Parametric Study of Multistorey Tall Building Using Composite Member and Conventional Member

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Abstract:— *In ancient times structures were made of wood and after that masonry structures come into action. But recently there are so many jaw dropping revolutionary structures which have made the world really many steps ahead than it really was on. Now a days RCC structures and steel structures are generally constructed but a new form of structures known as composite structures also come into considerations. It is very difficult to know that in case of a low rise buildings as well as high rise buildings which type of structure will be more economical and also provides considerable strength. Generally high rise buildings are preferred to be constructed as a steel structure and low rise as R.C.C. structures but composite structures would also make structure more economical and strong. With the latest requirements in the market, it has become a necessity of time in India to reduce the construction time by adopting fast track construction methodologies as well as allowing parallel construction activities. The saving in construction time yields two fold benefits like reduction in investment in the form of interest and early return of the capital invested. Steel-concrete composite construction being a faster technology saves lot of time of construction and hence adoption of such methodology will help the planner to narrow the gap between demand and supply. In this paper the review on multi storey building of R.C.C. and composite structure are analysed and the performance and the various characteristics such as storey drift, joint displacement, base reaction, time period are going to be compared. By the analysis which structure gives the optimum result under the worst condition are obtained and the structural stability is determined from this work.*

Keywords — *Composite Member, R.C.C. Structure, Steel Structure, Building, Displacement, Base Reaction, Storey Drift*

I. INTRODUCTION

A composite member is defined as consisting of a rolled or a built-up structural steel shape that is either filled with concrete, encased by reinforced concrete or structurally connected to a reinforced concrete slab. Composite members are constructed such that the structural steel shape and the concrete act together to resist axial compression and or bending. Smaller structural steel sections are required compared to non-composite construction, therefore reduction in overall weight of the composite structure compared to the RCC construction results in less structural and foundation cost. Faster construction by utilizing rolled and/or pre-fabricated components[1]. Use of reinforced concrete in case of high rise building is not suitable because of the increased dead load; span restrictions, cost of construction and even the time required is more. To overcome this, structural engineers nowadays are using different materials for construction of high rise building. Steel is being used as an alternative construction material especially when we are dealing with the earthquake and wind forces[3].In composite construction the various members such as composite beam, composite column, shear connector and composite slab sections are used in practice and the concrete fill steel tube sections are used as a composite column member have high tensile strength, ductility, compressive strength and stiffness.

II. PROBLEM STATEMENT

Grid system (G+10), (G+20), (G+30) storey residential building along with terrace in three different type i.e of RCC structure, Steel structure and Composite structure were analysed by ETABS 2015 software.

Table 1:-Building design data

Plan dimension	24 m x16 m
No of bay in X direction	6
No of bay in Y direction	4
Spacing in X direction	4 m
Spacing in Y direction	4 m
Floor height	3.5 m
Height of parapet	1 m
Live load	3 kN/m^2
Floor finish	1 kN/m^2
Terrace water proofing	1 kN/m^2
Live load on terrace	0.75 kN/m^2
External wall	230 mm
Internal wall	115 mm

Slab	150 mm
Importance factor	1
Response reduction factor	5
Nature of Soil	Medium soil
Type of soil	2
Zone factor	0.16
Concrete grade	M30
Steel grade	Fe 415

