International Journal of Research Available at https://edupediapublications.org/journals

e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 05 Issue 12
April 2018

Seismic retrofit of reinforced concretebuildings using jacketing

Sirigineedi Naga Lakshmi[1],Dr. Dumpa Venkateswarlu[2,3]

[1] M.Tech (student) in structural Engineering, department of civil engineering, Godavari Institute of Engineering and Technology (Autonomous),Rajahmundry, Velugubanda Village,Rajanagaram (mandal) East Godavari, A.P, India, pin code: 533296.

[2,3] Professor and Head of the Department, department of civil engineering, Godavari Institute of Engineering and Technology (Autonomous),Rajahmundry, Velugubanda Village,Rajanagaram(mandal) East Godavari, A.P, India, pin code:533296.

Abstract:

Many parts of the country have suffered earthquake in last three decades. In costalpart of South India faced Tsunami. In first three earthquakes it was found that many ofdamaged structures were build in non-engineered masonry techniques.Unreinforced masonry structures are the most vulnerable during an earthquake.Normally they are designed for vertical loads and since masonry has adequate compressivestrength, the structures behave well as long as the loads are vertical. When such a masonrystructure is subjected to lateral inertial loads during an earthquake, the walls develop shearand flexural stresses.In previous earthquakes many R.C.C buildings have also collapsed and are found unsafe due to faulty workmanship. Many other causes are responsible for major collapse anddamage to the R.C.C structures. This thesis presents a study of PL+SC+S+G+5 storeybuilding, where this PL+SC+S+G+5 storey residential building is being converted tocommercial building which results increase of live load in existing building This overallanalysis is done by using ETABS software . we follow the technique of retrofitting byjacketing method to increase resistance of the building towards lateral forces.

Keywords: PL+SC+S+G+5 story, ETABS, dead loads, live loads ,retrofitting, jacketing etc,.

1. Introduction

When the normal residential building is being change to general commercial buildingthat gives results in increasing the live load in existing building, this was proven in physicaland experimental investigations also. It was concluded that the buildings either should bedemolish or at least should be redefined with suitable techniques, to increase its service life. This can be overcome by new technique called retrofitting by jacketing. It was decided to implement reinforced cement concrete column jacketing technique due to its feasibility and ease for execution of the existing building. All the columns and beams on all the floors are now suitably jacketed. The loose pockets of concrete that were investigates during the test are re-concreted, and rusted the reinforcement is replaced with new reinforcement as per thegiven design requirements.

Redefining utilizes the concepts of confinements by strengthen the existing beam orcolumn with external pressures. Confinement in reinforced concrete also uses the lateralsteel reinforcement to delay the lateral expansion of the confined concrete. This is known as The concrete core. While strengthening the longitudinal steel and reinforcement by braceincreasing and its buckling strength. Certain reinforcement concrete columns are alsodesigned and utilizing the concept of confinement with steel rebars hoops or spirals insidethe concrete core. The need for additional confinement is sometimes necessary. It is alsoimportant to know the how new retrofit material will enhance and strengthen the existingmember.

Objectives

So many researchers have been developed equations and models to predict thebehavior of the reinforced concrete columns confined with steel rebars, the

International Journal of Research Available at https://edupediapublications.org/journals
e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 05 Issue 12
April 2018

continuoussteel bar, concrete jacketing, or even fibre composite material. The purpose of this thesis is to examine the existing normal residential building and to retrofit to general commercialbuilding as increases in live load. We can do the retrofitting in various ways as in hereadopted the retrofitting by jacketing method.There is a scope of retrofitting for existing building with various methods depending upon various parameters like functionality, cost and type of structure.Retrofitting is technical evaluation in structural system of the building that improves the resistance to earthquake by optimizing the strength of the building, ductility andearthquake loads. Strength of the building is generated from the structural dimensions,materials used, shape of the structure, and number of structural elements like beams andcolumns etc. Ductility of the building is generated from good detailing, materials used, degree of seismic resistant, etc. Earthquake load is generated from the site seismicity, mass ofthe structures, important of buildings, degree of seismic resistant, etc.Due to the variety of structural condition of building, it is hard to develop typical rulesfor retrofitting. Each building has different approaches depending on the structuraldeficiencies. so there is a need to prepare and design the retrofitting approaches. In thedesign of retrofitting approach, the engineer must comply with the building codes. The resultsgenerated by the adopted retrofitting techniques must fulfill the minimum requirements on thebuildings codes, such as deformation, detailing, strength, etc.

