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Review Paper on Seismic Analysis of RCC and Steel Composite Building

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Abstract

It is a customary in our country to use RCC is used to construct the buildings up to G+3 height building. The low-income groups prefer RCC. But for the high rise and mid height structures the RCC type is not economical as the dead load increases and longer spans are not favourable. The economic and less time consuming design solutions are required. The composite structures can replace RCC structures. The concrete and steel are used in composite structures. The composite structure designs are complex and less efficient that is why not so popular. The developed countries have wider acceptance for the composite structures as compared with pure steel and concrete frames. All the plus points of steel and concrete are incorporated in composite type frame work. The structures take lesser time in construction and much waste is produced on the construction sites. This paper covers the review on the composite construction prevalent globally.

Keywords:reinforced concrete structures, low-rise building, span restriction, complex frame work, composite structure.

Introduction

It is commonly seen in our country to go for the RCC structures for low rise buildings. The factors responsible for this are ease to design and economical to construct RCC framework. But high rise buildings can suffice the need of ever increasing population. The land resources are limited and therefore the expansion can go in vertical direction. The inherent limitations of the RCC structures have inspired the construction industry to adopt more economical and efficient method of the deign namely composite structures. The conventional methods based on the use of virgin steel and concrete need to be replaced by concrete-steel composite structures. The composite type of the framework is light in weight as compared with the RCC Framework. All the good properties of steel and concrete are adopted. Ihe composite structures require lesser time, are fire resistant and can be constructed in lesser time.

Composite Structure

The composite structures are becoming popular every day in transportation bridges and residential buildings. The commonly fastening of I beam with the concrete component like floor slabs results in the composite component. The compressive strength of the concrete and higher tensile strength of the steel are used in tandem. The composite structures can be floor slabs, beams, columns and foundation systems. The commonly available steel I beam are tied to concrete slabs with the help of fasteners like cut channels, studs, anchor nut bolts etc. The steel columns are embedded inside the RCC.

Literature Review

The following research work in the field of the application of the composite structure in the low and high rise building has been surveyed at the global and Indian level. The brief discussion is as under:

Joshua G. Sizemore et al. (2019)[1] The authors in this study have considered a composite structure of varying heights. The novel prototype R ¼ 4 CBF structure has been simulated. It is an effective replacement of RCC and economical too. The incremental DA(Dynamic Analysis) has been used to validate FEMA P695 recommended Frame work.

Mahdieh Miralami et al. (2019)[2]The study is based on the circularcolumn-foundationconnection were glass fibre reinforced plastic (GFRP)and shape memory alloys (SMAs). The lateral displacement and axial loads are applied. The GFRP and CFRP structure results into better connections. The maximum lateral load bearing approaches 131%. SMA-blended connections are able to bear 71% lateral displacement.

Prof. Rajendra R. Bhoir et al.(2018)[3] The work compares the results obtained by applying the same forces on the same structure and the difference is made between the RCC and composite structure. The smaller sections are tested for same loading conditions. The concrete reduces for the same beam sections under same load. The smaller sections of the column size show more strength as compared with RCC.

Claudio Amadio et al. (2017) [4] In this paper, the structural performance of welded steel concrete joints has been investigated. The advanced (FEN) Finite-Element numerical model (ABAQUS) has been used.The composite welded connections and bolted joints have been evaluated on real life models. The WJ(welded Joint) structure show more capacity to dissipate the energy. The Eurocdes are applied and found the compliance with the same.

D. R. Panchal and P. M. Marathe (2017)[5]
In this work the authors show that the composite structures outperform the classical RCC structures. The dead weight reduction is 2% more when steel structure is replaced with the composite structure. The section size reduces by 25% in main beams and 60% in secondary beams when the composite structures are adopted over the steel. The bending moment is increased by 83% in steel and reduced by 10% in CS(composite structures.). There is sharp decline in the bending moments in case of CS as compared with the RCC. Steel and composite structures are more ductile and therefore more safe under horizontal forces.

S. Boke et al.(2017)[6] The composite structure has been designed in this work. The authors are of the opinion that the base shear for composite structure has reduced by 34% and for steel structure by 26% compared to that of Reinforced concrete structure. The displacement is 3% higher in CS than RCC. The storey drift in steel structure is more than that in RCC or CS but within safe limits in all cases. The stress reduction in column is 10% more in CS as compared with SS.

Bhavin H. Zaveri et al.(2016)[7] In this research work low rise building comparisons are studied in which same seismic conditions are applied to all the structures and analysis results have been compared to check the suitability of RCC, steel and composite low rise buildings under seismic conditions. The authors have concluded that the CS are more stiff as compared with RCC or SS(Steel Structures) and therefore seismic resistant.

