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ANALYSIS AND DESIGN OF COMPOSITE COLUMN BUILDING BY USING ETABS

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Abstract: An extensive study has been carried out on the behavior of composite column in a structure. In composite column construction steel and concrete are united in such a manner that the advantages of the materials are employed in a efficient manner. By bonding and friction between steel and composite material these materials will accept the external loading in composite columns. In this study comparison of composite and conventional structure is carried out. Just varying the design of column i.e., by using composite and conventional column and keeping all other structural members same for both the structures. Composite column design is carried out according to Euro code 4 and conventional column design is by IS 456-2000. The buildings are taken to be true to be placed in III seismic zone. Seismic design is followed by IS 1893-2002. There are many different types of composite column from those we have taken concrete encased composite column for our analysis. Concrete encasement would increase the load resistance of steel column. During seismic activity the response of structure is also influenced by the material property which depends on the materials and also its configuration in the structural system. The base of the structure is assumed to be fixed. The building height is 36.8m which comes under low rise building. Modeling and analysis has been carried in ETABS software. The results are obtained of various parameters such as base shear, storey overturning, storey drift etc.., thus by obtaining those results graphs have been plotted. And comparison of two different type of structure has been done. Thus, we found that low rise Conventional building is more suitable than low rise composite building.

Key Words: Composite columns, Seismic behavior, ETABS Software, roof displacement, Storey drift, overturning moment etc.

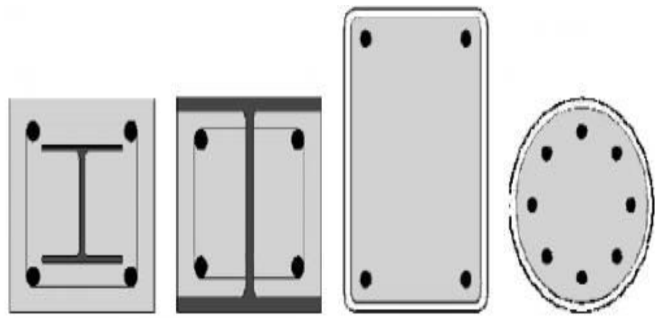
INTRODUCTION

Structural engineers do not traditionally consider fire as a load on the structural frame. This is in contrast to other loads they must consider. Seismic design relies on modeling, risk analysis and changes to the structural stiffness. Wind design relies on additional structural members and wind tunnel tests. Fire design relies on very simple, single element tests and adding insulating material to the frame. Thermal induced forces are generally not calculated or designed.Natural disasters are inevitable and it is not possible to get full control over them. The history of human civilization reveals that man has been combating with natural disasters from its origin but natural disasters like floods, cyclones, earthquakes, volcanic eruptions have various times not only disturbed the normal life pattern but also caused huge losses to life and property and interrupted the process of development. With the technological advancement, man tried to combat with these natural disasters through various ways like developing early warning systems for disasters, adopting new prevention measures, proper relief and rescue measures. But unfortunately it is not true for all natural disasters. Earthquakes are one in all such disasters that's connected with in progress tectonic process; it suddenly comes for seconds and causes nice loss of life and property. So earthquake disaster prevention and reduction strategy is a global concern today. Hazard maps indicating seismic zones in seismic code are revised from time to time which leads to additional base shear demand on existing buildings.

The design is created by using ETABS software. The constructing subjected to every the vertical hundreds additionally as horizontal masses. The vertical load consists of lifeless load of structural elements equivalent to beams, columns, slabs etc and are living loads. The horizontal load includes the wind forces so building is intended for lifeless load, reside load and wind load as per IS 875. The constructing is meant as two dimensional vertical body and analyzed as per IS 456-2000. The help is taken via program furnished in institute and for this reason the computations of hundreds, moments and shear forces and received from this program.

COMPOSITE COLUMNS

Composite columns may take a range of forms, as shown in the figure below. As with all composite elements they are attractive because they play to the relative strengths of both steel and concrete. This can result in a high resistance for a relatively small cross sectional area, thereby maximising useable floor space. They also exhibit particularly good performance in fire conditions.



Typical composite column cross sections

Design rules for composite columns in structural frames are given in BS EN 1994-1-1. This is the first time that guidance has been given in a code for use in the UK, which may explain why composite columns have been rarely used to date. Rules are provided for composite H sections, either fully or 'partially encased' (web infill only), and for concrete filled hollow sections. Typical cross sections are shown. Composite columns requiring formwork during execution tend not to be viewed as cost-effective in the UK.