2. Literature review

E. Senthil Kumar, A.Murugesan And G.S.Thirugnanam et all,.Did an experimental investigation of the behavior of retrofitted FRP (fibre reinforcedpolymer) wrapped exterior beam-column joint of a G+4 building in Salem, which lies inseismic zone III. The test specimen was taken to be one fifth model of beam column jointfrom the prototype specimen and was evaluated in terms of load displacement relation,ductility, stiffness, load ratio and cracking pattern. On comparing the test results with theanalytical modeling of the joint on ANSYS and STAAD Pro, it was found that such externalconfinement of concrete increased the load carrying capacity of the control specimen by 60%
And energy absorption capacity by 30-60%.

Durgesh C. Rai : Gave the guidelines for seismic evaluation and strengthening of buildings. This document isdeveloped as part of project entitled Review of Building Codes and Preparation of Commentary and Handbooks awarded to Indian Institute of Technology Kanpur by the Gujarat State Disaster Management Authority (GSDMA), Gandhi agar through World Bank finances. This document is particularly concerned with the seismic evaluation and strengthening of existing buildings and it is intended to be used as a guide.

Yen-Po Wang Introduced the fundamentals of seismic base isolation as an effective technique for seismicdesign of structures. Spring-like isolation bearings reduce earthquake forces by changing the fundamental time period of the structure to avoid resonance. However, sliding-type isolationbearings filter out the earthquake forces via discontinuous sliding interfaces and forces areprevented from getting transmitted to the superstructure because of the friction. The design ofthe base isolation system includes finding out the base shear, bearing displacement etc. inaccordance with site-specific conditions.

3.Methods of Retrofitting

Increase the capacity/strength of the system (Seismic Resistance Based Design)
(i) Concrete Jacketing.
(ii) Steel Jacketing.
(iii) FRP Wrapping

Fig 1. Column jacketing at basement stag

Fig 2.Beam column junction strengthening in basemen

4. Software review of ETABS

ETABS is a sophisticated, but easy to use, for analysis and design purpose. ETABS program is

International Journal of Research Available at https://edupediapublications.org/journals
e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 05 Issue 12
April 2018

developed specifically for building systems (structural). ETABS features are intuitive and have powerful graphical interface coupled with unmatched modeling, analytical, and design procedures, all integrated using a common database. ETABS can also handle most complex building structural models which includes a wide range of nonlinear behaviors, making it as tool of choice for structural engineering by structural engineer is perfect in the building industry.

5. modeling with Etabs

Here a G+5 storey building that is Existing Building before Retrofitting modeled by using ETABS 9 software. The detailed features of the normal building are given below.

Features of building (model 1)

Structure = Before retrofitting of the building (structure 1)
Floors = Plinth level + Sub cellar + Cellar +Ground + 5
Grid lines in X-direction = 1
Grid lines in Y-direction = 12
Grid width in X-direction = 19.75 m
Grid width in Y-direction = The grid width of building in y-direction varies as per
the plan
Live load on slab = 2.0 kN/m2(all floors except terrace floor)
= 1.5 kN/m2 (terrace floor)
Dead load on slab = 2.0 kN/m2(all floors except terrace floor)
= 1.5 kN/m2 (terrace floor)
Floor Finish = 1.0 kN/m2
Water proofing = 1.0 kN/m2
Storey height = 3.2 m
Wall Thickness = 0.25 m (exterior wall)
= 0.15 m (interior wall)
Thickness of Slab = 0.15 m
Grade of concrete = M25 (For beams)
= M30 (For columns)
Grade of steel = Fe415