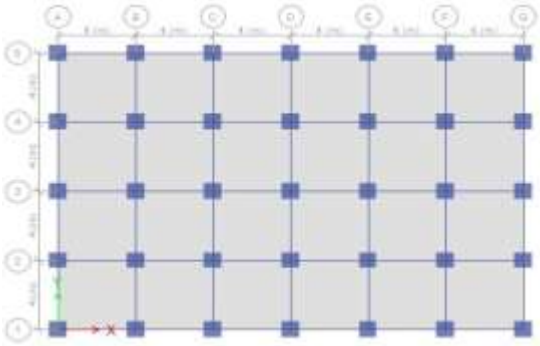

Figure 1 Grid details

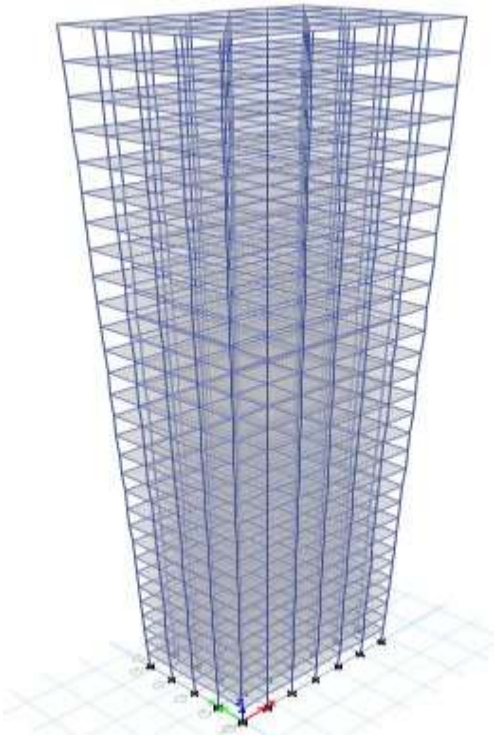

Figure 2:-3D View of 30 storey building

STRUCTURAL DETAILS

In the RCC residential model:

- Column size: 900 mm x 900 mm.
- Beam size: 450 mm x 600 mm.
- Slab size: 150 mm

In the Steel residential model:

- Column: ISWB 600-2.
- Beam: ISMB 400.
- Slab size: 150 mm.

In the Composite residential model:

- Column: Steel section ISWB600-2 encased with RCC section 900 mm x 900 mm.
- Beam size: Steel section ISMB 40 encased with RCC section 450 mm x 600 mm.
- Slab size: 150 mm.

III. RESULTS AND DISCUSSION

BASE REACTION

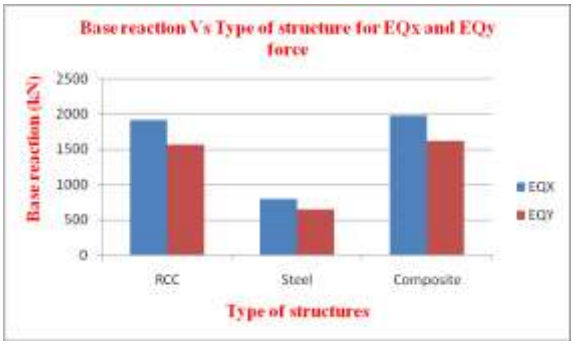

Chart 1:-Graph of base reaction for 10 storey building

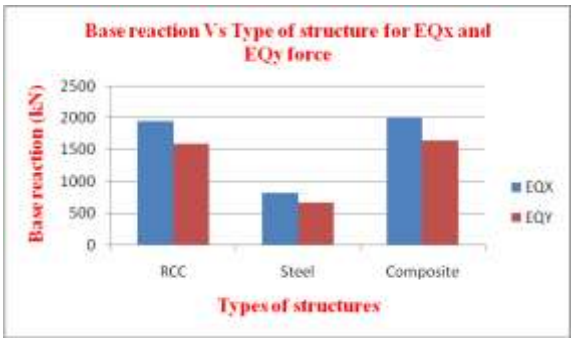

Chart 2:-Graph of base reaction for 20 storey building

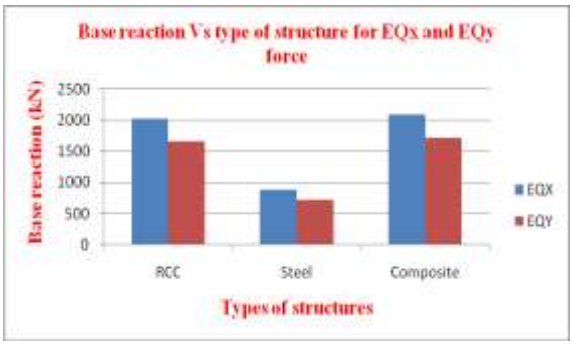

Chart 3:-Graph of base reaction for 30 storey building

As the result shows that the composite structure gives the more base reaction as compare the steel building model. The value of base shear for composite structure is near about same as the RCC model and the increment is around 35-40% for steel building model.

