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A RESEARCH PAPER ON - "STUDY ON COST ANALYSIS OF R.C.C AND COMPOSITE STRUCTURE"

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ABSTRACT:
Structural engineers are facing the challenge of striving for most efficient and economical design solutions while ensuring final design of a building to be serviceable for its intended function, habitable for its occupants and safe over its design life-time. As our country is the fastest growing country across the globe and need of shelter with higher land cost in major cities where further horizontal expansion is not much possible due to space shortage, we are left with the solution of vertical expansion.
Steel-concrete composite construction has gained wide acceptance worldwide as an alternative to pure steel and pure concrete construction. Reinforced concrete members are used in the framing system for most of the buildings since this is the most convenient and economic system for low-rise buildings. However, for medium to high-rise buildings this type of structure is no longer economical because of increased dead load, less stiffness, span restriction and hazardous formwork. Steel-concrete composite frame system can provide an effective and economic solution to most of these problems in medium to high rise buildings. An attempt has been made in this study to explore cost effectiveness of composite construction. Steel-concrete composite construction with castellated steel beams for large span member is economical in construction, which also saves lot of time and money in construction, which will help the planners to meet the demand with minimum time. This technology provides more carpet area than any other type of construction Composite construction also enhances life expectancy of structures. Hence, the aim of present study is to ultimately compare cost of R.C.C. structures, Composite structure with solid sections and composite structure with openings. All frames are designed under same gravity loading. Equivalent static method of analysis is used for Seismic force analysis. Etabs software is used and the results are compared Cost effectiveness based on material cost for all types of buildings models is determined.

INTRODUCTION
In India, most of the building structures fall under the category of low-rise buildings. So, for these structures reinforced concrete members are used widely because the construction becomes quite convenient and economical in nature. However, as the population in cities is growing exponentially and the land is limited, there is a need of vertical growth of buildings in these cities. Therefore, for the fulfilment of this purpose a large number of medium to high-rise buildings are coming up these days. For these high-rise buildings, it has been found out that use of composite members in construction is more effective and economic than using reinforced concrete members. The popularity of steel-concrete composite construction is more due to its advantage over the conventional reinforced concrete construction. Reinforced concrete frames are used in low-rise buildings because loading is nominal. But

in medium and high rise buildings, the conventional reinforced concrete construction cannot be adopted as there is increased dead load along with span restrictions, less stiffness and formwork which is quite Vulnerable to hazard.

Structural engineers are facing the challenge of striving for the most efficient and economical design solution while ensuring that the final design of a building must be serviceable for its intended function, habitable for its occupants and safe over its design lifetime. As our country is one of the fastest growing country across the globe and need of shelter with higher land cost in major cities where further horizontal expansion is not much possible due to space shortage, we are left with the solution of vertical expansion.

Steel-concrete composite construction has gained wide acceptance worldwide as an alternative to pure steel and pure concrete construction. However, this system is a relatively new concept for the construction industry. Reinforced concrete members are used in the framing system for most of the buildings since this is the most convenient and economic system for low- rise buildings. However, for medium to high-rise buildings this type of structure is no longer economic because of increased dead load, less stiffness, span restriction and hazardous formwork. Steel-concrete composite frame system can provide an effective and economic solution to most of these problems in medium to high-rise buildings and for buildings having Longer spans. An attempt has been made in this study to explore the cost effectiveness of composite construction for high-rise buildings and for the long span composite system.

LITRATURE REVIEW

GENERAL INTRODUCTION:

In order to contextualize the current work, related works in literature is discussed. There are many good references that can be used as a starting point for dissertation study. In this chapter the studies concerning to the, economical dimensions and positions of different types of openings in beams is carried out. This literature review gives a comprehensive review of the work carried out by various researchers for utilization of perforated web openings in the beams.

LITERATURE REVIEW :

With the help of computer software comparison of structures i.e. R.C.C, Steel and Composite can be done effectively.

Anish N. Shah and P.S. Pajgade (2013) did a comparative study on G+15 storey office building which is situated in earthquake zone IV & wind speed 39m/s. Equivalent Static Method of Analysis wad used. For modelling of Composite & Reinforced concrete. Structures, staad- pro software is used and the results are compared; and it was found that composite structure are more economical. It was concluded that composite structures behave well than Reinforced concrete structures from structural parameters point.

