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COMPARITIVE SEISMIC ANALYSIS OF COMPOSITE STRUCTURE USING DIFFERENT STEEL SECTION: -A REVEIW

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Abstract:

Steel-Concrete composite constructions are nowadays very popular owing to their advantages over conventional Concrete and Steel constructions. Concrete structures are bulky and impart more seismic weight and less deflection whereas Steel structures instruct more deflections and ductility to the structure, which is beneficial in resisting earthquake forces. Composite Construction combines the better properties of both steel and concrete along with lesser cost, speedy construction, fire protection etc. Hence the aim of the present study is to compare seismic performance of a 3D (G+11) story Composite building structure situated in earthquake zone V. All frames are designed for same gravity loadings. The RCC slab is used in all three cases. Column sections are made of Steel-concrete composite sections. Equivalent static method and Response Spectrum method are used for seismic analysis. MIDAS GEN. software is used and results are compared. Seismic effectiveness based on material properties for all types of building Structure is determined.

Comparative study concludes that the composite frames are best suited among all the three types of constructions in terms of material properties benefit added with better seismic behavior.

Keywords

Composite, RCC slab, gravity loadings, Response Spectrum method and seismic behavior.

1. 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. But since the population in cities is growing exponentially and the land is limited, there is a need of vertical growth of buildings in these cities. So, for the fulfillment 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 in cities can be owed to its advantage over the conventional reinforced concrete construction. Reinforced concretes 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 framework which is quite vulnerable to hazards.

In construction industry in India use of steel is very less as compared to other developing nations like China, Brazil etc. Seeing the development in India, there is a dire need to explore more in the field of construction and devise new improved techniques to use Steel as a construction material wherever it is economical to use it. Steel concrete composite frames use more steel and prove to be an economic approach to solving the problems faced in medium to high rise building structures.

1.1 Composite Structures

When a steel component, like an I-section beam, is attached to a concrete component such that there is a transfer of forces and moments between them, such as a bridge or a floor slab, then a composite member is formed. In such a composite T-beam, as shown in Figure 1, the comparatively high strength of the concrete in compression complements the high strength of the steel in tension. Here it is very important to note that both the materials are used to fullest of their capabilities and give an efficient and economical construction which is an added advantage.

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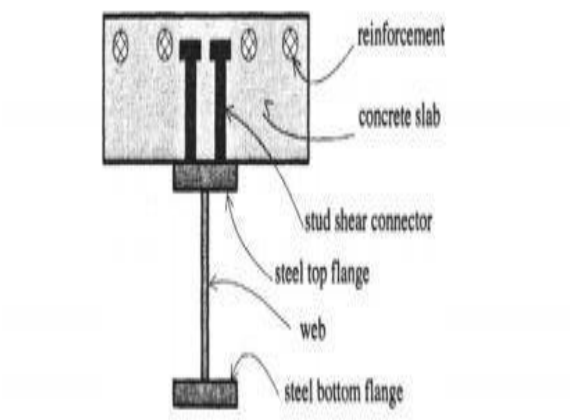

Figure 1 Cross Section of a typical composite member

2. Literature Review

D.R. Panchal&Dr. S.C. Patodi evaluated the seismic performance of multistoried building for which they have considered Steel-Concrete Composite and R.C.C. For their analysis the methods that they used were Equivalent static method and Linear Dynamic Response Spectrum Analysis. The results thus obtained were analyzed and compared with each other.

Jingbo Liu, Yangbing Liu, Heng Liu proposed a performance based fragility analysis based method in which the uncertainty due to variability in ground motion and structures are considered. By the proposed method of fragility analysis, they performed analysis of a 15 storeyed building having composite beam and concrete filled square steel tube column.

G.E. Thermou, A.S. Elnashai, A. Plumier, C. Doneux have discussed clauses and deficiencies of the Eurocode which earlier used to cause problem for the designers. For obtaining the response of the frames, methods of pushover analysis were also employed. Their main purpose was to study and investigate if the designed structure could behave in an elastically dissipative way.

Shashikala. Koppad, Dr. S.V.Itti considered steel-concrete composite with RCC options for analyzing a B+G+15 building which is situated in earthquake zone III and earthquake loading is as per the guidelines of IS1893(part-I): 2002. The parameters like bending moment and maximum shear force were coming more for RCC structure than the composite structure. Their work suggested that composite framed structures have many benefits over the traditional RC structures for high rise buildings.