STOREY DRIFT

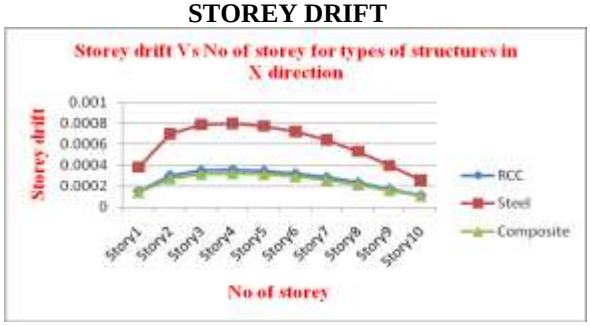

Chart 4:-Graph of storey drift of 10 storey building for EQx force

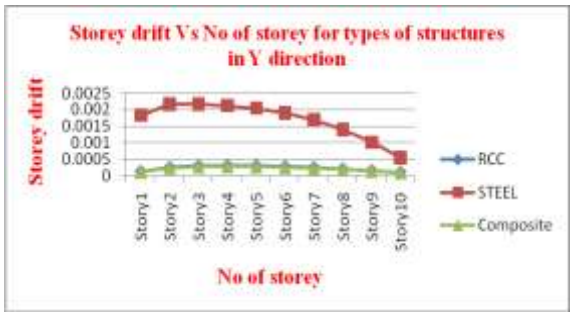

Chart 5:-Graph of storey drift of 10 storey building for EQy force

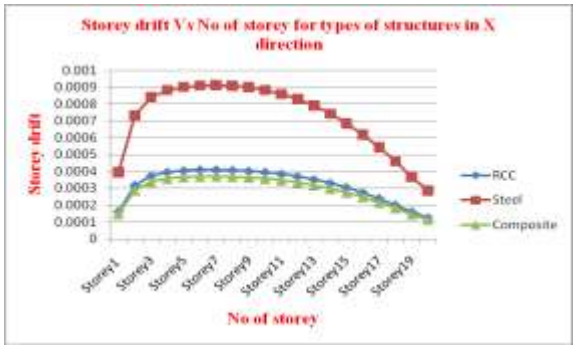

Chart 6:-Graph of storey drift of 20 storey building for EQx force

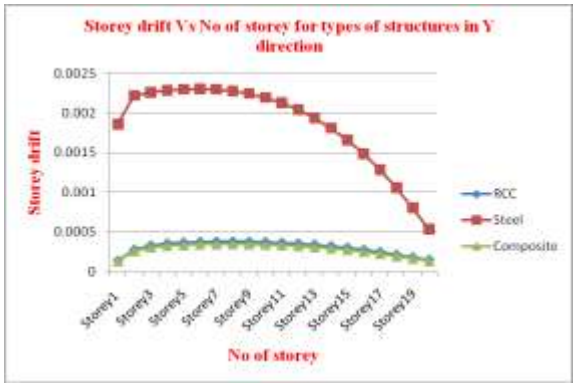

Chart 7:-Graph of storey drift of 20 storey building for EQy force

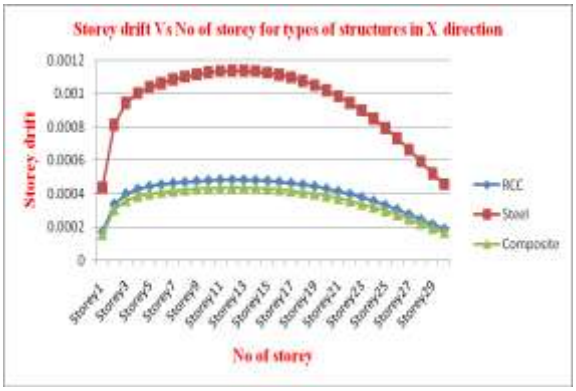

Chart 8:-Graph of storey drift of 30 storey building for EQx force

Chart 9:-Graph of storey drift of 30 storey building for EQy force

Here from the chart it shows that the storey drift are highest in case of steel, which is well within permissible limit of (0.004) times the height of the storey(as per IS 1893:2002) up to 20 storey building but above that the limit exceeds so the usage of composite practice is taken into consideration. The drift of the composite structure is reduction up to (45-50) % compare to steel structure and (15-20) % for RCC structure.

It is observed that storey drift in Equivalent Static Analysis in X-direction is more for Steel structure as compared to Composite and RCC structures. Composite structure has the lowest values of storey drift because of its high stiffness.

The differences in storey drift for different storey along X and Y direction are owing to orientation of column sections. Moment of inertia of column sections are different in both directions.