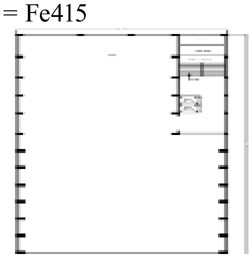


Fig 3: plan view

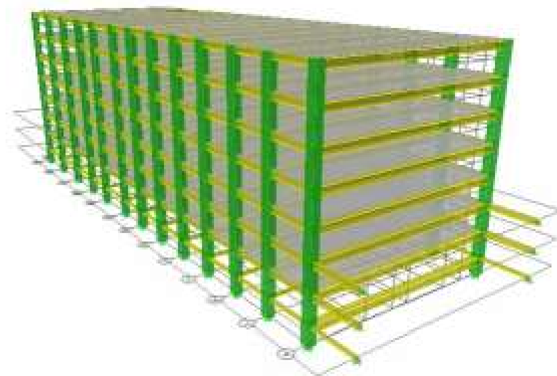


Fig 4 3d view

Base Shear of Building = Ah * W
= 0.0666 * 104125.082
= 6934.730 kN

Model 2

Structure = Existing Building after Retrofitting (Structure 2)
Floors = Plinth level + Sub cellar + Cellar +Ground + 5
Grid in X-direction = 1
Grid in Y-direction = 12
Grid width in X-direction = 19.75m
Grid width in Y-direction = The grid width of building in y-direction varies as per
the plan
Live load on slab = 6.0 kN/m2(all floors except terrace floor)
= 2.5 kN/m2 (terrace floor)
Dead load on slab = 2.0 kN/m2(all floors except terrace floor)
= 1.5 kN/m2 (terrace floor)
Floor Finish = 1.0 kN/m2
Water proofing = 1.0 kN/m2
Storey height = 3 m
Wall Thickness = 0.25 m (exterior wall)
= 0.15 m (interior wall)
43Thickness of Slab = 0.15 m
Grade of concrete = M25 (For beams)
= M30 (For columns)
Grade of steel = Fe415

Fig 5: 3D view

Base Shear of Building = Ah * W
= 0.0666 * 101449.098
= 6756.5099 KN

6. Retrofitting by jacketing method

Jacketing of Columns

Jacketing of columns consists of added concrete with longitudinal and transversereinforcement around the existing columns. This type of strengthening improves the axialand shear strength of columns while the flexural strength of column and strength of thebeam-column joints remain the same. It is also observed that the jacketing of columns is not successful for improving the ductility. A major advantage of column jacketing is that it improves the lateral load capacity of the building in a reasonably uniform and distributedway and hence avoiding the concentration of stiffness as in the case of shear walls. This ishow major strengthening of foundations may be avoided. In addition the original function ofthe building can be maintained, as there are no major changes in the original geometry of the building with this technique. The jacketing of columns is generally carried out by twomethods:

(i) reinforced concrete jacketing

(ii) Steel jacketing

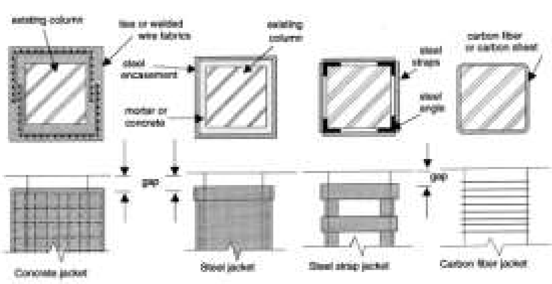


Fig 6 :Types of jacketing in seismic retrofitting

Reinforced Concrete Jacketing:

Reinforced concrete jacketing can be employed as a repair or strengthening scheme.Damaged regions of the existing members should be repaired prior to their jacketing. Thereare two main purposes of jacketing of columns:

(i) Increase in the shear capacity of columns in order to accomplish a strong columnweak beam design and

(ii) To improve the column's flexural strength by the longitudinal steel of the jacketmade continuous through the slab system are anchored with the foundation. It isachieved by passing the new longitudinal reinforcement through holes drilled in theslab and by placing new concrete in the beam column joints .