8 D. Datta et al.(2016)[8] In this paper the author says that for high-rise buildings Steel-Concrete composite construction is cost-effectiveThe author is of the opinion that the cost of the structure depends upon the quality of the structure and the purpose for which it is constructed. It is expected that the steel would be used in optimized way by switching over the composite structure deign.

9 Shovona Khusru et al.(2016)[9] In this paper rubberised concrete (RuC) is currently used mainly for non-structural elements such as crash barriers, floor surfaces, flexible pavements, vibration control applications etc.This paper treated the behaviour of RuCFDST columns under axial loads and evaluated the influence of several important parameters. The results suggest a significant delay in the axial shortening of RuCFDST columns at peak loads and an improvement in ductility compared to conventional CFDST columns without much loss in peak load. RuCFDST columns can hence be considered as high performance structural columns for critical infrastructure applications where ductility is required such as in seismic prone areas.On the basis of FEM models RuCFDST columns with rubberised concrete 15% and 30% respectively along with steel yields more seismic resistant structure.

10 Nileshkumar V. Ganwani et al.(2016)[10]. The paper includes comparative study of seismic performance of a 3D (G+8) Storey RCC and Steel Concrete Composite Building frame situated in earthquake zone IV. Equivalent Static Method and Response Spectrum Method are used for seismic analysis. ETAB 2015 software is used and results are compared. In composite structures, the self-weight of frame is less and therefore results in large reduction in cost of construction of foundation. Under seismic considerations because of the inherent ductility characteristics, steel-concrete structure will perform better than a conventional R.C.C. structure.

Aim of the present study and the Research Methodology

The aim of the present study is to compare performance of a 3D (G+12) story RCC, Steel and composite building frame situated in earthquake zone IV. All frames are designed for same gravity loadings. The ESD (Equivalent Static Design) and RSD (Response Spectrum Design) are used to find the ductility and study seismic behaviour where the Slab is Reinforced Concrete Cement made with three combinations of column-beam only RCC, steel and Steel-concrete composite sections.Staad-Pro 8vi and SAP 2000 software are used and results are compared.

Problem Statement:

Twelve storey (G+12) building frame with three bays in horizontal and three bays in lateral direction is analysed by Equivalent Static Method and Response Spectrum Method.

The geometrical parameters of the building are as follows: Height of each storey = 3.m

Center-to-center span between each column along X and Y direction = 10 m , Fixed type support at the bottom.

The loads on acting the building are as follows: Dead Load:-

1. Self weight of the framed Structure The self weight of the structure consists of floor loads, dead load of all columns, beams, slab loads and the load of the footings. The software calculates all these loads by itself once the sections and dimensions are defined.

2 . Dead load of floors a. Dead floor load = 6 KN/m2 b. Dead load of the roof floor = 5 KN/m2 3. Dead load of walls a. On outer beams = 10 KN/m2 b. On inner beams = 5 KN/m2Live Load a.

Live load on all floors = 4KN/m2 b. Live load on roof floor = 3 KN/m2 Earthquake load in X-direction & Y-direction as specified in IS 1893: 2002. The seismic parameters of the building site are as follows:

Seismic Zone: I V Zone factor 'Z' : 0.36 , Soil type= Hard Soil

3.2 Building Frame System:

Moment resisting RC frame. Response Reduction Factor = 5 Importance factor = 1

Fundamental natural time period, **T= 0.075 $H^{0.75}$** (moment-resisting frame building without brick in the panels).

Methodology . The RC frames are exposed to gravity load and then designed. The RCC, steel and Steel –RCC sections are used as columns and the beams. The Equivalent Static Procedure and Response Spectrum Procedure is applied over the structure to evaluate the seismic demand followed by comparison of the results

Design of beam and column sections

The frame is analyzed with dead and live loads for RCC sections for beams and columns in SAP 2000. The maximum forces in columns and beams are determined. Indian Structural Code and AISC LFRD are applied for three type of sections. The RCC section 300mmx 400 mm are used.

Analysis

Each type of frame is analysed separately by using Equivalent Static Load Method and Response Spectrum Method by using SAP 2000. The analysis is conducted for IS 1893(Part 1), 2002 specified combinations of loadings. The results obtained are compared in terms of base shear, story deflections, story drifts,modal participation factor etc. and cost effectiveness with respect to material quantities are determined.

IV Conclusion

The expected results are storey drift in Equivalent Static Analysis in X-direction is more for Steel frame as compared to Composite and RCC frames. The RCC shows minimum drift. The drift varies because of differences in the orientation of column. Moment of inertia of column sections are different in both directions. Same storey drift patterns are obtained by using Response Spectrum method validating the results obtained by the Equivalent Static method.

The RCC is heavier than Steel and composite sections and thereby higher base shear.

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