COMPARATIVE STUDY OF TIME HISTORY ANALYSIS OF COLD FORMED STEEL FRAME

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ABSTRACT

Cold-formed steel (CFS) framing has been successfully used in a variety of construction applications for many years. Common uses include nonstructural partitions and ceilings, exterior curtain wall and façade support, and complete load-bearing structures, including lateral force-resisting systems (LFRS). Recent advances in the understanding of CFS framing and ongoing research related to the Analysis of seismic force-resisting systems (SFRS) are expected to expand the use of cold-formed steel framing into more complex, robust structural systems. This project focuses specifically on the use of cold-formed steel SFRS in buildings. Standard analysis procedures apply to cold formed steel analysis. However, because CFS shapes often include elements with high width-to-thickness ratios, limit states not common to other construction materials must be considered in the design process. These limit states are discussed in Project. The analysis is carried out using E-TABS software.To analyse and compare the structure the 2 model is formulated of 5 story and 10 story. The model is symmetric in plan having 2×2 grid.The main objective of this study is to examine the behaviour of cold formed steel frame considering different modelling systems. All the above cases are analysed for El Centro earthquake records i.e. Time History Analysis.

Keywords:*Time History Analysis, E-Tabs, Cold Formed Steel(CFS), SFRS*

1. INTRODUCTION

All over world, there is high demand for construction of tall buildings due to increasing urbanization and spiraling population, and earthquakes have the potential for causing the greatest damages to those tall structures. Since earthquake forces are random in nature and unpredictable, the engineering tools need to be sharpened for analyzing structures under the action of these forces. Earthquake loads are required to be carefully modeled so as to assess the real behavior of structure with a clear understanding that damage is expected but it should be regulated. Analyzing the structure for various earthquake intensities and checking for multiple criteria at each level has become an essential exercise for the last couple of decades. Earthquake causes different shaking intensities at different locations and the damage induced in buildings at these locations is also different. Thus, there is necessary to construct a structure which is earthquake resistance at a particular level of intensity of shaking a structure, and not so much the magnitude of an earthquake. Even though same magnitudes of earthquakes are occurring due to its varying intensity, it results into dissimilar damaging effects in different regions. Therefore, it is necessary to study variations in seismic behavior of multistoried cold formed steel framed building for different seismic intensities in terms of various responses such as lateral displacements and base shear. It is necessary to understand the seismic behavior of buildings having similar layout under different intensities of earthquake. For determination of seismic responses, it is necessary to carry out seismic analysis of the structure using different available methods. In contrary to the hot-rolled steel member, cold-formed steel member is made in room temperatures by feeding sheet steel through roll forming machines. Cold-formed steel members can be formed from a wide range of material thickness that enables them to meet the requirements of nearly all structural and non-structural applications. Cold-formed steel is widely used in buildings, automobiles, equipment, home and office furniture, utility poles, storage racks, grain bins, highway products, drainage facilities, and bridges. Its popularity can be attributed to ease of mass production and prefabrication, uniform quality, lightweight designs, economy in transportation and handling, and quick and simple erection or installation. In building construction, cold-formed steel products can be classified into three categories: members, panels, and prefabricated assemblies. Typical cold-formed steel members such as studs, track, purlins, girts and angles are mainly used for carrying loads while panels and decks constitute useful surfaces such as floors, roofs and walls, in addition to resisting in-plane and out-of-plane surface loads. Prefabricated cold-formed steel assemblies include roof trusses, panelized walls or floors, and other prefabricated structural assemblies. Cold-formed steel possesses a significant market share because of its advantages over other construction materials and the industry-wide support provided by various organizations that promote cold-formed steel research and products. Cold-formed steel is widely used in interior and exterior walls systems, floor systems and roof truss systems for low-rise and mid-rise (4-9 stories) structures. Due to its light weight, high strength, non-combustible nature, fast and ease of installation, it has gain popularity in recent years. As a recognized green building material, steel framing projects can also earn credits or points for green building rating programs as well as other government incentives. Cold-formed steel (CFS) framing has been successfully used in a variety of construction applications for many years. Common uses include nonstructural partitions and ceilings, exterior curtain wall and façade support, and complete load-bearing structures, including lateral force-resisting systems (LFRS). Recent advances in the understanding of CFS framing and ongoing research related to the design of seismic force-resisting systems (SFRS) are expected to expand the use of cold-formed steel framing into more complex, robust structural systems.