Rehabilitated sections are designed in this way so that the flexural strength ofcolumns should be greater than that of the beams. Transverse steel above and belowthe joint has been provided.

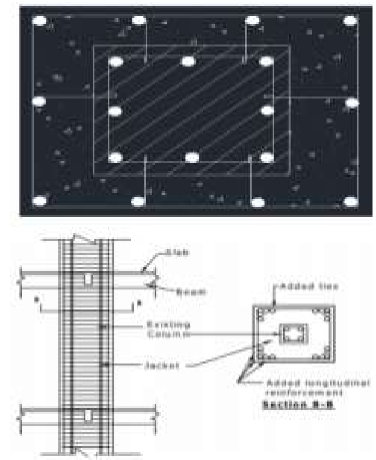
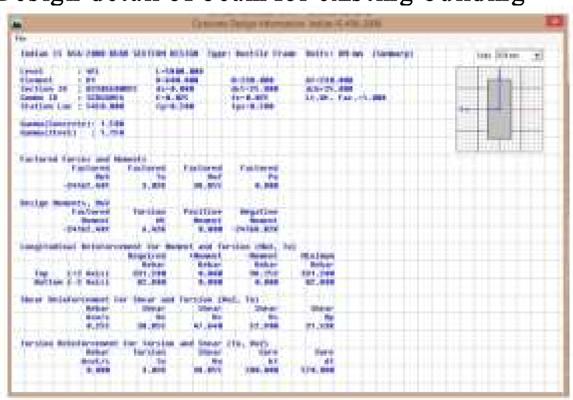
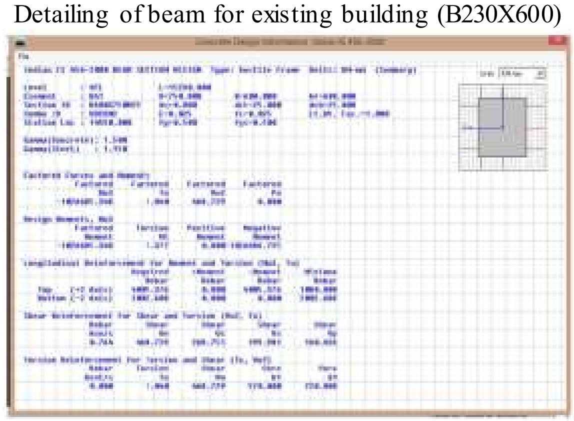


Fig. 7: Construction Technique for Column Jacketing

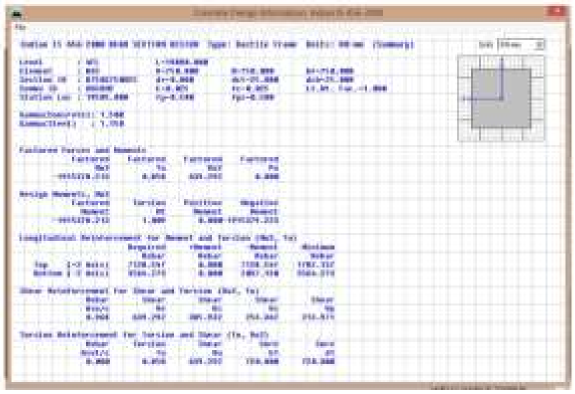
Design detail of beam for existing building



Detailing of beam for existing building (B230X600)

