitting and slow break conclusion influences under inversion pressure stacking. Thusly, this examination analyzes if the current kept solid models precisely anticipate the conduct, quality, and pliability of limit zone solid repression in strengthened solid sidelong burden opposing dividers where inelastic pliable cyclic stacking is applied to the restrictedcement.

1.3 Confinedconcrete

Richart et al. (1928) were the first to see that kept cement indicated extraordinarily expanded greatest compressive quality, expanded solidness, and broadened resist which the pinnacle pressure was come to. The bound cement can continue huge distortion without significant decrease of the heap bearing limit and flops progressively in a bendable manner. Pliability of cement is accomplished by giving satisfactory transverse fortification to keep the solid profoundly district and to counteract clasping of the longitudinal pressure support. Especially touchy are the basic limited solid smashing locales in individuals supporting huge pivotal burdens, for example, the base of limit zones of strengthened solid parallel burden opposing dividers, where inelastic distortion jumps out at build up a full plastic pivot component. At the point when unconfined cement is worried to enormous twisting qualities, high sidelong ductile strains create due to the development and engendering of longitudinal small scale breaks. This outcomes in insecurity and disappointment of the pressure zone concrete. Firmly dispersed transverse support related to longitudinal fortification is utilized to limit the sidelong development of the solid, giving cement higher limit and continuing higher compressive strain before coming up short. The transverse fortification (constrainment loops) can be winding, round, rectangular, or square shape. In contrast to the winding and roundabout bands, the rectangular or square loops can just apply full limiting responses close to the sides of the circles as the weight of the solid against the sides of the bands will in general twist the sides outward. This issue can be constrained by utilizing covering bands or cross-ties. The nearness of longitudinal support bars that are very much appropriated around the edge of the area, and tied over the segment, improve the solid restriction. The solid bears against the longitudinal support bars and the transverse fortification give the restricting responses to the longitudinal bars. Repression of cement is improved if transverse fortification separating is decreased. There is a basic dispersing of transverse fortification dividing above which the area halfway between the transverse loops will be inadequately bound. In any case, examinations show that a progressively exacting constraint on longitudinal dispersing of repression circles is forced by the need to abstain from claspingof longitudinal fortification under pressure load. Examinations shows that this separating, in plastic pivoting locales, ought not surpass in excess of multiple times the distance across of the longitudinal support bars to be limited. Concrete is viewed as restricted when exposed to triaxial pressure; the triaxial pressure expands solid ability to support bigger compressive qualities and distortions. (Montoya et al., 2001). For instance, KotsovosI (1987) shows the variety of the pinnacle hub compressive pressure continued by a solid chamber with expanding keeping pressure. It was noticed that a little keeping weight of around 10 percent of the uniaxial chamber compressive quality was adequate to expand the heap bearing limit of the example by as much as 50percent

1.4 Confinedreinforcement

Imprisonment support is typically remembered for the type of shut circle ties, welded bands or nonstop spirals so that as parallel burden is applied to the auxiliary framework the level fortification opposes the horizontal development of the solid by giving sidelong obstruction, consequently expanding the limit and flexibility of the solid segment. This methodology is significant in limit plan strategies, in which planners guarantee a sufficient bendable reaction of scaffold section basic areas while averting improvement of bothersome disappointment systems all through the structure. Various rules and details recommend various techniques for processing the suitable measure of transverse fortification for constrainmentpurposes.

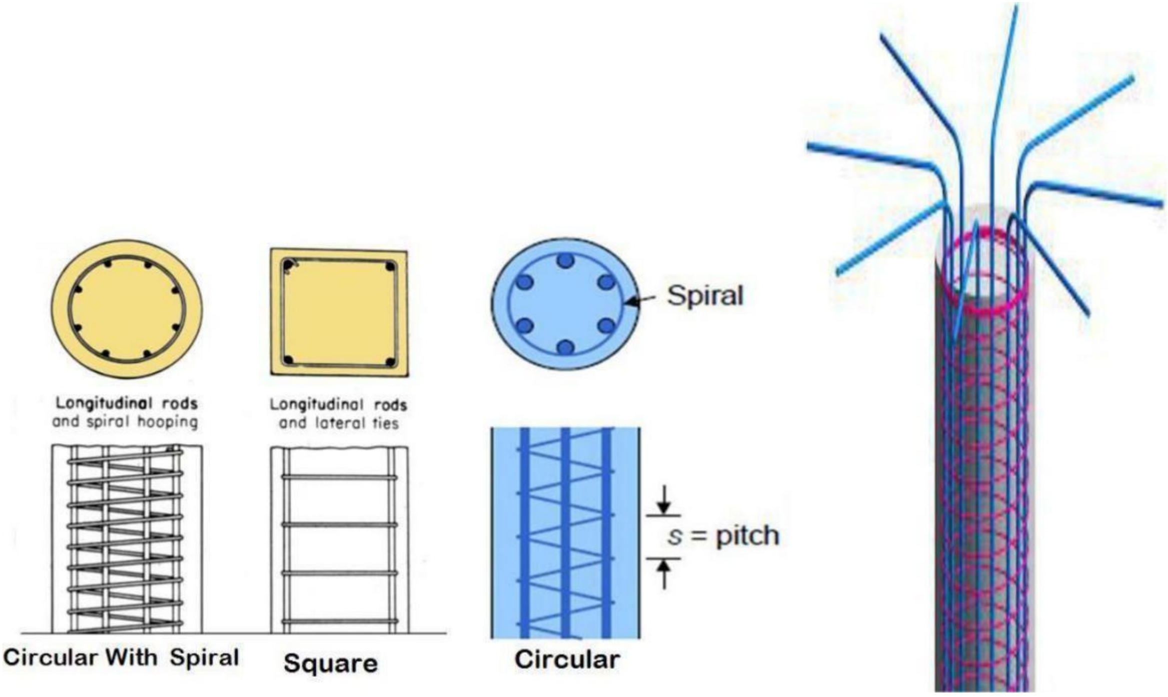


Fig.1.2 Confined column

Chapter 2

Literature Review

As recently noted, bound support is fundamental for segment plan, as it enables solid segments to have an a lot more prominent level of adaptability, in this way guaranteeing its flexibility. In particular, The solid utilized in segments has made conceivable to react plastically, which permits the abrupt and rough ground development to be dealt with by constraining the seismic power granted to the structure, empowering the structure to twist without critical debasement or breakdown. Different structure specialists determine the amount of this is required dependent on the size of the section by either a proportion of the volume of flat steel to volume of cement, ρs, or by requiring the shut circle band steel to have a specific region (Debris) and dividing, s, inside a given length along the solid part.

Youssef et al. (2006)

The essential guideline on which current basic plan code prerequisites for transverse fortification are based is that the expansion in quality of the solid center because of restriction should counterbalance the misfortune in quality of the auxiliary part due to spalling of the solid spread. This implies keeping up the heap conveying limit of the segment after spread spalling is basic. Further, transverse steel support expands the flexibility of a part, which is significant for the general quality and solidness of a structure during outrageous stacking conditions.

A schematic of the successful limited solid center dependent on various arrangements of longitudinal mellow steel fortification inside the kept cement. Figure 3 shows schematic of the impact of expansion of longitudinal fortification bars and cross-ties on kept solid center from the top. The figures are embraced from Paultre and Légeron (2008). Richart et al. (1928) were the first to see that kept cement indicated significantly expanded greatest compressive quality, expanded firmness, and broadened endure which the pinnacle pressure was come to. The restricted cement can continue enormous disfigurement without considerable decrease of the heap bearing limit and flops progressively in a flexible manner. Pliability of cement is accomplished by giving satisfactory transverse fortification to keep the solid profoundly locale and to anticipate clasping of the longitudinal pressure support. Especially touchy are the basic kept solid pounding areas in individuals supporting huge hub loads, for example, the base of limit zones of strengthened solid parallel burden opposing dividers,where inelastic misshapening jumps out at build up a full plastic pivot instrument. At the point when unconfined cement is worried to huge disfigurement esteems, high sidelong ductile strains create in light of the development and engendering of longitudinal microcracks. This outcomes in flimsiness and disappointment of the pressure zone concrete. Firmly separated transverse fortification related to longitudinal support is utilized to limit the sidelong development of the solid, giving cement higher limit and continuing higher compressive strain before falling flat. The transverse fortification (restriction circles) can be winding, roundabout, rectangular, or square shape. In contrast to the winding and round circles, the rectangular or square bands can just apply full restricting responses close to the sides of the loops as the weight of the solid against the sides of the circles will in general twist the sides outward. This issue can be constrained by utilizing covering circles or cross-ties. The nearness of longitudinal fortification bars that are very much circulated around the edge of the segment, and tied over the area, improve the solid restriction. The solid bears against the longitudinal fortification bars and the transverse support give the limiting responses to the longitudinal bars. Repression of cement is improved if transverse support dispersing is diminished. There is a basic separating of transverse support dividing above which the segment halfway between the transverse bands will be ineffectually restricted. Be that as it may, examinations show that an increasingly severe restriction on longitudinal dividing of control bands is forced by the need to abstain from clasping of longitudinal fortification under pressure load. Examinations demonstrates that this dividing, in plastic pivoting areas, ought not surpass in excess of multiple times the measurement of the longitudinal support bars to becontrolled.

To think about the expanded quality of cement because of restriction, Richart et al. (1928) proposed the well-known empirical formulas:

$$f'_{cc} = f'_c + k_1 \sigma_{lat}$$

$$\varepsilon'_{cc} = \varepsilon'_c (1 + k_2 \frac{f_l}{f'_c})$$

Where k1 is the so-called triaxial factor and is found to be 4.1 and k2=5k1. Although newer test results have suggested a modification of this relation, the basic approach for determining the confined strength is the same. The maximum effective lateral pressure f1 that can be applied to concrete by hoops happens when the hoops are stressed to their yield strength, fyh. The maximum effective lateral stress in a circular confinement hoops can befound:

$$f_l = \frac{2f_{yh}A_{sh}}{d_s s_h}$$

where, Ash is the cross-section area of hoop; dsh is the diameter of the circular hoops; sh and is the longitudinal spacing of the circular hoop reinforcement.