Anamika Tedia1 and Dr. Savita Maru (2014) Steel-concrete composite construction means steel section encased in concrete for columns & the concrete slab or profiled deck slab is connected to the steel beam with the help of mechanical shear connectors so that they act as a single unit. Steel concrete composite with R.C.C. options are considered for comparative study of G+5 storey office building with 3.658 m height, which is situated in earthquake zone III (indore)& wind speed 50 m/s. The overall plan dimension of the building is 56.3 m x 31.94 equivalent Static Method of Analysis is used. For modeling of Composite & R.C.C. structures, staad-pro software is used and the results are compared; and it is found that composite structure is more economical.

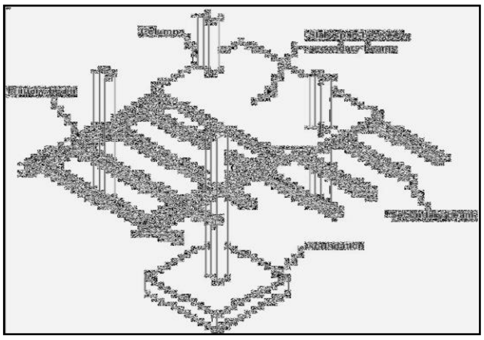
Mahesh Suresh Kumawat and L G Kalurkar (2014) Steel concrete composite construction means the concrete slab is connected to the steel beam with the help of shear connectors, so that they act as a single unit. In the present work steel concrete composite with RCC options are considered for comparative study of G+9 storey commercial building which is situated in earthquake zone-III and for earthquake loading, the provisions of IS: 1893 (Part1)-2002 is considered. A three dimensional modeling and analysis of the structure are carried out with the help of SAP 2000 software.

THEROTICAL FORMULATION

The land available for buildings to accommodate the migration from rural to urban area is becoming scarce, resulting in rapid increase in the cost of land. Thus, developers have looked to the sky to make their profits. The result is multi-storied buildings, as they provide a large floor area in a relatively small area of land in urban centres. Thus to overcome this problem of scarcity of land composite construction proves to be a lot helpful, as time required for construction of multi-storeyed commercial or residential buildings is less compared to that of R.C structures. Figure 3.1 shows a typical composite structure and figure 3.2 shows different components of composite structure.

Typical composite structure

Components of Composite Structure



The dissertation aims at finding the optimum structure. In proposed work, Static and Dynamic analysis of Multi-storeyed R.C.C. and Composite Buildings with and without openings has been analysed using ETABS software. Analysis of Multi-storeyed Buildings has been performed and comparison of parameters viz. shear force, bending moments, deflection, axial forces etc. is done. An approximate study of cost comparison has also been done based on material cost.

METHODS OF ELASTIC ANALYSIS

Seismic Engineering is a sub discipline of the broader category of Structural engineering.
Its main objectives are

- To understand interaction of structures with the shaky ground.
- To foresee the consequences of possible earthquakes.
- To design, construct and maintain structures to perform at earthquake exposure up to the expectations and in compliance with building codes.

Structural analysis methods can be divided into the following categories

- Equivalent Static Analysis
- Response Spectrum method

- Time history method
- Linear Dynamic Analysis

TYPES OF LOADS

- Different types of loads as shown in below
- All loads listed below, shall be considered in design of structure.

DL: Dead Load
LL: Live Load
EQ: Earthquake load
EQx: Earthquake load in X-direction.
EQy: Earthquake load in Y-direction.
Buildings, structures, foundations and all structural components are designed for the following load combination and checked for most critical combinations.

SUMMARY

This chapter focuses on a concept of all seismic parameters required during dynamic analysis and are explained in detail. An analysis procedure of seismic coefficient method and response spectrum method are discussed in detail.

Detail Features of Building

Sr. No.	Parameters	Values
1	Material used	Concrete-M25 Reinforcement Fe-415 Structural steel 250-Mpa
2	Plan Dimension	(3.5mx5m) (3.5mx7.5m)
3	Height of each Storey	4m
4	Density of concrete	25 kN/m3
5	Poisson Ratio	0.3-concrete 0.2-steel
6	Density of masonry	20 kN/m3
7	Damping	5%-R.C.C. 2%-Steel 2%-Composite
8	Seismic zone	III
9	Importance Factor	1
10	Response Reduction Factor	5
11	Foundation soil	Medium
12	Slab thickness	125mm
13	Wall thickness	230mm
14	Floor Finish	1 kN/m2
15	Live load	3 kN/m2
16	Earthquake load	As per IS 1893-2002

BASE SHEAR (kN) :

It is the total design lateral force at the base of the structure. Variation of Base Shear in X and Y direction has been studied.