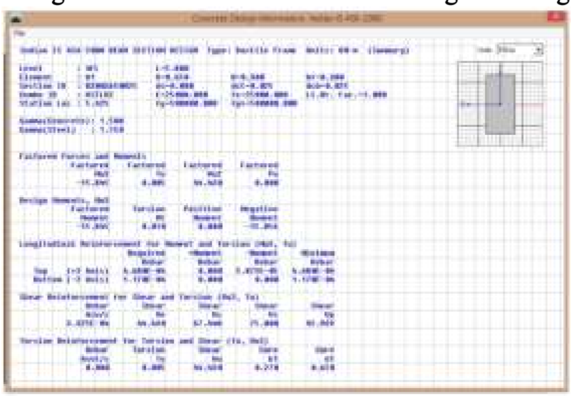


Detailing of beam for existing building (B600X750)

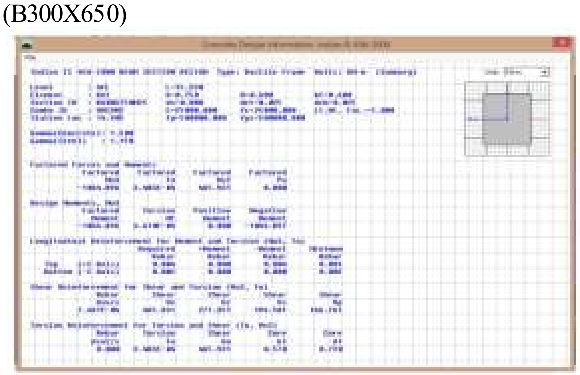


Detailing of beam for existing building (B750X750)

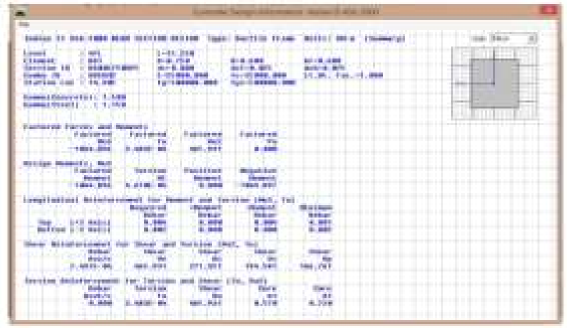
Design detail of column for retrofitting building



Detailing of beam for retrofitting building (B300X650)

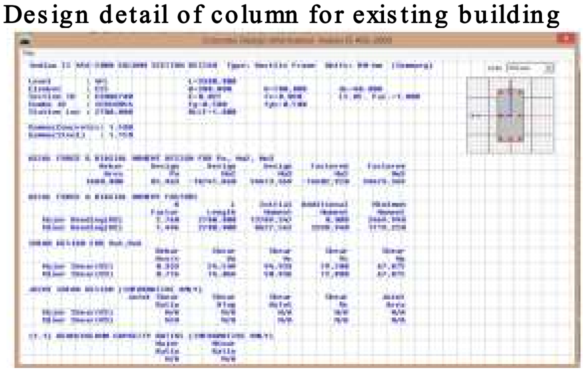


Detailing of beam for retrofitting building (B600X750)

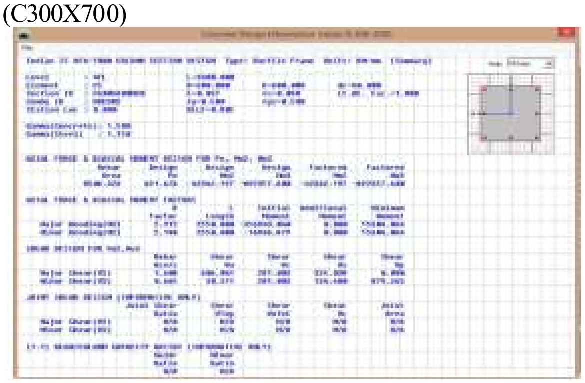


Detailing of beam for retrofitting building (B750X750)