Blume, Newmark and Corning (1961) proposed an expression to calculate the strength increase in concrete confinements by rectangular hoops. They used the following expression to calculate the lateral confinement stress:

$$f_l = 0.5\left(\frac{2\,f_{sh}\,A_{sh}}{a\,s_h}\right)$$

where the term a is the longer side of the rectangular concrete area enclosed by the hoop; fsh is the stress in hoop; Ash and is the hoop cross-sectional area.

Hassan and Ahmed (2015)

This paper presents consequences of an exploratory examination did to evaluate the conduct of CFRP restricted low quality solid chambers under concentric and capricious pressure. The test parameters incorporated the quantity of the CFRP sheets and the unusualness of the applied burden. 16 Plain solid chambers with measurements of 150x300mm are readied, twelve CFRP completely restricted solid chambers and four of them unconfined examples were tried. It is discovered that the CFRP can fundamentally expand the compressive quality and pliability of the solid, subsequently unreinforced solid individuals with low quality cement can be wrapped by CFRP sheets for an exceptionally improved conduct. A noteworthy reduction in constrainment impact was found with nearness of burden flightiness. The quality addition for tried examples under concentric stacking for one, two and three layers of CFRP control were 125%, 250% and 310%, individually contrasted and 85%, 200% and 280% for the examples under whimsical stacking. The disappointment of the kept cement was ruled by the break of CFRP sheets at a normal strain a lot more noteworthy than a definitive strain acquired from unconfined tests. A definitive strain of the examples under concentric stacking for one, two and three layers of CFRP restriction increments 675, 900 and 996 % separately contrasted and 779,860 and 1113% for the examples under unusual loading.Analytical articulations proposed for the compressive quality of CFRP wrapped low quality cement, demonstrated great concurrence with trialresults

In view of the test outcomes and investigation, the accompanying ends are gotten:

1- Every single solid example under concentric and erratic pressure fortified with CFRP overlays show sensible increment in quality and pliability. The improvementis progressively articulated if there should be an occurrence of concentricpressure.

2- The quality and malleability increment fundamentally with the expansion number of CFRP layers.

3- Strengthened solid individuals with low quality cement can be wrapped by CFRP sheets to expand their ability and conductimprovement.

4- Expository articulations proposed for the compressive quality of CFRP wrapped low quality cement anticipate results that are in great concurrence with testresults.

Shinde. V.M &Bhusari. J.P (2015)

Trial comprises of 30 examples under uniaxial pressure barrel shaped example of 120 width and 600 mm tallness. Examination was led to show the impact of constrainment to improve a definitive quality with single and twofold layer of work when contrasted with unconfined examples.
Distinctive direction of work differed from 90°, 80°, 70°, 60°, 45°

They saw that the underlying splits framed at 20 to 35% of extreme burden for single and twofold layer. In first case the heap conveying limit of kept example was expanded in a scope of 17, 25, 36, 40, and 47 % when contrasted with controlled examples in single layer. In second case in which twofold layer is utilized the expanding pattern was seen as 50, 52, 54, 54 and 56 % .For each situation the direction was shifted from 90°, 80°, 70°, 60°,45°.
It was reasoned that twofold layer welded wire work invigorate about twofold than single

layer of welded wire work. This is because of huge limiting weight applied on cone content. The quality of example additionally fluctuated when work point changes from 90° to 45°. Additionally the impact of work in single layer was 36% more when contrasted with twofold layer.

Eidet al. (2007)

This paper exhibits generally straightforward, scientifically determined bends to demonstrate the pivotal and the parallel pressure strain relations of roundabout solid segments. The explanatory bends portray the full elastoplastic conduct of the kept solid section. The answer for the halfway limited fortified solid section in the elastoplastic extend is inferred by supplanting the discrete parallel support with a proportional cylinder and the Drucker–Prager DP yield paradigm is applied to speak to the solid conduct in the plastic range. Use of the DP model doesn't require an iterative technique so as to take care of the issue and in this way an express arrangement is acquired. It is indicated that the proposed model appropriately recreates the conduct of strengthened solid sections incompletely limited by steel ties and of segments that are completely bound by fiber-fortified polymer sheets The determined model depends on versatile or flexible splendidly plastic restricting material conduct and on the Drucker–Prager yield foundation without solidifying surfaces. While the kept solid quality isn't impacted by these properties, they do influence the limited solid endure top worry because of the way reliance of the solid distortions. In this way, this model is progressively proper for solid segments bound by flexible or elastic perfectly plastic material. The model was checked against accessible exploratory consequences of solid segments in part restrictedby steel ties or completely kept by FRP sheets. It was indicated that the proposed model properly. Reenacts the general conduct of the restricted cement and that the bound solid quality and its comparing strain are in great concurrence with the test outcomes

Xiao and Wu (2003)

As of late, solid sections in seismic areas. Noteworthy research endeavors have been composite materials have been applied to retrofitting as of late did to investigate the adequacy of fiber fortified polymer (FRP) composites in retrofitting or fortifying strengthened cement (RC) structures. Because of its great material properties including lightweight, high-quality and modulus, consumption obstruction and designed execution, FRP offers numerous beneficial potential to structural building. A FRP composite jacketed segment can be ordered as the tubed framework, from the way that the FRP coat, once introduced, structures a cylinder to give essentially extra transverse fortification to the first segment. Contingent upon how and when the coat is made, FRP jacketing can be arranged as in situ manufactured framework and pre-assembledframework.

This paper condenses the test results from a far reaching research program to think about the basic pressure strain conduct of cement kept by different sorts of fiber fortified polymer (FRP) composite coats. In excess of 200 solid stub sections with 9 sorts of FRP composite coats were tried under pivotal pressure. The effect of various structure parameters including plain cement unconfined quality, sorts of composites just as coat thickness were considered in this examination. The quality upgrade and pliability improvement of examples kept with FRP composite coats are talked about. Furthermore, another pressure strain model to foresee the conduct of hub individuals jacketed with FRP composites is displayed. Correlations between the expository outcomes utilizing the proposed model and test outcomes are likewiseexhibited.

An enormous number of solid chambers kept by different FRP coats were tried to consider the crucial pressure strain conduct of limited cement. This paper gives an advancement report on test results and examination led close by layup FRP jacketed solid chambers. In view of the consequences of this investigation, the accompanying ends can bedrawn

1. Noteworthy increment in quality and pliability of cement can be accomplished by FRP Composite coats. The constrainment modulus and the imprisonment quality of the compositecoat have been recognized as the two basic parameters in portraying the framework restrictionadequacy.

2. In addition to the material properties such as concrete strength, results of this investigation suggested that the performance of the confined concrete is dominated by the composite confinementmodulus.
3. The ultimate condition of the confined concrete is determined by the rupture of the composite jacket. The rupture strain of the jacket is much lower than the rupture strain obtained from flat tensile coupon samples
4. A refined constitutive model of concrete confined by FRP is presented. It provides a good predication to the mechanical behaviour of CFRP confined concrete with circular cross sections.

Toutanjiand and Saafi (2001)

A new type of concrete columns was developed at the University of Alabama in Huntsville for new construction to achieve more durable and economical structures. The columns are made of concrete cores encased in a PVC tube reinforced with fiber reinforced polymer (FRP).

The PVC tubes are remotely strengthened with persistent impregnated filaments as circles at various dividing. The PVC goes about as formwork and a defensive coat, while the FRP circles give constrainment to the solid with the goal that a definitive compressive quality and pliability of solid sections can be fundamentally expanded. The volume of strands utilized in this half and half section framework is unassuming contrasted with other existing control strategies, for example, FRP cylinders and FRP coats. This paper examines the pressure strain conduct of these new composite solid chambers under hub pressure stacking. Test factors incorporate the sort of fiber, volume of fiber, and the dividing between the FRP circles. A hypothetical investigation was performed to foresee a definitive quality, disappointment strain and the whole pressure strain bend of cement restricted with PVC-FRP tubes. Test outcomes show that the outside constrainment of solid segments by PVC-FRP tubes brings about improving compressive quality, pliability and vitality retention limit. An examination among test and systematic outcomes shows that the models give agreeable forecasts of extreme compressive quality, disappointment strain and stress-strainreaction.

Tests were performed to study the behaviour of axially loaded concrete columns confined with PVC-FRP tubes. The following conclusions can be drawn from this study.

1. The PVC-FRP tubes are an effective confinement. They significantly increase both strength and failure strains of concrete. The rate of increase is dependent upon the type of FRP composites and the FRP hoop spacing.
2. The strength enhancement is linearly proportional to the volumetric ratio oflateral FRP reinforcement. On the other hand, it decreases linearly with the increaseof FRP hoop spacing .

3. The stress-strain response of PVC-FRP tubes confined concrete is bilinear in both the axial and lateral direction. The first slope of the response depends on properties of the concrete core, while the stiffness and the spacing control the second slope. The bentbetween the two slopes takes place at a stress level slightly higher than unconfined strengthof the concretecore.

The proposed equations for predicting the ultimate strength and ultimate axial strain of PVC-FRP confined concrete predict well the experimental results.

4. The stress-strain model depends mainly on the volume and the stiffness of confining FRP composite materials and it predicts quite well the experimental stress straincurves.
5. The experimental results and the predictive models presented in this paper are limited to one fixed geometry, size and category of concrete. More tests are needed to investigate the applicability of the proposed models for different cross sections, shapes, high strength concrete and type ofbond.

Manderet al. (1988)

In a companion paper by Mander et al. (1988), a theoretical stress-strain model for confined concrete was developed for members with either circular or rectangular sections, under static or dynamic axial compressive loading, either monotonically or cyclically applied. The concrete section may contain any general type of confinement with either spirals or circular hoops, or rectangular hoops with or without supplementary cross ties. For a particular transverse reinforcement configuration, the effective confining stresses $f\backslash x$ and $f'ly$in the x and y directions can be calculated from the transverse reinforcement and the confinement effectiveness coefficient ke,which defines the effectively confined concrete core area by taking into account the arching action that occurs between the transverse bars and between longitudinalbars.