D.R. Panchal and P.M. Maratheused a comparative method of study for RCC, Composite and steel options in a G+30 story commercial building situated in earthquake Zone IV. For this they used Equivalent static method and used the software ETABS. The comparative study included size, deflections, material consumption of members in RCC and steel sections as compared to composite sections was also studied closely and based on cost comparison of cost analysis.

A.S. Elnashai and A.Y. Elghazouli developed a model for analysis of structures subjected to cyclic and dynamic loads. These structures were primarily Steel-Concrete Composites and the model they developed was a non-linear model. The efficiency and accuracy of the developed model is shown through correlation between the experimental results and analytical simulations. The model was used for parametric studies resulting in providing important conclusion for ductility-based earthquake-resistant design.

Radomir Folic, in his research paper he studied Composite steel/concrete structures are used widely in modern bridge and building construction. The very large amount of theoretical and experimental research, design application and construction work carried out has shown the efficiency and economy solution of composite structure. In this paper presented the current state of the art related to design and analysis, based on quoted references, in steel-concrete composite structures. Furthermore, it comments some provisions of recently adopted Euro codes that are being publish as EN for structures and their applications in composite construction. The focus is on steel beam-concrete slab and their connections and the effects of their interaction. The concrete slab can executed as cast in situ or as precast, reinforced and/or prestressed. Various components (beams, slabs and columns) of a structure and their properties are considered.

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3. Aim of the present study

The aim of the present study is to compare performance of a 3D (G+10) story composite building frame situated in earthquake zone V. All frames are designed for same gravity loadings. The RCC slab is used in all three cases. Beam and column sections are made of Steel-concrete composite sections. Equivalent static method and Response Spectrum method are used for seismic analysis. MIDAS GEN software is used and results are compared. Seismic effectiveness based on quantity of materials properties of all types are determined.

4. Objectives

Following are the objectives of present study.

- To understand the different performance characteristics of composite building.
- To understand the behaviour of the structure under the influence of the different steel section used in composite structure.
- To find out damage condition of structure at performance point in composite building.
- P-delta analysis composite structure.
- Story drift, base shear study of composite building.
- P-delta static analysis of composite building with different shapes considering non linearity of materials.

5. Methodology

Step1:

Design of beam and column sections

The frame is analyzed with dead and live loads for RCC sections for beams and columns in MIDAS GEN.

The maximum forces in columns and beams are determined from output file.

The sections are designed manually for these maximum forces as Composite sections for the three types of frame separately.

The codes IS 456-2000, IS 800-2007 and AISC LRFD 1999 are used for Composite column section design. The steel beam designed for steel frame is provided in composite frame too. The RCC beam section provided is 0.3m x 0.4 m.

Step 2:

Analysis

Each type of frame is analyzed separately by using Equivalent Static Load Method and Response Spectrum Method by using MIDAS GEN.

The analysis is conducted for IS 1893(Part 1), 2002 specified combinations of loadings.

Step 3:

Comparison of results

The results obtained are compared in terms of base shear, story deflections, story drifts, modal participation factor etc. and Seismic effectiveness with respect to material quantities are determined.

6. Analysis

In the present work the two methods of analysis which have been performed are as follows.

- **Equivalent Static Analysis:**

This method is based on the assumption that whole of the seismic mass of the structure vibrates with a single time period. The structure is assumed to be in its fundamental mode of vibration. But this method provides satisfactory results only when the structure is low rise and there is no significant twisting on ground movement. As per the IS 1893: 2002, total design seismic base shear is found by the multiplication of seismic weight of the building and the design horizontal acceleration spectrum value. This force is distributed horizontally in the proportion of mass and it should act at the vertical center of mass of the structure.

- **Response Spectrum Analysis:**

Multiple modes of responses can be taken into account using this method of analysis. Except for very complex or simple structure, this approach is required in many building codes. The structure responds in a way that can be defined as a combination of many special modes. These modes are determined by dynamic analysis. For every mode, a response is perused from the design spectrum, in view of the modal frequency and the modal mass, and they are then combined to give an evaluation of the aggregate response of the structure. In this we need to ascertain the force magnitudes in all directions i.e. X, Y & Z and afterwards see the consequences for the building. Different methods of combination are as follows:

1)Absolute-peak values are added together.
2)Square root of the sum of squares (SRSS).
3)Complete quadratic combination (CQC).

In our present study we have used the SRSS method to combine the modes. The consequence of a response spectrum analysis utilizing the response spectrum from a ground motion is commonly not quite the same as which might be computed from a linear dynamic analysis utilizing the actual earthquake data.

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