Variation of base shear in X-direction and Y-direction for Reinforced concrete structures, composite structures without opening and composite structures with opening are shown in table

Variation of Base Shear (KN) in X-Direction and Y-Direction

Trials	Direction	Zone	R.C.C.	Composite W.O.
Trial 1 (3.6m X 5m)	EQx	III	141.066	88.544
	EQy		119.372	61.938

OBSERVATIONS ON BASE SHEAR

Base shear in X-direction (i.e. EQx) for R.C.C. structure, composite structure without opening and composite structure with opening is more, less and more respectively for trial 1 and trial 3. Whereas base shear in X-direction (i.e. EQx) for R.C.C. structure, composite structure without opening and composite structure with opening for trial 2, trial 4 and trial 5 is reducing respectively.

Base shear in Y-direction (i.e. EQy) for R.C.C. structure, composite structure without opening and composite structure with opening is more, less and more respectively for trial 1 and trial 3. Whereas base shear in Y-direction (i.e. EQy) for R.C.C. structure, composite structure without opening and composite structure with opening for trial 2, trial 4 and trial 5 is reducing respectively.

Similarly, base shear for composite structure without opening has reduced by 36.97% than that of Reinforced concrete structure and base shear for composite structure with opening has reduced by 23.32% than that of Reinforced concrete structure respectively in X direction.

Similarly, base shear for composite structure without opening has reduced by 47.71% than that of Reinforced concrete structure and base shear for composite structure with opening has reduced by 39.68% than that of Reinforced concrete structure respectively in Y direction.

BEAM MOMENTS:

Beam moments have been studied are shown in the following tables and figures. Beam moments have been observed for dead load, live load and earthquake load.

Variation of Beam Moments

Beam Moments (KN-m)		
	Trial 1	
Moment	**R.C.C.**	**Composite W.O.**
support	43.241	26.39
center	72.580	21.563

BEAM SHEAR FORCE: Beam deflections have been studied and are shown in below tables and figures.

Variation of beam deflections (mm)

Deflection (mm)		
Trial no.	**R.C.C.**	**Composite W.O.**
1	1.477	2.901

Observation on beam Shear forces:

Trial 1 (Max. S.F.) : It can be seen from above table and figures that beam shear forces in composite structure without opening have reduced by a good amount of 57.59% compared to that of reinforced concrete structure respectively.

BEAM DEFLECTIONS:

Beam deflections have been studied and are shown in below tables and figures.

Variation of beam deflections (mm)

		Deflection (mm)
Trial no.	**R.C.C.**	**Composite W.O.**
1	1.477	2.901

COLUMN AXIAL FORCES:

Column axial forces have been studied and are shown in below tables and figures. Column axial forces have been observed for dead load and earthquake load as well as for dead load and live load.

The intention of this study is to minimize the cost of short rectangular reinforced concrete column design under combined axial loads plus uniaxial bending and approach the economical column design without prior knowledge of optimization. The total cost of column includes cost of concrete, reinforcement and formwork.

Blast loading and earthquake excitations can be regarded as the most destructive events a building structure can experience during its life time response of the structures to these two types of dynamic loading can be of comparable magnitude.

Variation of column axial forces

	Column forces	
	Trial	
Floor	**R.C.C.**	**Composite W.O.**
G.F.	566.748	399.611
F.F.	377.345	247.042
S.F.	186.949	94.52

COLUMN MOMENTS

Column moments have been studied are shown in table 4.16-4.20 and figure number 4.31-4.35. Column moments have been observed for dead load and earthquake load in x-direction as well as for dead load and live load.

Columns are structural elements used primarily to support compressive loads. All practical columns are members subjected not only to axial load but also to bending moments, about one or both axes of the cross section. The bending action may produce tensile forces over a part of the cross sections, even in such cases; columns are generally refereed to as compression members.

The ties shall be so arranged that every corner and alternate longitudinal bar shall have lateral support provided by the corner of a tie having an included angle of not more than 135°.No bar shall be farther than 6 in. clear on either side from such a laterally supported bar. Where the bars are located around the periphery of a circle, complete circular ties may be used.

Variation of Column Moments

Column B.M.		
Trial		
Floor	**R.C.C.**	**Composite W.O.**
G.F.	12.0166	11.127
F.F.	13.084	12.599
S.F.	18	10.728

COLUMN SHEAR FORCES :

Column S.F. have been studied are shown in table 4.21-4.25 and figure number 4.36-4.40. Column S.F. have been observed for dead load and earthquake load in x-direction as well as for dead load and live load.