Concrete filled hollow section compression members need no formwork and they use material more efficiently than an equivalent H section. Concrete infill adds significantly to the compression resistance of the bare steel section by sharing the load

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and preventing the steel from buckling locally. The gain in fire resistance may be at least as valuable, especially if it permits the column to be left unprotected or only lightly protected. Infill concrete retains free water which in other situations would be lost; its latent heat of evaporation significantly delays temperature rise.A programme, Fire Soft, for the design of concrete filled hollow sections in ambient and fire conditions has been developed.

The buildings in India are constructed with RCC and the adoption of steel structures is generally confined to industrial buildings and of late multi-storey buildings, which have acquired prominence by adopting composite structural elements. However, in recent times, the composite columns are gaining popularity for use in multi-storey buildings by virtue of their excellent static and earthquake resistant properties such as lower mass, high strength, rigidity and stiffness, significantly high toughness and ductility, large energy dissipation capacity. Besides these advantages, easy site erection and installation capability can lead to reduction in labour and foundation costs compared to RCC columns and have excellent buckling resistance, reduced maintenance and fireproofing cost compared to steel columns. Also, the composite systems are lighter in weight (about 20 to 40% lighter than concrete construction). Thus, the composite system is a more complete structural system than simple reinforced concrete or steel elements. When adopting a composite section, the amount of structural steel, reinforcing steel and concrete area, and the geometry as well as the position of the three materials represent relevant design parameters. Indeed, a number of different combinations are possible thus leading to a flexible design. Due to these reasons composite members are gaining importance for the making of sky-scrapers, infrastructure growth and especially for high rise structures of seismic regions in the world. A steel-concrete composite column is a compression member, comprising either a concrete encased hot-rolled steel section or a concrete filled tubular section of hot-rolled steel and is generally used as a load-bearing member in a composite framed structure. The load carrying capacity of composite columns is more than that of the bare reinforced column and the structural steel column included in the system.

Uses for Composite Columns

- Extra capacity in concrete column for no increase in dimension
- Large unbraced lengths in tall open spaces – Lower story in high rise buildings – Airport terminals, convention centers
- Corrosion, fireproof protection in steel buildings
- Composite frame – high rise construction
- Transition column between steel, concrete systems
- Toughness, redundancy as for blast, impact

Aspects for using composite structures:

- Architectural
- Economical

- Functionality
- Service and Flexibility
- Assembly

Service and building flexibility

Adaptable structures

- Modification during the life of the building
- Modify services without violating the privacy of other occupants
- Accommodation of service facilities

1. in the ceiling
2. within a false floor
3. in a coffer box running along the walls

INTRODUCTION TO ETABS

ETABS is a sophisticated, yet easy to use, special purpose analysis and design program developed specifically for building systems. ETABS features an intuitive and powerful graphical interface coupled with unmatched modeling, analytical, and design procedures, all integrated using a common database. Although quick and easy for simple structures, ETABS can also handle the largest and most complex building models, including a wide range of geometrical nonlinear behaviors, making it the tool of choice for structural engineers in the building industry (Computers and structures Inc. 2003)

OBJECTIVE OF THE PROJECT:

1. To study irregularities in structures analyze and design of G+20 storied structure as per code (IS1893:2002) provision by using different cross sections of the columns (rectangular, circular, I sections)
2. To analyze the buildings in Etabs and Staad pro V8i SS6 softwares to carry out the storey deflection, storey drift, storey shear force and base shear of structures using response spectrum analysis and compare the results
3. Time history analysis subjected to intermediate frequency ground motion for the response of regular buildings and compare with response spectrum analysis
4. Ductility-based earthquake-resistant design as per IS 13920

LITERATURE REVIEW

Mahesh N et al. : This paper provides complete guide line for manual as well s software analysis of seismic coefficient method. The effective design and the construction of earthquake resistant structures have much greater importance in all over the world. In this paper, the earthquake response of symmetric multistoried building is studied by manual calculation and with the help of ETABS 9.7.1 software. The method includes seismic coefficient method as recommended by IS 1893:2002. The responses obtained by manual analysis as well as by soft computing are compared.

M. Jeevanathan, et al.: The present day scenario witnesses a series of natural calamities like earthquakes, tsunamis, floods etc. Of these the most damaging and recurrent phenomena is the earthquake. The Effective design and the construction of Earthquake resistant structure have gained greater importance all over the world. In this paper the earthquake resistance of a G+20 multi-storey building is analyzed using

Equivalent static method with the help of E-TABS 9.7.4 software. The method includes seismic coefficient method as recommended by IS 1893:2002. The parameters studied were displacement, storey drift and storey shears.There is increase in displacement value from bottom floor to top floor. In this type of model wind displacement is within the limits the and earthquake displacement are beyond the permissible limits of the building (h/500 = 135mm). Drift is within the limits for the building (0.004 times of the height of the storey) 0.004x3.2 = 12.8mm. Earthquake Base shear is greater than Wind Base shear. Complete guideline for the use of E-TABS 9.7.4 for seismic coefficient analysis is made available by this paper.