STOREY DISPLACEMENT

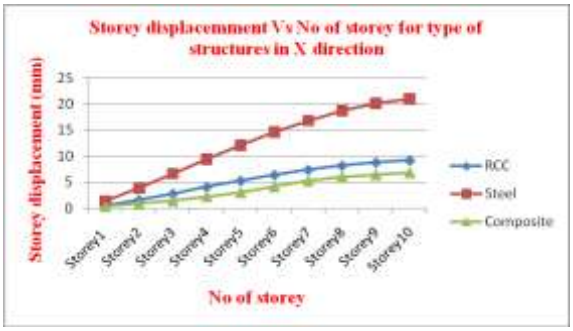

Chart 10:-Graph of storey displacement in X direction for 10 storey building

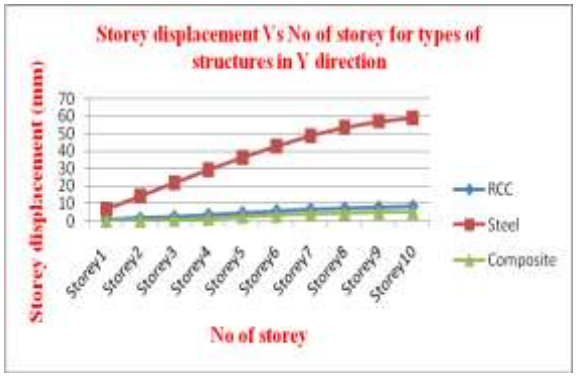

Chart 11:-Graph of storey displacement in Y direction for 10 storey building

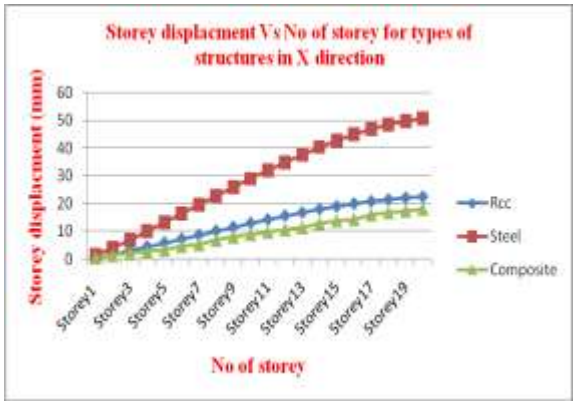

Chart 12:-Graph of storey displacement in X direction for 20 storey building

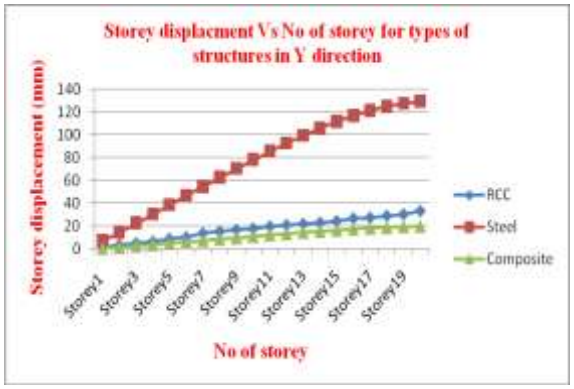

Chart 13:-Graph of storey displacement in Y direction for 20 storey building

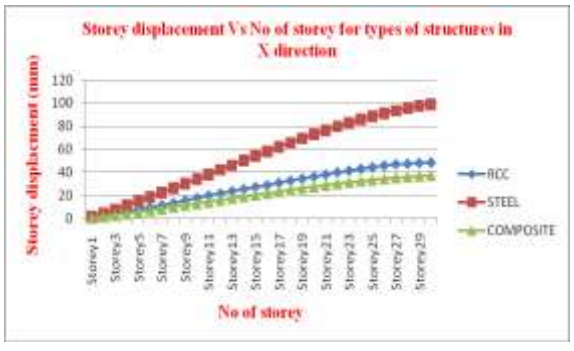

Chart 14:-Graph of storey displacement in X direction for 30 storey building

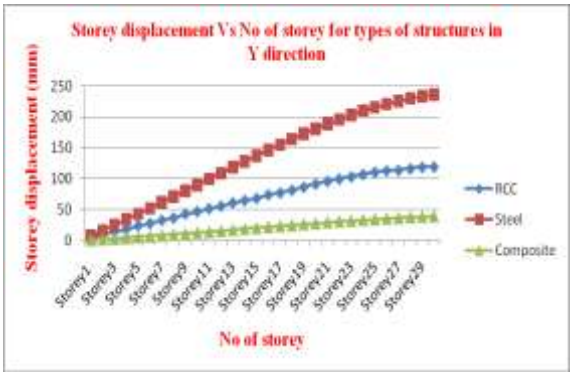

Chart 15:-Graph of storey displacement in Y direction for 30 storey building

It is observed that storey displacement in Equivalent Static Analysis is lowest in composite structure compare to the RCC and Steel structure. From the limit of the IS code 1893-2002 the value of the storey displacement should not be exceed than the ratio of total height of the building to the 500. The results were obtained within permissible limit.