Thirty-one nearly full-size reinforced concrete columns, of circular, square, or rectangular wall cross section, and containing various arrangements of reinforcement, were loaded concentrically with axial compressive strain rates of up to 0.0167/s. The circular sections contained longitudinal and spiral reinforcement, the square sections contained longitudinal reinforcement and square and octagonal transverse hoops, and the rectangular wall sections contained longitudinal reinforcement and rectangular hoops with or without supplementary cross ties. The longitudinal stress-strain behaviour of the confined concrete was measured and compared with that predicted by a previously derived stress-strain model with allows for the effects of various configurations of transverse confining reinforcement, cyclic loading, and strain rate. The measured longitudinal concrete compressive strain when thetransverse

steel first fractured was also compared with that predicted by equating the strain energy capacity of the transverse reinforcement to the strain energy stored in the concrete as a result of the confinement.

Tests were conducted on reinforced concrete short columns with either circular, square, or rectangular cross sections. The loading was applied concentrically at either quasi-static or high strain rates. Various arrangements of longitudinal and transverse reinforcement were investigated. The following trends were observed:

1. The most significant parameter affecting the shape of the stress-strain curve of confined concrete for all section shapes was the quantity of confining reinforcement, in the form of spirals for circular columns, or rectangular hoops or cross ties for square or rectangular columns. As the volumetric ratio of confining reinforcement increased, the strength developed increased, the slope of the falling branch decreased, and the longitudinal strain at which hoop fracture occurred increased. These trends followed the theoretical predictions of a stress-strain model proposed by the writers for confinedconcrete.

2. The influence of the configuration of transverse reinforcement can b predicted through the confinement effectiveness coefficient ke. The configuration of transverse reinforcement had a particularly large effect, with ke varying in the range 0.40-0.70 for the rectangular walls and 0.89-1.0 for the circular columns. Also the only significance of the configuration of longitudinal reinforcement was through its effect onke

3. As predicted, the circular columns confined with spiral reinforcement performed better than rectangular or square columns. This was apparent in both the strength enhancement and the ultimate compression strain for a given volumetric confinement ratio.

The analytical stress-strain model proposed by the writers and described in the companion paper was found to give good prediction of experimental behaviour for circular, square, and rectangular columns with various reinforcement configurations. As well as accurately predicting the enhanced strength and general shape of the stress-strain curves for the confined concrete, the longitudinal strain at first hoop fracture was predicted within surprisingly close tolerances using the energy balance approach. This approach, which relates the increase in strain energy absorbed by the confined core to the strain energy available In the yielding hoop sets provides a neat explanation for the enhancement of ductility of concrete confined by spirals orhoops

Manderet al. (1986)

In the seismic design of reinforced concrete columns of building and bridge substructures, the potential plastic hinge regions need to be carefully detailed for ductility in order to ensure that the shaking from large earthquakes will not cause collapse. Adequate ductility of members of reinforced concrete frames is also necessary to ensure that moment redistribution can occur. The most important design consideration for ductility in plastic hinge regions of reinforced concrete columns is the provision of sufficient transverse reinforcement in the form of spirals or circular hoops or of rectangular arrangements of steel, in order to confine the compressed concrete, to prevent buckling of the longitudinal bars, and to prevent shear failure. Anchorage failure of all reinforcement must also beprevented.

A stress-strain model is developed for concrete subjected to uniaxial compressive loading and confined by transverse reinforcement. The concrete section may contain any general type of confining steel, either spiral or circular hoops; or rectangular hoops with or without supplementary cross ties. These cross ties can have either equal or unequal confining stresses along each of the transverse axes. A single equation is used for the stress-strain equation. The model allows for cyclic loading and includes the effect of strain rate. The influence of various types of confinement is taken into account by defining an effective lateral confining stress, which is dependent on the configuration of the transverse and longitudinal reinforcement. An energy balance approach is used to predict the longitudinal compressive strain in the concrete corresponding to first fracture of the transverse reinforcement by equating the strain energy capacity of the transverse reinforcement to the strain energy stored in the concrete as a result of theconfinement

The development of the analytical stress-strain model for confined concrete leads to the following conclusions:

1. Reinforced concrete members with axial compression forces may be confined by using transverse steel to enhance the member strength and ductility. For a particular transverse reinforcement configuration the effective confining stresses $f'lx$and $f'ly$in the x and y directions can be calculated from the transverse reinforcement and a confinement effectiveness coefficient kewhich defines the effectively confined concrete core area by taking into account the arching action that occurs between the transverse hoops and between Longitudinalbars.

A "five-Parameter" maximum strength criterion uses the effective confining stresses to determine the confined concrete strength fccon the ultimate strength surface. The increase in

the strain at ultimate strength ECC is assumed to be about five times the strengthincrease.

2. The form of the stress-strain curve for confined concrete can be expressed in terms of a simple uniaxial relation suggested by Popovics and only requires three controlparameters

3) (f'cc ,ecc , and *Ec).* Unloading and reloading curves can be developed for cyclicloading response.

4. An allowance for the dynamic response in stress-strain modeling may be incorporated by modifying the quasi-static concrete parameters *{fee*>*ecc*>a n a *Ec)* by dynamic magnification factors which are subsequently used in the stress-strainmodel.

5. The ultimate concrete compressive strain of a section, defined as that strain at which first hoop fracture occurs, may be determined by tracing the work done on the confined concrete and longitudinal steel when deformed in compression. In this energy balance approach, when the work done exceeds the available strain energy of the transverse steel, then hoop fracture occursand the sectioncan be considered to have reached its ultimate deformation.

6. The usefulness of the model presented herein will become apparent when compared with the observed behaviour of confined reinforcement concrete members under dynamic cyclic loading. Such studies are reported in a companion paper (Mander et al. 1988)

Chapter 3

OBJECTIVE

1) To analyze the confined circular columns under uni-axialloading

2) To observe the effect ofconfinement:

   a) With varying water cementratio
   b) With varying transverse reinforcement for cement waterratio.

Chapter 4

Material Used

4.1 GIWire

Specifications:

Standard Mesh for Concrete Reinforcement, the production of mesh reinforcement complies with Indian standard. Mesh is produced from cold reduced deformed steel wires according to Indianstandard.

Fig.4.1GI Wire

Mechanical Properties

Specified characteristic strength: 460 N/mm²

- Tensile Strength: min 510N/mm².
- Shear strength of the weld: The shearing load required to produce failure of a weldedintersection shall be not less than 0.25 A fy, where A is the nominal cross-sectional area of the smaller wire at the welded intersection and fy is the characteristic yield stress of the wire (460N/mm²)

Chemical composition of steel

Carbon C: max 0.25% Sulphur S: max 0.060% Phosphorous

P: max 0.060% Carbon Equivalent Value Ceq: max 0.42% Where Ceq = C + Mn/6 + (Cr+V+Mo)/5 + (Cu+Ni)/15

Features:

1. High tensilestrength
2. Corrosionresistance
3. Flexible

Welded Wire Mesh Advantages

The possibility of inappropriate twisting of bars is decreased by utilizing WWM since bowing machines twist the tangle as a solitary unit.

1. The utilization of WWM limits the opportunity of scattering since just one kindof tangle is utilized on a givenarea.
2. Provides the careful size of support where required through factor bar sizeand dividing, consequently lessens steelsquander.
3. Any wire size can be utilized from, beginning at W 1.4 up to W 46.5 in additions of 0.1.
4. Faster erection time implies you can beat changing climateconditions.
5. Removes fortification arrangement from the basic way.
6. Barrier dividers on connect deck development could be built quicker. This diminishes the ideal opportunity for fall presentation and protection premiumexpenses.
7. WWM can decrease development time, accordingly sparing: hardware rentingtime.
8. Material cost is decreased because the small bar is not fabricated. For example, for a #3 bar the cost is $5/ 100 wt. while a #6 bar is $1.25/ 100wt.
9. Less field laborneeded.

4.2 CEMENT

OPC 43 grade:

OPC Cement or Ordinary Portland Cement (OPC) is manufactured by grinding a mixture of limestone and other raw materials like argillaceous, calcareous, gypsum to a powder. This cement is available in three types of grades, such as

OPC 33 grade, OPC 43 grade and OPC 53 grade.

Fig.4.2 Cement

OPC is the most commonly used cement in the world. This type of cement is preferred where fast pace of construction is done. However, the making of OPC has reduced to a great extent as blended cement like PPC has advantages, such as lower environmental pollution, energy consumption and more economical.

Advantages:

- Develops early quality at 3 and 7 days with particularly high 28 days quality. Structure work of chunks and bars can be expelled a lot before which brings about expanded speed ofdevelopment
- Unbeatable consistency in quality gives better responsibility for blendstructure
- The higher qualities quality of solid prompts higher bond quality limitingthe probability of slippage offortifications.
- The thick and least penetrable cement avoids spillage/leakageissues.
- Its high fineness offers better usefulness for a given water bondproportion guaranteeing extremely thick, minimized and solidcement.
- Being the low antacid bond it gives protection against soluble base total response, this outcomes in toughstructures.