METHODS OF ANALYSIS OF THE STRUCTURE:

The seismic analysis should be carried out for the buildings that have lack of resistance to earthquake forces. Seismic analysis will consider dynamic effects hence the exact analysis sometimes become complex. However for simple regular structures equivalent linear static analysis is sufficient one. This type of analysis will be carried out for regular and low rise buildings and this method will give good results for this type of buildings. Dynamic analysis will be carried out for the building as specified by code IS 1893-2002 (part1). Dynamic analysis will be carried out either by Response spectrum method or site specific Time history method. Following methods are adopted to carry out the analysis procedure.

Non linear dynamic analysis:

Nonlinear dynamic analysis utilizes the combination of ground motion records with a detailed structural model, therefore is capable of producing results with relatively low uncertainty. In nonlinear dynamic analyses, the detailed structural model subjected to a ground-motion record produces estimates of component deformations for each degree of freedom in the model and the modal responses are combined using schemes such as the square-root-sum-of-squares.

In non-linear dynamic analysis, the non-linear properties of the structure are considered as part of a time domain analysis. This approach is the most rigorous, and is required by some building codes for buildings of unusual configuration or of special importance. However, the calculated response can be very sensitive to the characteristics of the individual ground motion used as seismic input; therefore, several analyses are required using different ground motion records to achieve a reliable estimation of the probabilistic distribution of structural response. Since the properties of the seismic response depend on the intensity, or severity, of the seismic shaking, a comprehensive assessment calls for numerous nonlinear dynamic analyses at various levels of intensity to represent different possible earthquake scenarios. This has led to the emergence of methods like the Incremental Dynamic Analysis.

Loading on tall buildings is different from low-rise buildings in many ways such as large accumulation of gravity loads on the

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floors from top to bottom, increased significance of wind loading and greater importance of dynamic effects. Thus, multi-storied structures need correct assessment of loads for safe and economical design. Except dead loads, the assessment of loads cannot be done accurately. Live loads can be anticipated approximately from a combination of experience and the previous field observations. Wind and earthquake loads are random in nature and it is difficult to predict them. They are estimated based on a probabilistic approach. The following discussion describes some of the most common kinds of loads on multi-storied structures.

COMPOSITE COLUMN BUILDING MODEL

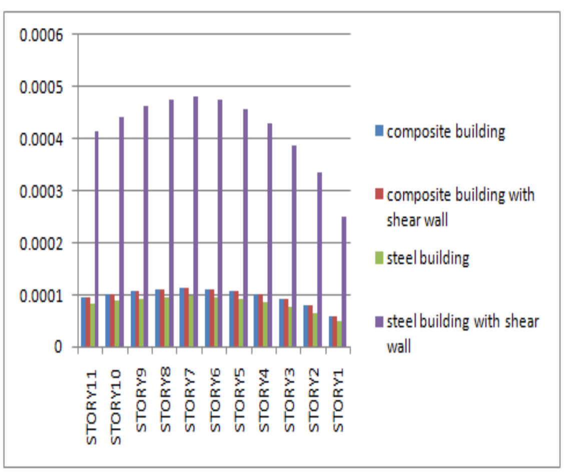
STEEL BUILDING COLUMN

RESULTS AND ANALYSIS

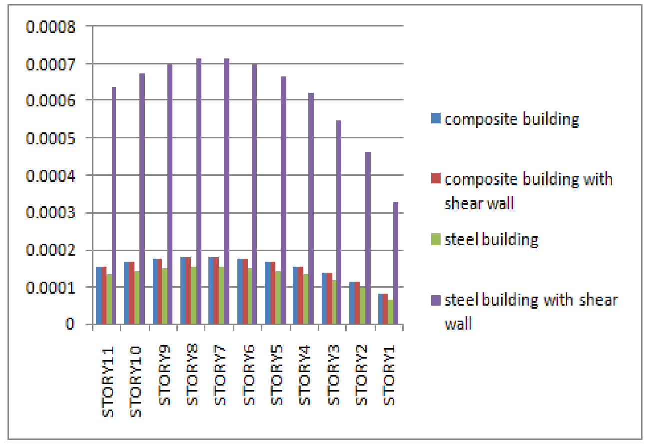
Comparison of the steel building, composite building and with shear wall in steel building:

1. storey drift

A. Drift in X direction

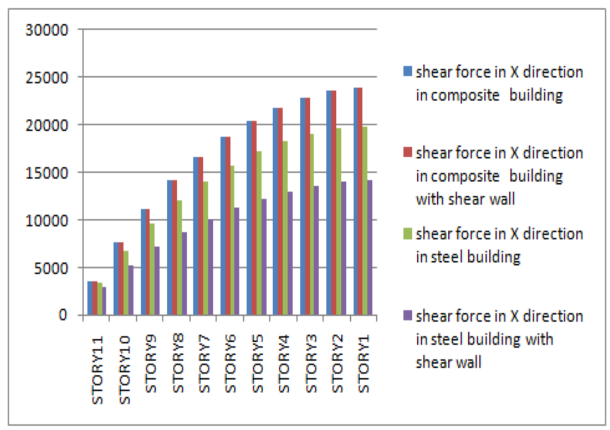


B. Storey drift in Y direction

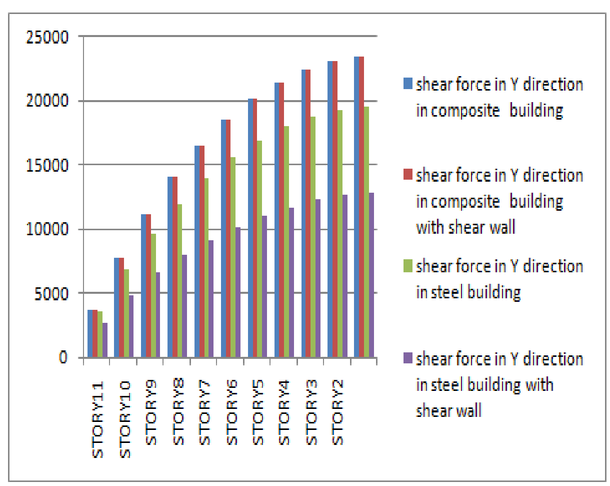


2. shear force

A. shear force in x direction



B. Shear force in Y direction



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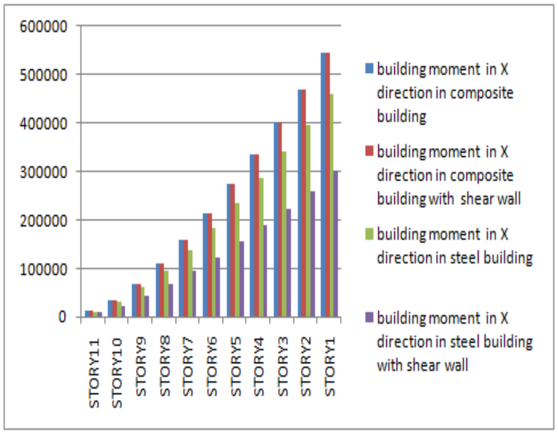
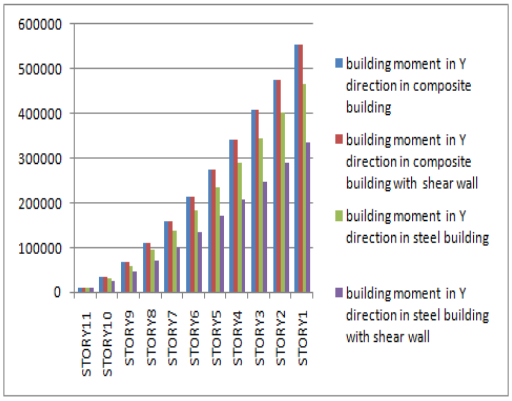
4. Storey moment in X direction



5. storey moment in Y direction



CONCLUSIONS

The following are the conclusions were made

1. The values of story Drift in X and Y directions are increases from story 11 to the bottom story in both buildings (Steel Building and Composite column Building). And the maximum values are obtained from composite column buildings.
2. The values of shear force and bending moment and building twist are increases for 11th to bottom story. For the composite column building has less SF and BM values than the Steel buildings due to presence of steel section in the column.
3. The maximum values of support Reactions are obtained for steel Building than composite column buildings. And the optimum value is obtained for SPEC case.
4. The beam forces are maximum for building twist and are approximately equal values for both buildings (Steel Building and Composite column Building).
5. For the above points the Composite column building has less values of SF, BM, Twist, Story Drift and other factors than the steel building.
6. Storey drift in Analysis in X-direction is more for Steel frame as compared to Composite and RCC frames.
7. RCC frame has the lowest values of storey drift because of its high stiffness.
8. The differences in storey drift for different stories along X and Y direction are owing to orientation of column sections. Moment of inertia of column sections are different in both directions.
9. Base Shear for RCC frame is maximum because the weight of the RCC frame is more than the steel and the composite frame. Base shear gets reduced by 40% for Composite frame and 45% for Steel frame in comparison to the RCC frame.

10. Reduction in cost of Composite frame is 33% and Steel frame is 27% compared with cost of RCC frame. This involves material cost only and doesn’t include fabrication cost, transportation cost, labour cost etc.

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