As well as the displacement of the composite structure is in reduction of (16-18) % average from RCC structure and (45-50) % average for steel structure. The reason for more reduction in steel structure is because ability to resist load is very less compare to the RCC and Steel structure.

TIME PERIOD

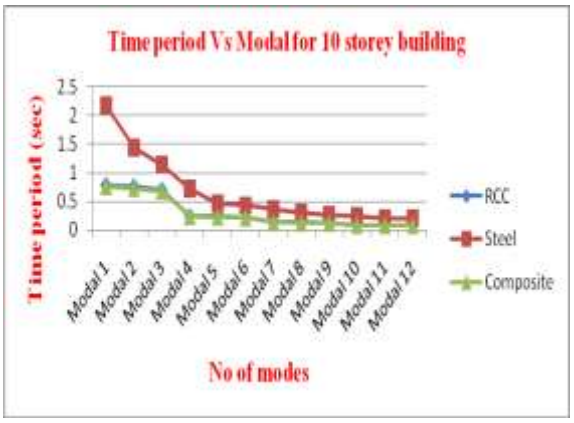

Chart 16:-Graph of time period for 10 storey building

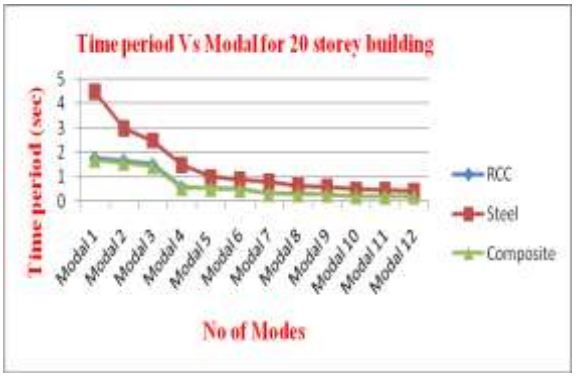

Chart 17:-Graph of time period for 20 storey building

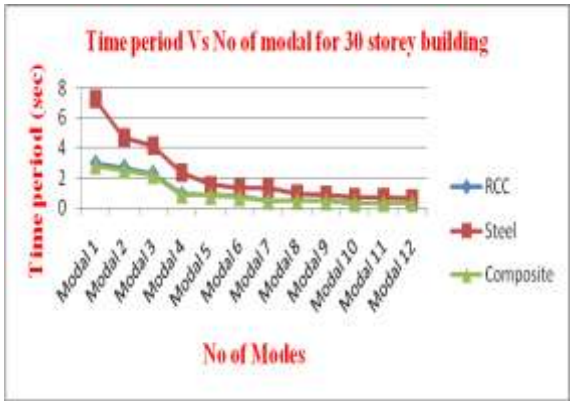

Chart 18:-Graph of time period for 30 storey building

From the above results it is said that composite structure is having less time period value compare to the steel building. The RCC structure is having nearer value than Composite structure.

IV. CONCLUSIONS

1. Base shear in X and Y directions along with all the base reactions are approximately similar for both composite and RCC structures, but lesser in case of steel structures.
2. Composite structure is having least storey drifts in both X and Y directions as compared to RCC and steel structures. RCC structure is having those parameters less in X direction and Y direction as compared to steel structure.
3. If we are considering all the loads, then storey displacement is least in the composite structure in all X and Y directions as compared to RCC and steel structures. Whereas RCC structure is having less joint displacement in X direction and more joint displacement in Y direction than steel structure.
4. For the time period consideration the composite structure gives the less results compare to RCC and steel structure.
5. The storey stiffness is more in composite structure compare to RCC structure. It shows that composite structure is not safe for low rise building due to higher stiffness and steel structure is not safe because of its higher deformation. The RCC structure is designed in such a way that they can give better performance in case of weaker planes.
6. As well as for the tall building the RCC structure is not stable at that time the composite construction is used in practice.

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