Ideal Applications

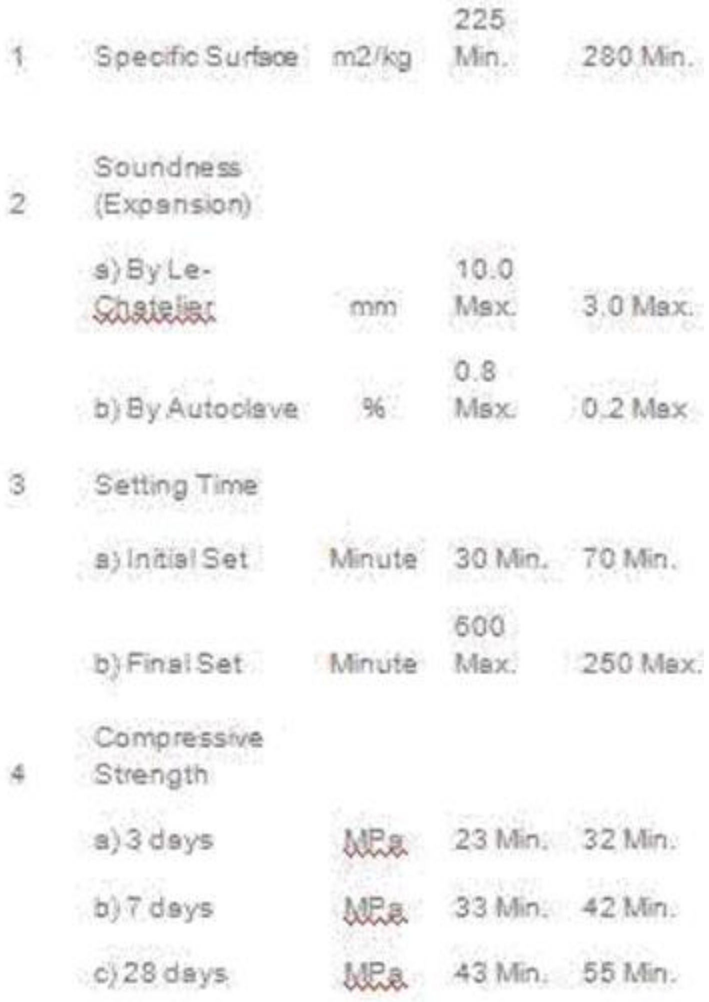
- Residential and commercialcomplex.
- PCC solid and hollowblocks
- DefenseConstructions
- Airport-Runways
- Cement tanks
- Asbestos cementproducts
- Concrete roads and Ferro-cement concreteelements

Bis Specifications for 43 Grade Opc

A.) Chemical Properties

S.No.	Description	Unit	Req. as per IS-12269-1987	SDCC Norms
1	Insoluble Residues(IR)	%	3.0 Max	2.0 Max.
2	Magnesium Oxide(MgO)	%	6.0 Max	2.5 Max.
3	Sulphuric Anhydride(SO3)	%	2.5 Max when C3A<5 & 3.0 Max when C3A>5	2.75 Max.
4	Loss on Ignition(LOI)	%	5.0 Max	3.5 Max.
5	Lime Saturation Factor (LSF)	%	0.66-1.02	0.89Min.
6	Alumina Iron ratio (A/F)	%	0.66 Min.	1.10 Min.
7	Chloride (Cl-)	%	0.10 Max.	0.05 Max

PHYSICAL PROPERTIES



1	Specific Surface	m2/kg	225 Min.	280 Min.
2	Soundness (Expansion)			
	a) By Le-Chatelier	mm	10.0 Max.	3.0 Max.
	b) By Autoclave	%	0.8 Max.	0.2 Max
3	Setting Time			
	a) Initial Set	Minute	30 Min.	70 Min.
	b) Final Set	Minute	600 Max.	250 Max.
4	Compressive Strength			
	a) 3 days	MPa	23 Min.	32 Min.
	b) 7 days	MPa	33 Min.	42 Min.
	c) 28 days	MPa	43 Min.	55 Min.

4.3 HYSDBars

Reinforcement 12mm dia steel bars

Tiscon 500 is a high strength ribbed TMT reinforcement bar. For reference, the strength of the rebar is 500 MPa by keeping the level of impurities like Sulphur and Phosphorous to below 0.075%, the consistency in strength across the rebar is maintained. TATA Tiscon 500 conforms to the latest standards set by Bureau of IndianStandards(BIS)

Fig. 4.3HYSD Bars

Tiscon 500 is a high strength ribbed TMT reinforcement bar. For reference, the strength of the rebar is 500 MPa by keeping the level of impurities like Sulphur and Phosphorous to below 0.075%, the consistency in strength across the rebar is maintained. TATA Tiscon 500 conforms to the latest standards set by Bureau of Indian Standards(BIS)

Chemical properties:

BIS Specifications for Chemical Properties

Chemical Properties (maximum)	Fe 500
% Carbon	0.3
% Carbon Equivalent (CE)	0.42
% Sulphur (S)	0.055
% Phosphorus (P)	0.055
% Sulphur & Phosphorus (S&P)	0.105
% Nitrogen (PPM)	120

Mechanical properties:

BIS Specifications for Mechanical Properties

Mechanical Properties (minimum)	**Fe 500**
Yield Stress- YS (N/mm2)	500
Ultimate Tensile Stress- UTS (N/mm2)	545
UTS/YS Ratio	1.08

4.4 Mildsteel

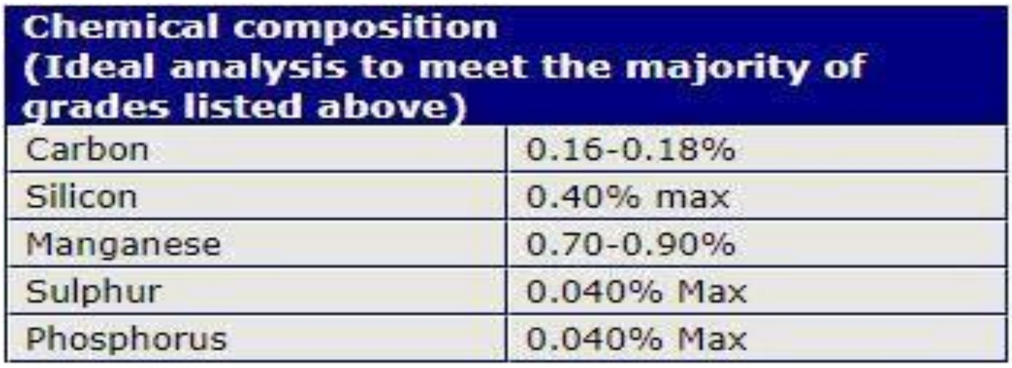
Mild steel circular ring

Mild steel contains approximately 0.05–0.25% carbon making it malleable and ductile.

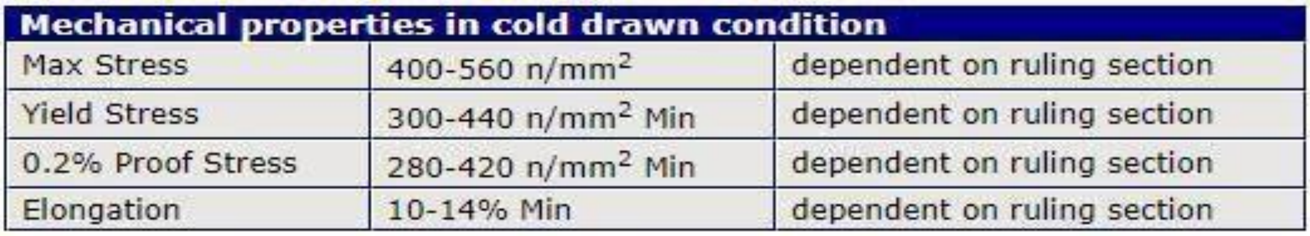
Mild steel has a relatively low tensile strength, but it is cheap and easy to form; surface hardness can be increased through carburizing.

Fig.4.4 Mild Steel Rings

Broadly useful steel bars for machining, reasonable for delicately focused on parts including studs, jolts, apparatuses and shafts. Regularly determined where weld capacity is a prerequisite. It very well may be ase-solidified to improve wear obstruction. Accessible in splendid rounds, squares and pads, and hot moved rounds. It tends to be provided in sawn spaces, and bespoke size squares.



Chemical composition (Ideal analysis to meet the majority of grades listed above)	
Carbon	0.16-0.18%
Silicon	0.40% max
Manganese	0.70-0.90%
Sulphur	0.040% Max
Phosphorus	0.040% Max



Mechanical properties in cold drawn condition		
Max Stress	400-560 n/mm^2	dependent on ruling section
Yield Stress	300-440 n/mm^2 Min	dependent on ruling section
0.2% Proof Stress	280-420 n/mm^2 Min	dependent on ruling section
Elongation	10-14% Min	dependent on ruling section

Advantages of using mild steel bars

Black mild steel is produced by a hot rolling process, and may have a scaly, rough surface. It is not precise in its dimensions, straightness or flatness.

Suitable machining allowances should therefore be added when ordering.

It does not contain any additions for enhancing mechanical or machining properties.

Bright drawn mild steel is an improved quality material, free of scale, and has been cold worked (drawn or rolled) to size. It is produced to close dimensional tolerances. Straightness and flatness are better than black steel. It is more suitable for repetition precision machining.

Bright drawn steel has more consistent hardness, and increased tensile strength.

Bright steel can also be obtained in precision turned or ground form if desired.

Chapter 5

METHODOLOGY

- 6 mould of 900 mm length and 150 mmdiameter
- 2 mould is used for unconfinedcolumn
- 2 mould used for external confinedcolumn,
- 2 mould used for internal confinedcolumn
- Mash size (50x50) were used for confining inner and outer part ofreinforcement
- As 4#12 Φ mm HYSD are used in single column on fourcorner
- Column is casted with different water cement ratio and also by changing thespacing of circular stirrups from 220mm to 900mm and full compacted by needlevibrater
- Along with it 3 cylinders of each water cement were also casted to check theconcrete strength
- Sample were tested after after 30days of curing by water bathcuring