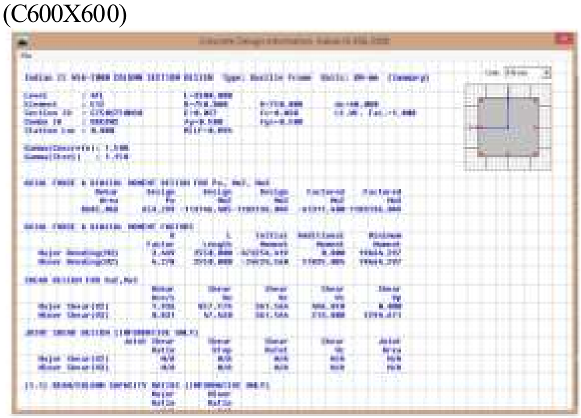
Design detail of column for existing building



Detailing of column for existing building (C300X700)

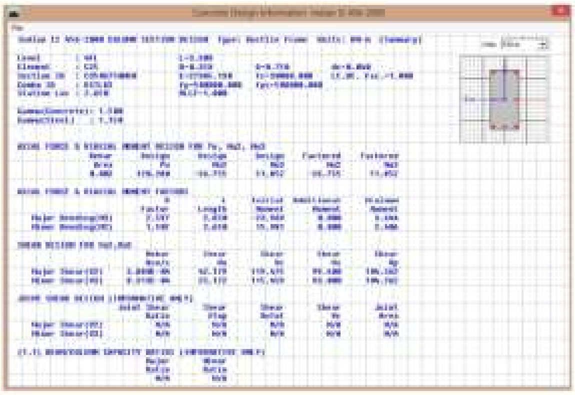


Detailing of column for existing building (C600X600)

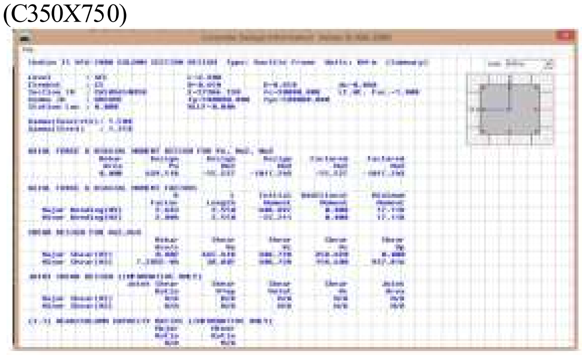


Detailing of column for existing building (C750X750)

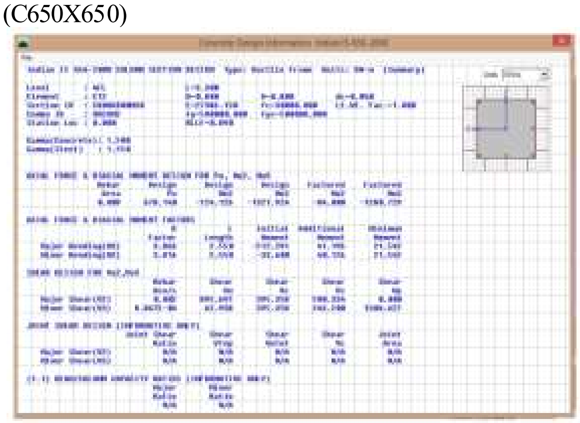
Design detail of column for retrofitting building



Detailing of column for retrofitting building (C350X750)



Detailing of column for retrofitting building (C650X650)

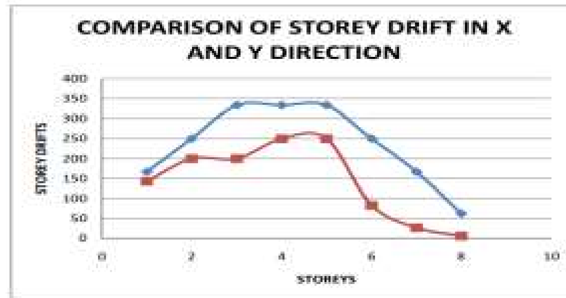


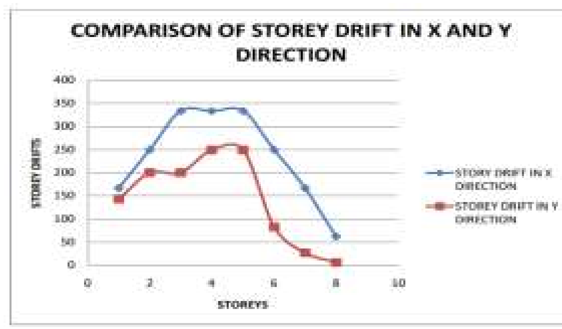
Detailing of column for retrofitting building (C800X800)