It permits the shear strength Vc of a beam without shear reinforcement to be taken as the product of an index limit stress of 2√fc’ times a nominal area bwd. With fc’ expressed in lb/in2 units and beam dimensions in inches, nominal shear strength Vc = 2√fc’bwd in units of lb. Shear reinforcement is not required for slabs, which can be considered as very wide beams. If the width of a beam is more than twice the thickness h of the beam, ACI 318-05, Section 11.5.6.1(c) exempts such beams from the requirement of shear reinforcement as long as the shear capacity of the concrete is greater than the required shear force

The most common form of shear reinforcement is composed of a set of bars bent into U-shaped stirrups as indicated by the vertical bars in Fig. 2.2. The stirrups act as tension hangers with concrete performing as compression struts.

Variation of Column S.F.

Column S.F. (kN)		
Trial		
Floor	**R.C.C.**	**Composite W.O.**
G.F.	5.861	5.226
F.F.	5.727	6.009
S.F.	9.674	3.946

Variation of cost for R.C.C. Structure

Material	Quantityused	Rate of steel /kg	Rate of concrete /m^3	Total (Rs)
Reinforced steel(kg)	5100	75	-	382500
Concrete(m^3)	52	-	4500	234000
				616500.00

Variation of cost for R.C.C. Structure (Trial)

Material	Quantityused	Rate of steel /kg	Rate of concrete /m^3	Total (Rs)
Reinforced steel(kg)	9233	75	-	692475
Concrete(m^3)	81	-	4500	364500
				1056975.00

Variation of cost for Composite Structure with solid sections (Trial)

Material	Quantityused	Rate of steel /kg	Rate of concrete /m^3	Total (Rs)
Reinforced steel (kg)	12233	75	-	917475
Concrete(m^3)	30	-	4500	135000
				1052475.00

VARIATION IN COST OF R.C.C., COMPOSITE WITH SOLID SECTION FOR ALL TRIALS

Variation in cost of Structures

Trials	**R.C.C.**	**opposite with solidsections**
	(Lakh)	**(Lakhs)**
Trial	6.16	10.52

OBSERVATIONS ON COST :

There is 38.96% of difference in cost of R.C.C. structure and composite structure with solid sections. In this case, R.C.C. structure is more economical than composite structure with solid sections.

FINAL OBSERVATIONS :

- As it can be seen that base shear for composite structure with solid sections has reduced by 36.97% compared to that of Reinforced concrete structure in X-direction.
- As it can be seen that base shear for composite structure with solid sections has reduced by 47.71% compared to that of Reinforced concrete structure in Y-direction.

- Column forces in composite structure with solid sections have reduced compared to that of Reinforced concrete structure.
- Column forces in composite structure with openings have reduced compared to that of Reinforced concrete structure.
- As span goes on increasing beam moments in composite structure with solid sections
- Column moments in composite structure have reduced by on an average of 4.85%, 8.8% and 30.24% for ground floor, first floor and second floor respectively compared to that of Reinforced concrete structure.
- Deflection of all the beams in structures are within permissible limit.

CONCLUSION

- As it can be seen that base shear for composite structure with solid sections has reduced by 36.97 compared to that of Reinforced concrete structure in X-direction.
- As it can be seen that base shear for composite structure
- Column forces in composite structure with solid sections have reduced compared to that of Reinforced concrete structure.
- Column forces in composite structure with openings have reduced with solid sections has reduced by 47.71% compared to that of Reinforced concrete structure in Y- direction. Compared to that of Reinforced concrete structure.
- As span goes on increasing beam moments in composite structure with solid sections have reduced compared to that of Reinforced concrete structure.
- As span goes on increasing beam moments in composite structure with solid sections have reduced compared to that of Reinforced concrete structure.
- Column moments in composite structure have reduced by on an average of 4.85%, 8.8% and 30.24% for ground floor, first floor and second floor respectively compared to that of Reinforced concrete structure.
- Deflection of all the beams in structures are within permissible limit.
- As performance of these structures from structural parameters point is better than reinforced concrete structures, they can be used effectively in areas of high seismic intensity.
- Initial investment of composite structure is more compared to that of reinforced concrete structures but speedy construction makes them economically viable. Thus for the structures with longer span beams, low rise structures composite structures cannot be used but in case of multi-storied structures or high rise buildings or skyscrapers where construction time is also very important.
- In such cases these structures are best suited as shown in below table.

VARIATION IN COSTOF R.C.C., COMPOSITE WITH SOLID SECTION AND COMPOSITE FOR ALL TRIALS

Trials	R.C.C.	Composite with solid sections
	(Lakhs)	(Lakhs)
Trial (3.6x5m)	6.16	10.52

SCOPE FOR FURTHER STUDIES :

- Structural steel of fy-250 is tried; high steel strength can also be tried.
- G+2 building have been tried.
- It can be studied for various zones and parameters.
- Effect of shear walls on the performance of composite structure can be calculated.

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