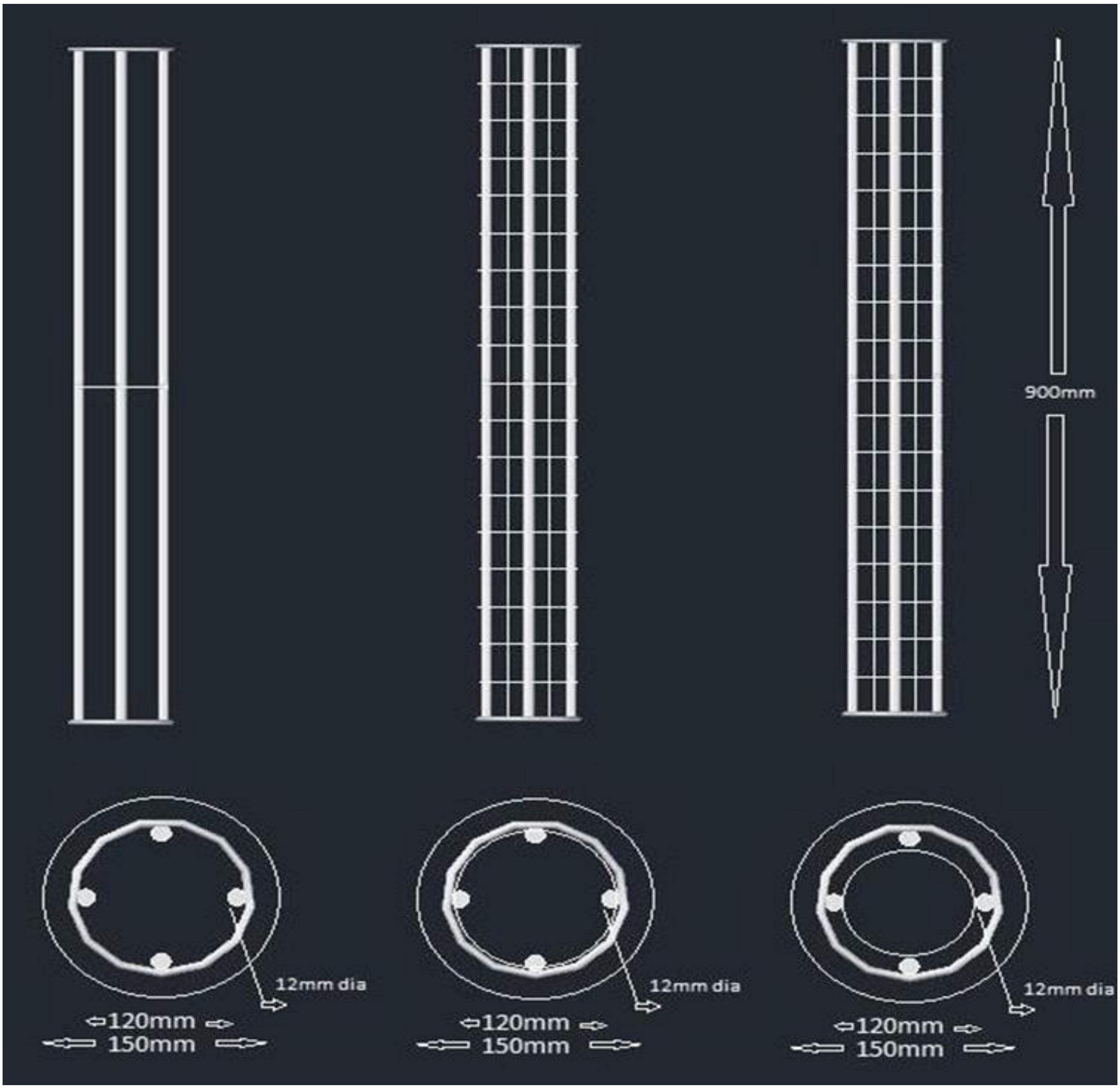


Fig 5.1 Plan & Elevation of Column

Fig.5.2 Plan & Elevation of Column

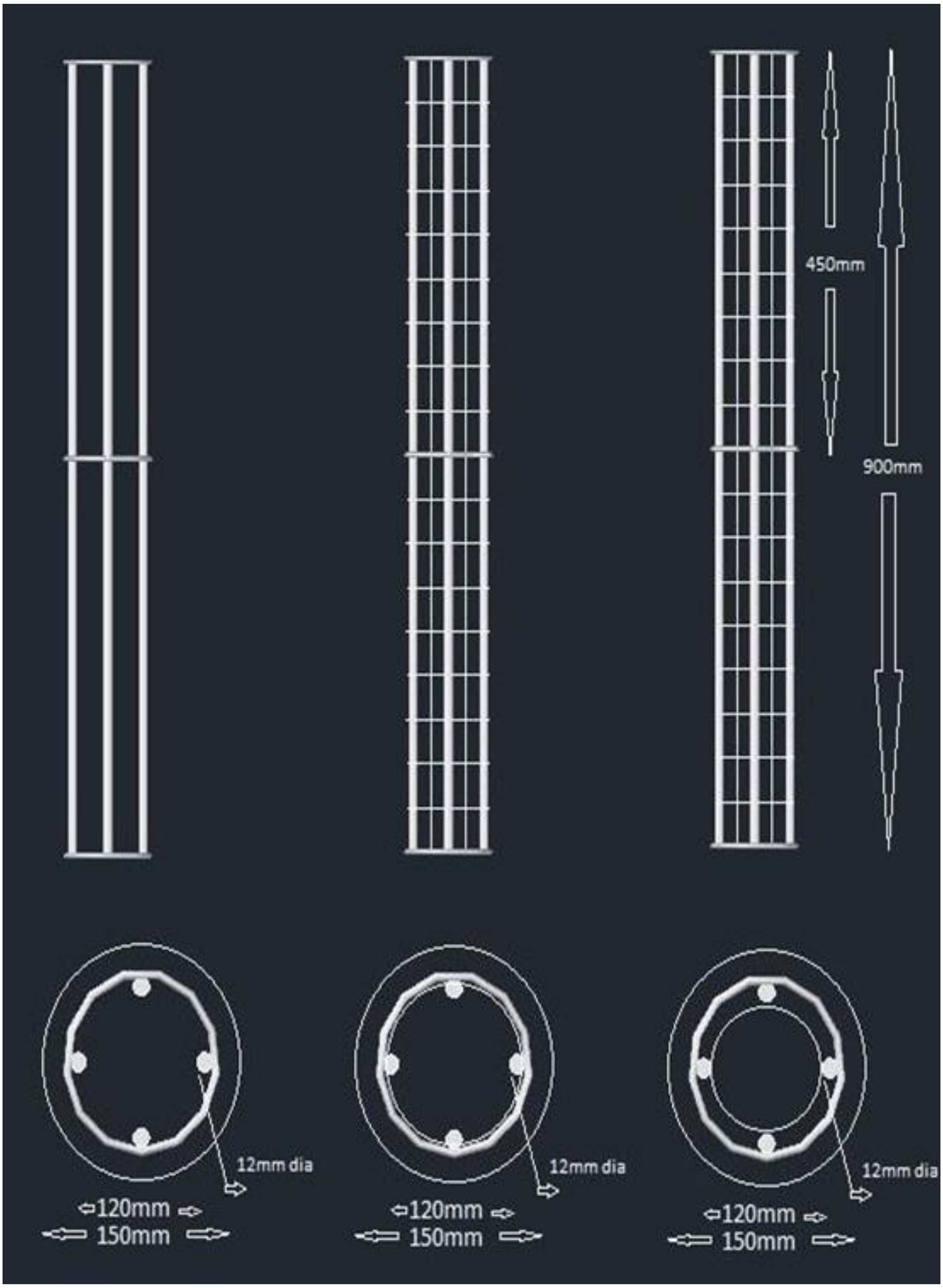


Fig.5.2 Plan & Elevation of Column

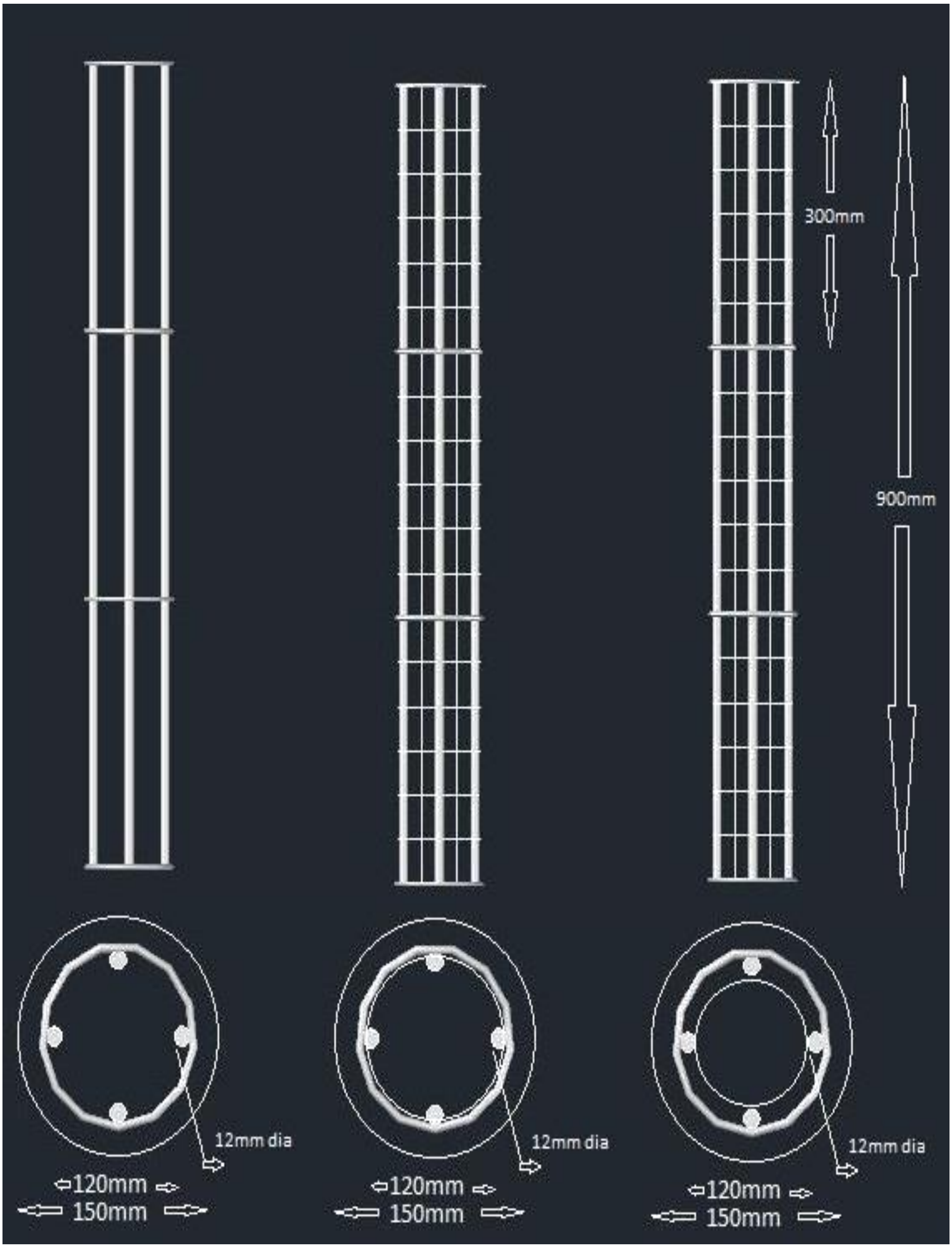


Fig.5.3 Plan & Elevation of Column

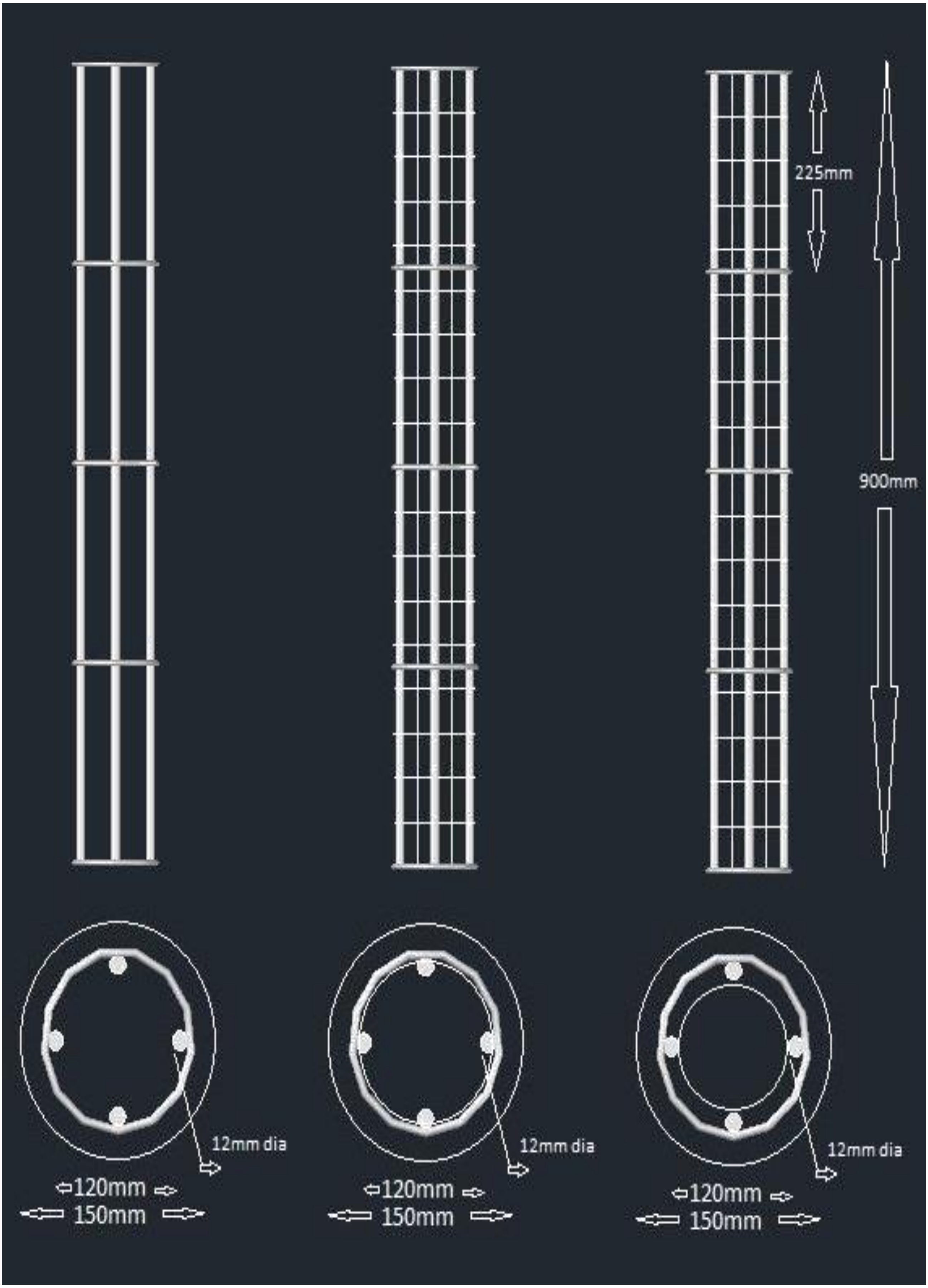
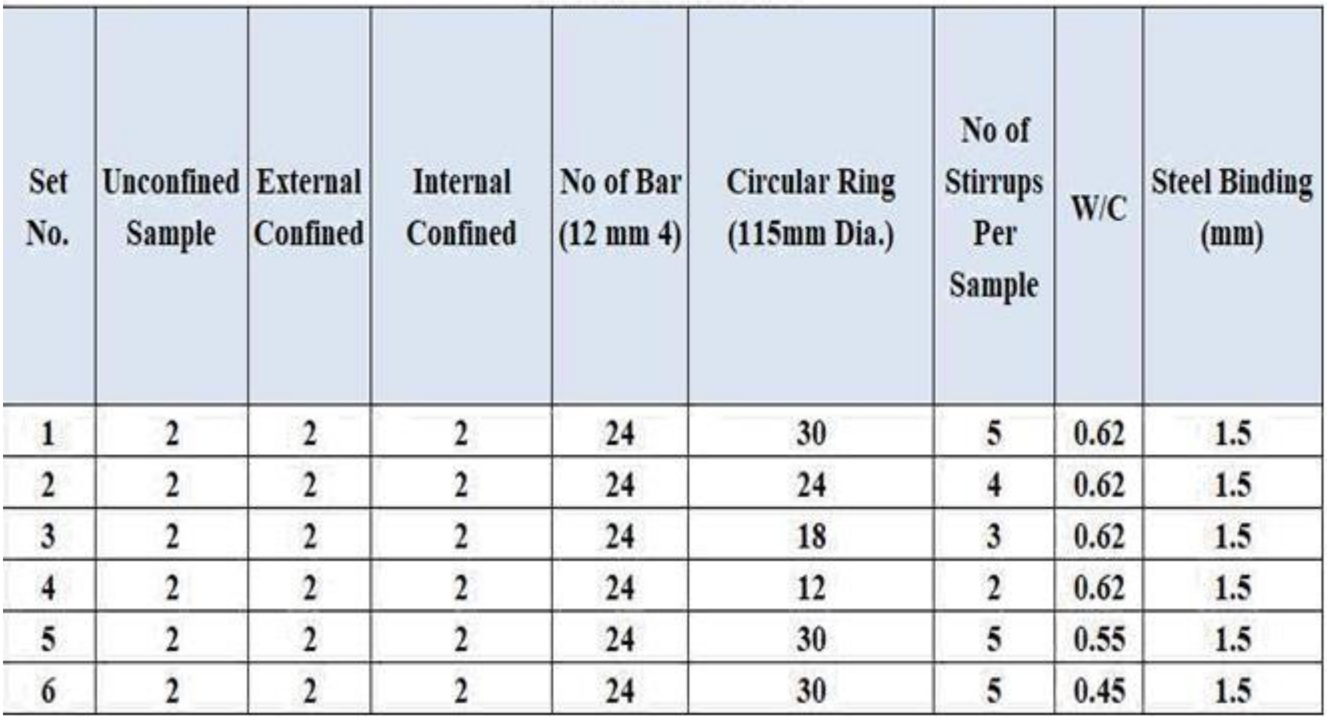


Fig.5.4 Plan & Elevation of Column