8.Results, conclusion and future research

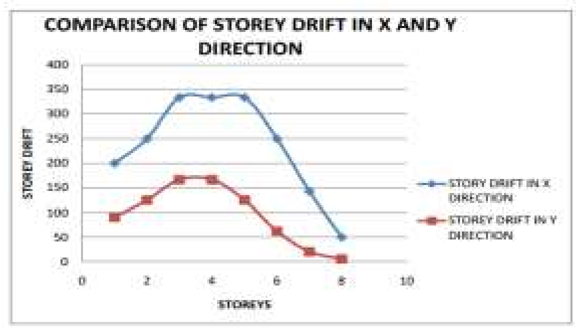
STORY DRIFTS (As per IS 1893-2002)

The storey drift in any storey due to the minimum specified design lateral force, withpartial load factor of 1.0. shall not exceed 0.004 times the storey height, For the purposes ofdisplacement requirements only (see 7.11.1,7.11.2 and7.11.3 only), it is permissible to useseismic force obtained from the computed fundamental period (7') of the building without the lower bound limit on design seismic force specified in 7.8.2



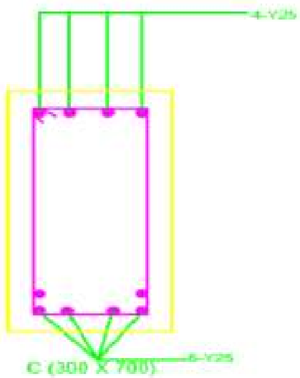


Comparison of storey drift for existing building

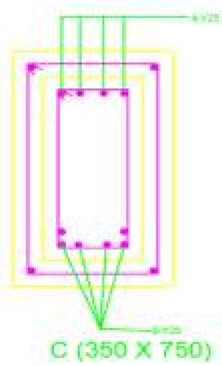


Comparison of storey drift for retrofitting building

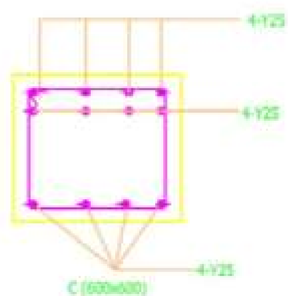
Detailing of the existing and retrofitting of column



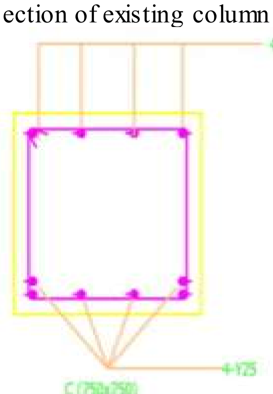
Cross section of existing column C (300X700)



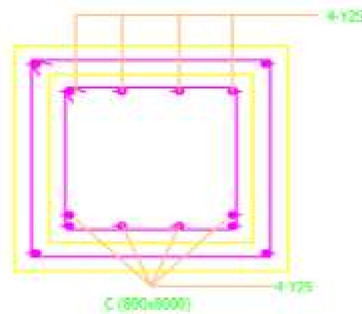
Cross section of retrofitting column C (350X750)



Cross section of existing column C (600X600



Cross section of existing column C (750X750)



Cross section of retrofitting column C (800X800)

CONCLUSION:

After an extensive bibliographical study and the revision of several Indian designprojects for the retrofit of structures, it can be concluded that there are some outlines thathelp, not only in a qualitative but in a quantitative manner, the design of a retrofit scheme of astructure by means of concrete jacketing. Although these guidelines can give a rational basis for a practical design, research stillneed to address critical aspects in the behaviour of jacketed elements .The change inbehaviour in jacketed elements whose shear span/death ratios are significantly reduced, due to their jacketing, needs to be clarified.In case of moderate seismic regions, reinforced concrete buildings are designed toresist dead and live loads only. This result in joint cores with reinforcement detail that cannotfulfill seismic design criteria, thus making such building frames vulnerable to joint shear failure when subjected to lateral loading or ground excitation. Even in seismic regions, oldbuildings designed according to the existing immature seismic design codes lack of sufficienthoops inside the joint cores. The joint cores are the most critical components in such frames,and the ultimate failure of such frames under lateral loading would be due to the inadequateshear capacity of the joint core. Hence, such lightly reinforced joints need to be strengthenedby adding additional reinforcement by the method of retrofitting before exposing them to anyform of lateral loading. Reinforced concrete (RC) jacketing is an effective method ofretrofitting such connections. In this paper, the usefulness of reinforced concrete jacketingtechnique to strengthen lightly reinforced beam-column joints is investigated experimentally.A full-scale lightly reinforced concrete beam-column sub-assembly was strengthenedby casting an reinforced concrete jacket outside of the column and at the joint and the improvement brought over by the retrofitting technique in the cyclic response of thespecimen was

verified experimentally. The joint of the original specimen was not adequatelyreinforced to fulfill seismic design requirements, and it was the weakest component of thesub-assembly. When subjected to cyclic lateral loading, the joint panel will experience severedamage due to excessive shear deformation while the beam and column remained virtuallyundamaged. The original specimen was vulnerable to joint shear failure. On the other hand,the retrofitted specimen failed after the formation of a plastic hinge in the beam, and the jointwas no longer the weakest component of the sub-assembly. Apart from the increase in thecapacity and deformability of the joint, the shear deformation of the joint panel reduced
significantly after retrofitting. It is concluded that the reinforced concrete jacketing method iseffective in strengthening non-seismic reinforced concrete frames with inadequatelyreinforced joints.

Scope of Future Work

- Due to lack of design procedures in IS code, the design was implemented only for beamsand columns. The project can be extended by suggestions on how to strengthen slabs.Also, schemes for shear strengthening of the failing members should be developed.
- The same 5-storey RC structure can be retrofitted using some different technique likebase isolation; steel bracings, shear wall etc. and a comparative study can be done to bymodelling the structures in ETABS software.
- Find out the most efficient technique with respect to cost, aesthetics, durability andother such criteria.
- Lastly, fibre reinforced plastic wrapping is a relatively a new technique in which newgenre of materials used in the realm of civil engineering and a lot of its properties canbe determined. Future work needs to be done to determine its behaviour in specificconditions.

References

- Retrofitting of existing reinforced cement concrete buildings by method of jacketing
- Alcocer, S. M., “rehabilitation of RC Frame Connections using Jacketing”, Tenth World Conference on Earthquake Engineering, Madrid, Spain, 19-24 July, 1992.
- IS13945, Repair and Seismic Strengthening of Buildings – Guidelines, Bureau of Indian Standards, New Delhi, 1993.
- Materials and jacketing technique for retrofitting of structures shri. Pravin b. Waghmar.
- Seismic Retrofit Of Reinforced Concrete Buildings - A Review And Case Study M C Griffith1 And A V Pinto2.
- Seismic retrofitting of reinforced concrete buildings using traditional and innovative techniques Giuseppe oliveto and Massimo marletta.
- Seismic evaluation and retrofitting of buildings and structures N.Lakshmanan.
- Effectiveness of Various Methods of Jacketing for RC Beams Sachin S. Ravala , Urmil V. Daveb
- Different Strengthening Techniques for RC Column, Dr. Gopal L. Rai.
- Seismic strengthening of RC columns using external steel cage ,PasalaNagaprasad, DiptiRanjanSahoo and Durgesh C. Rai