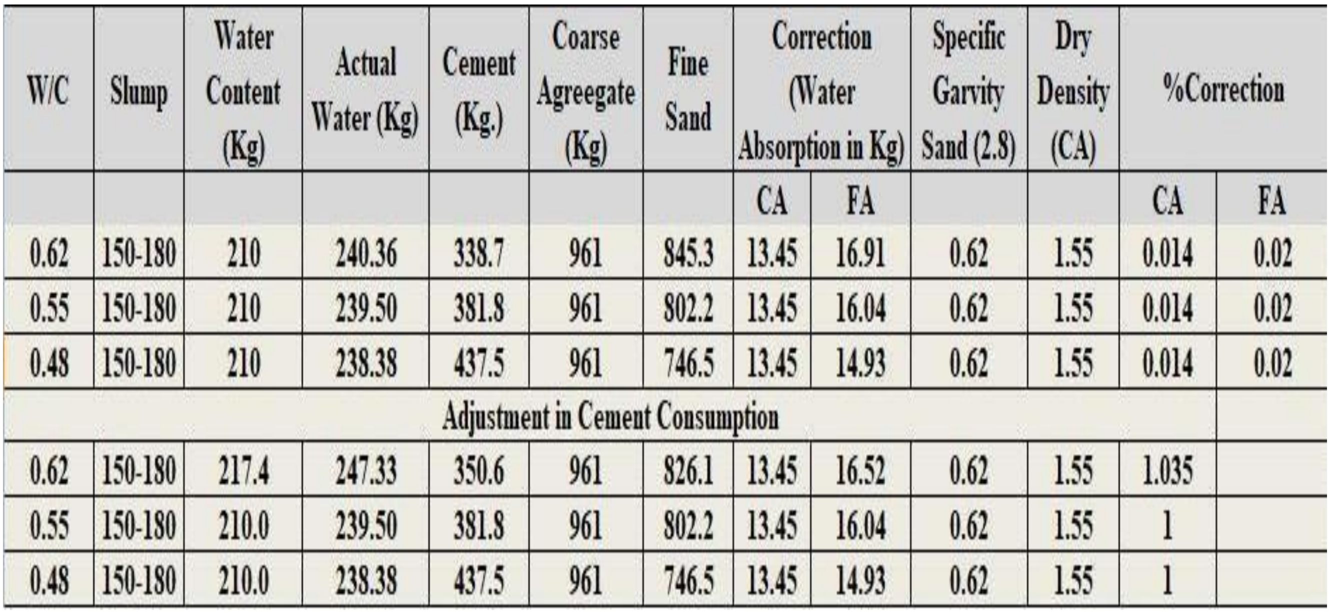
Fig.5.5 Column Sample

Column Confinement



Set No.	Unconfined Sample	External Confined	Internal Confined	No of Bar (12 mm 4)	Circular Ring (115mm Dia.)	No of Stirrups Per Sample	W/C	Steel Binding (mm)
1	2	2	2	24	30	5	0.62	1.5
2	2	2	2	24	24	4	0.62	1.5
3	2	2	2	24	18	3	0.62	1.5
4	2	2	2	24	12	2	0.62	1.5
5	2	2	2	24	30	5	0.55	1.5
6	2	2	2	24	30	5	0.45	1.5

Fig5.6 WorkProcedure



W/C	Slump	Water Content (Kg)	Actual Water (Kg)	Cement (Kg.)	Coarse Agreegate (Kg)	Fine Sand	Correction (Water Absorption in Kg)		Specific Garvity Sand (2.8)	Dry Density (CA)	%Correction	
							CA	FA			CA	FA
0.62	150-180	210	240.36	338.7	961	845.3	13.45	16.91	0.62	1.55	0.014	0.02
0.55	150-180	210	239.50	381.8	961	802.2	13.45	16.04	0.62	1.55	0.014	0.02
0.48	150-180	210	238.38	437.5	961	746.5	13.45	14.93	0.62	1.55	0.014	0.02
Adjustment in Cement Consumption												
0.62	150-180	217.4	247.33	350.6	961	826.1	13.45	16.52	0.62	1.55	1.035	
0.55	150-180	210.0	239.50	381.8	961	802.2	13.45	16.04	0.62	1.55	1	
0.48	150-180	210.0	238.38	437.5	961	746.5	13.45	14.93	0.62	1.55	1	

Fig.5.7 Mixdesign

TESTING

UTM (Universal Testing Machine)

Compression Test: The exact opposite of a tensile test. This is where you compress an object between two level plates until a certain load or distance has been reached or the product breaks. The typical measurements are the maximum force sustained before breakage (compressive force), or load at displacement (i.e. 55 pounds at 1” compression), or displacement at load (i.e. 0.28” of compression at 20 pounds of force).

Chapter 7

RESULT AND DISCUSSION

Introduction

The results obtained by testing samples are discussed in this section. Load-deflection curve were prepared of all unconfined specimens of different rings i.e. (uCW0.62X5, uCW0.62X4, uCW0.62X3, uCW0.62X2) and confined specimens i.e. (iCW0.62X5, iCW0.62X4, iCW0.62X3, iCW0.62X2, eCW0.62X5, eCW0.62X4, eCW0.62X3, eCW0.62X2, iCW0.55X5, iCW0.55X5,eCW0.48X5, eCW0.48X5).Every specimen were tested under concentric loading and ultimate load capacity were observed.

Result of Confined and Un-Confinedcolumn

Water-Cement ratio(0.62)

Five Rings

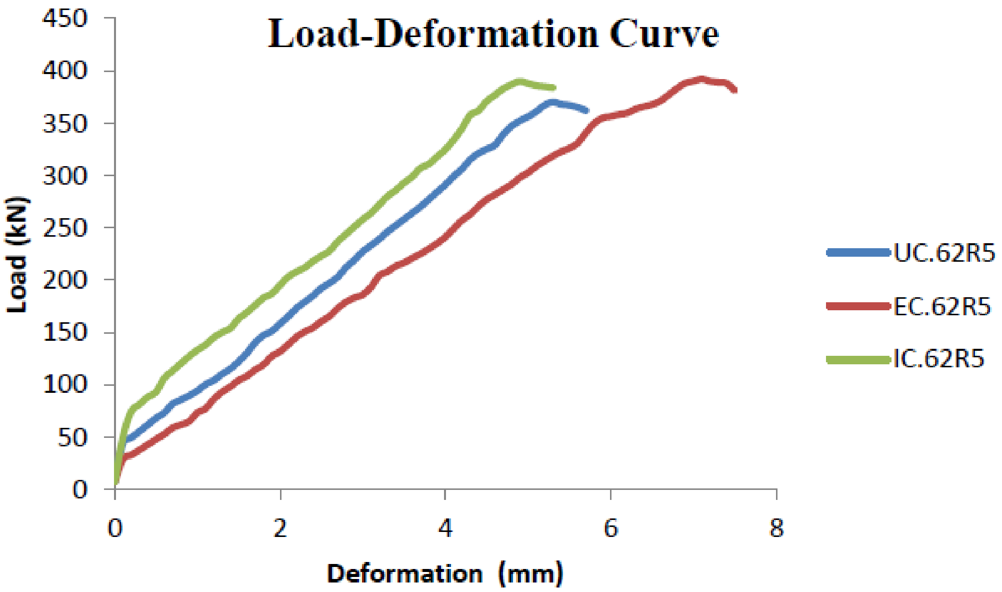


Fig.7.1 Load Deflection curve for column

UC.62R5 denotes unconfined specimen having water cement ratio .62with 5 rings.

EC.62R5 denotes externally confined specimen having water cement ratio .62 with 5 rings.

IC.62R5 denotes internally confined specimen having water cement ratio .62 with 5 rings.

FourRings

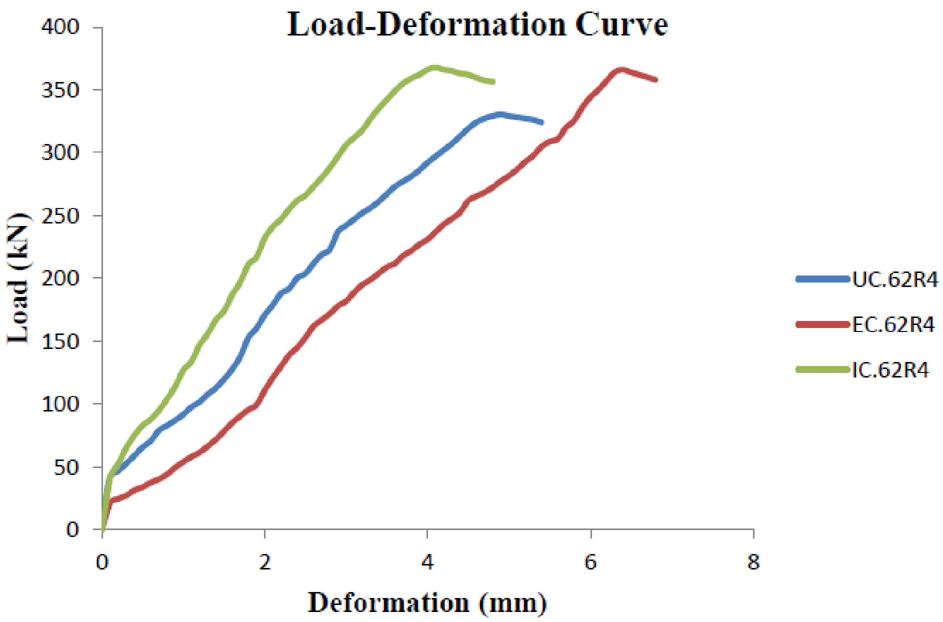


Fig.7.2Load Deflection curve for column

UC.62R4 denotes unconfined specimen having water cement ratio .62 with 4 rings.

EC.62R4 denotes externally confined specimen having water cement ratio .62 with 4 rings.

IC.62R4 denotes internally confined specimen having water cement ratio .62 with 4 rings.

ThreeRings

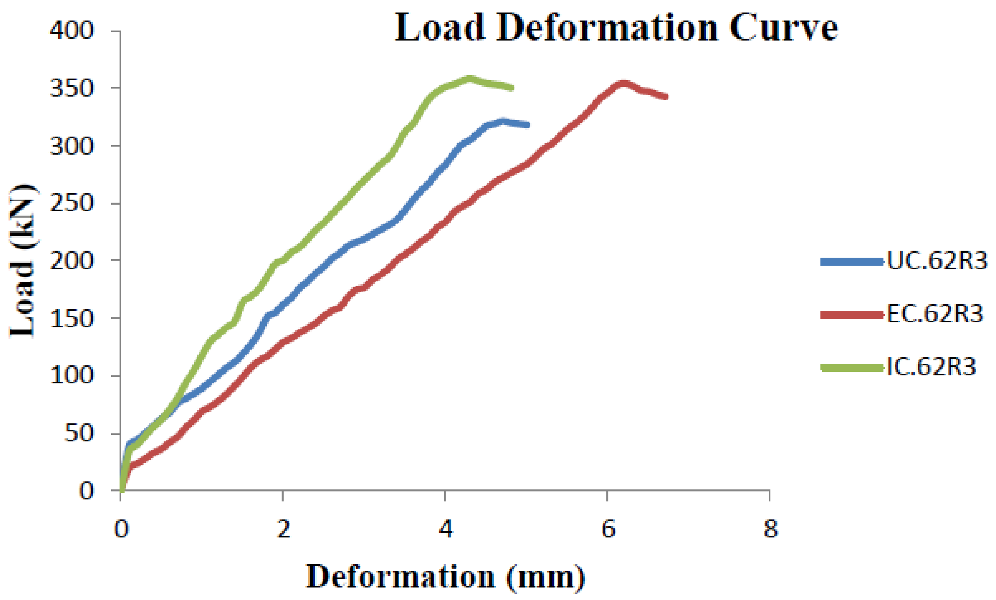


Fig.7.3Load Deflection curve for column

UC.62R3 denotes unconfined specimen having water cement ratio .62 with 3 rings.

EC.62R3 denotes externally confined specimen having water cement ratio .62 with 3 rings.

IC.62R3 denotes internally confined specimen having water cement ratio .62 with 3 rings.

Two Rings

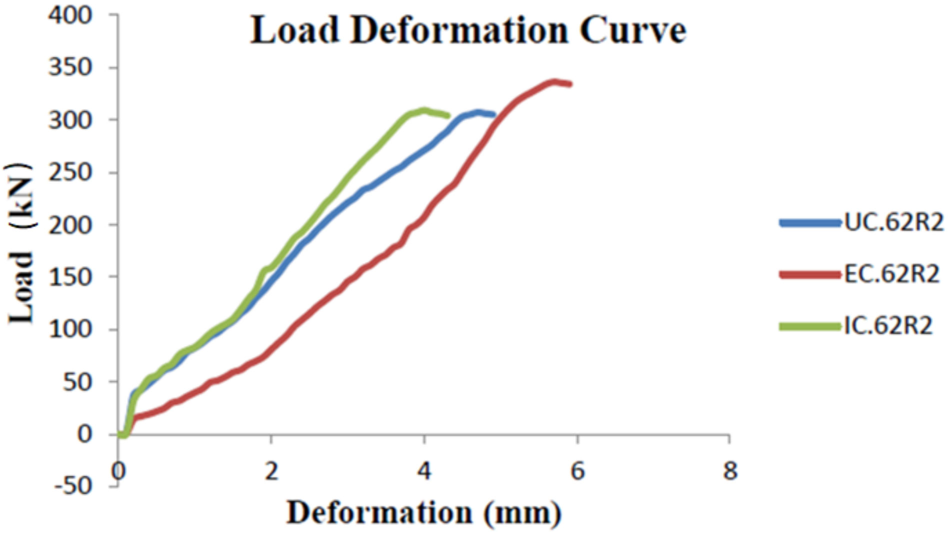


Fig.7.4Load Deflection curve for column

UC.62R2 denotes unconfined specimen having water cement ratio .62 with 2 rings.

EC.62R2 denotes externally confined specimen having water cement ratio .62 with 2 rings.

IC.62R2 denotes internally confined specimen having water cement ratio .62 with 2 rings.

Water-Cement ratio(0.55)

Five Rings

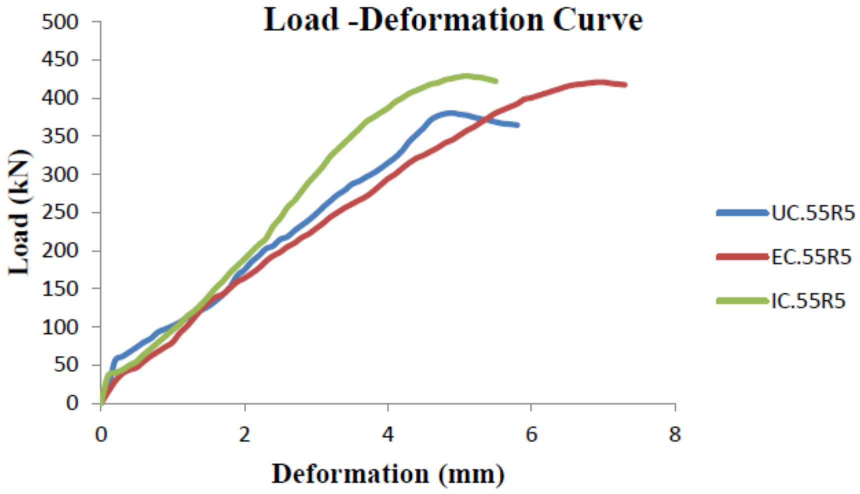


Fig.7.5 Load Deflection curve for column

UC.55R5 denotes unconfined specimen having water cement ratio .55 with 5 rings.

EC.55R5 denotes externally confined specimen having water cement ratio .55 with 5 rings.

IC.55R5 denotes internally confined specimen having water cement ratio .55 with 5 rings.

Water-Cement ratio(0.48)

Five Rings

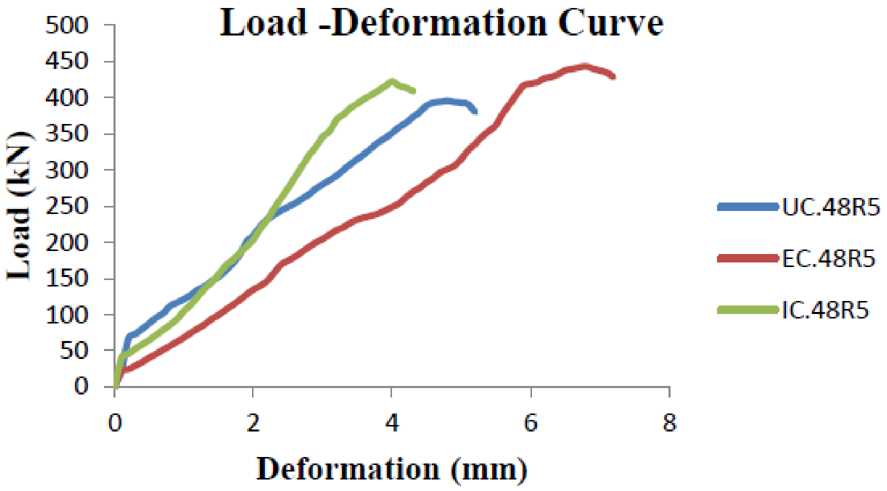


Fig.7.6 Load Deflection curve for column

UC.48R5 denotes unconfined specimen having water cement ratio .48 with 5 rings.

EC.48R5 denotes externally confined specimen having water cement ratio .48 with 5 rings.

IC.48R5 denotes internally confined specimen having water cement ratio .48 with 5 rings.

w/c ratio	Cube strength (Mpa)
0.62	19.5
0.55	23.2
0.48	25.4

Table 7.1 Cube strength

Fig

Tested columns

Fig. 7.8

Cracks and columns

NUMBER OF RINGS	PROPERTIES	NON CONF	EXT CONF	INT CONF	% increase Ext conf.	% increase inner conf.
5 RINGS	LOAD (kN)	370.7	381.6	373.7	2.94	0.80
	DEFORMATION (mm)	5.3	7.1	4.9		
4 RINGS	LOAD (kN)	340.2	362.8	339.7	6.64	-0.14
	DEFORMATION (mm)	4.8	6.9	4.4		
3 RINGS	LOAD (kN)	311.6	354	308.8	13.61	-0.89
	DEFORMATION (mm)	4.4	6.2	4.1		
2 RINGS	LOAD (kN)	284.4	340.7	266.7	19.79	-6.22
	DEFORMATION (mm)	4.3	5.6	4.1		

Table 7.1 Varying rings of non-confined, externally confined and internally conf. specimen

W/C	PROPERTIES	NON CONF.	EXT CONF.	INT CONF.	% increase Ext conf.	% increase inner conf.
.62 W/C	LOAD (kN)	370.7	381.6	373.7	2.94	0.80
	DEFORMATION (mm)	5.3	7.1	4.9		
.55 W/C	LOAD (kN)	386.6	405.5	392.1	4.89	1.42
	DEFORMATION (mm)	5.4	7.7	5.1		
.48 W/C	LOAD (kN)	412.3	443.2	422.5	7.49	2.47
	DEFORMATION (mm)	6.2	8.2	5.3		

Table 7.2 Varying W/C Ratio of non-confined, externally confined and internally conf. specimen

UNCONFINED 4 RING AND EXTERNALLY CONFINED 2 RING

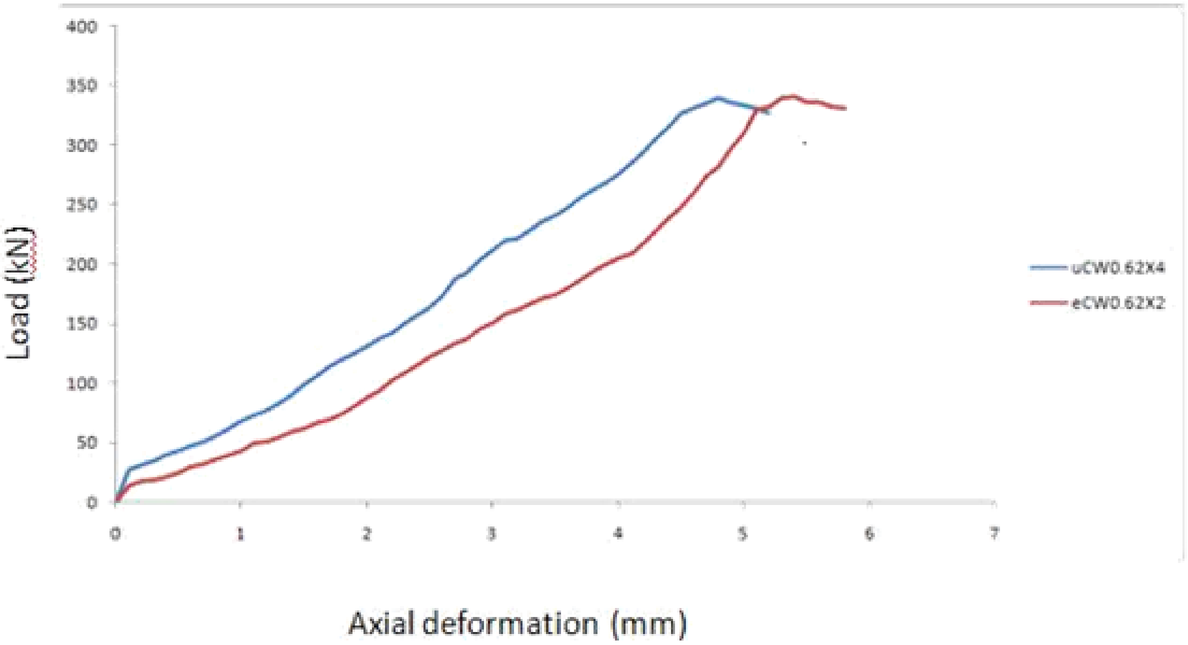


Fig.8.1 Load deflection curve for columns for unconfined 4 rings and externally confined 2 rings

uCW0.62X4 denotes unconfined specimen having water cement ratio .62 with 4 rings.

eCW0.62X4 denotes externally confined specimen having water cement ratio .62 with 2 rings.

Conclusion

- External confinement gives more axial deformation for same loadcapacity
- For group 1 external confinement increases the load taking capacity as it can be observed that maximum increase in peak load was for columns with 3 rings(17%).
- In group 1 by using external confinement occurrence of peak load was delayed with respect to unconfined specimens. The increment was maximum for columns with 3 rings(32%).
- In group 1 peak was obtained earlier in comparisons to unconfined ones and very low percentage increase in load takingability.
- For group 2 maximum increases in load capacity was for w/c 0.55 when confined internally(11%).
- For group 2 with w/c 0.55 shows increase in axial deformation at peak load(42%).
- External confinement provided moreductility.
- In group 1 it was also observed that external confined column with 3 and 2 rings have similar ultimate load capacity as compared to unconfined 3 and 2 rings columnsrespectively.
- High increase in energy absorption for group 2 column having w/c 0.55(52%).

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