2. COLD FORMED STEEL

Cold-formed steel products are shaped at ambient temperatures from steel sheet, strip plate or flat bars by roll-forming machines, press brakes or bending brake operations. They can be produced in large quantity and at high speed with consistent quality. A typical automated rolling machine can run at a speed range of 75-400 feet per minute, and the products can be as small as a three-quarter inch wide cold-rolled channel section to as big as a thirty-six-inch-wide roof deck section. Roll Forming Cold-formed steel possesses many advantages over other construction materials:

1. **Lightweight**

Cold-formed steel components weigh approximately 35% to 50% less than their wood counterparts, which means that they are easy to handle during construction and transportation.

2. **High-strength and stiffness**

As a result of the cold-forming process, cold-formed steel possesses one of the highest strength-to-weight ratios of any building material. This high strength and stiffness result in more design options, wider spans and better material usage.

3. **Fast and easy erection and installation**

Building components made of cold-formed steel can be fabricated with high accuracy in a plant and then assembled on job sites, which greatly increases erection efficiency and ensures construction quality.

4. **Dimensionally stable material**

Cold-formed steel does not expand or contract with moisture content. In addition, it does not split or warp as time goes by. Therefore, it is dimensionally stable. Cracked gypsum sheathed walls, nail head popping and other common problems with wood framed structures can be virtually eliminated in buildings with cold-formed steel stud walls.

5. **No formwork needed**

The use of cold-formed steel decks eliminates the formwork for pouring concrete floor. In addition, composite action between the steel deck and concrete increases floor strength and stiffness.

6. **Durable material**

Cold-formed steel is durable because it is resistant to termites and rotting. In addition, galvanized cold-formed steel products provide long-term resistance to corrosion.

7. **Economy in transportation and handling**

Lightweight cold-formed members or panels are easy to handle and transport. In addition, they can be nested and bundled, reducing the required shipping and storage space.

3. ANALYSIS METHODS

Land and seismological disclosures amid the 20th century have helped in starting the improvement of seismic construction regulations and tremor safe structures and structures. The improvement in seismic design requirements has led to more robust, safe and reliable buildings. Due to the earthquake many buildings collapsed killing thousands of people.The analysis of isolation system can be done by following ways:

1. **Linear Static Analysis:** Linear analysis methods give a good indication of the elastic capacity of the structures and indicate where first yielding will occur. The straight static strategy for investigation is restricted to little, standard structures.
2. **Linear Response Spectrum Analysis:** Linear response spectrum analysis is the most common types of analysis used. This is sufficient for almost all isolation system based on LRB and / or HDR bearings.

3. **Non-Linear Static Analysis:** In a nonlinear static analysis procedure, the building model incorporates directly the nonlinear force-deformation characteristics of individual's components and elements due to inelastic material response.
4. **Linear Time History Analysis:** Linear Time History Analysis provides little more information than the response spectrum analysis for a much greater degree of effort and is rarely used.**The direct static technique for investigation is restricted to little, customary structures.** Nonlinear time history analysis is thedynamic analysis in which the loading causes significant changes in stiffness.

4.METHODOLOGY

Nonlinear Time History Analysis

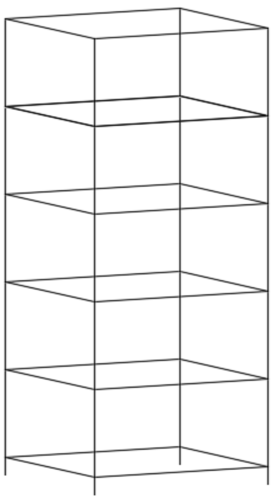
Time-History analysis is a step-by-step procedure where the loading and the response history are evaluated at successive time increments, Δt– steps. During each step the response is evaluated from the initial conditions existing at the beginning of the step (displacements and velocities) and the loading history in the interval.

Properties of ground motions under consideration are tabulated in Table

Earthquake Area	**Magnitude**	**Record/ Component**	**PGA**
EI-Centro (1940)	7.2	El-Centro 1940,	0.35 g
Bhuj(2001)	7.7	Bhuj (2001), India	0.38 g
Uttarkashi	6.6	Uttarkashi (2001), India	0.31 g
Koyna	6.5	Koyna(1967)	0.31g
Chamoli	6.8	Chamoli(1999)	0.31g

- **PROBLEM STATEMENT**

In the present Structure is designed for Laxmi township at Ranjangaon MIDC.



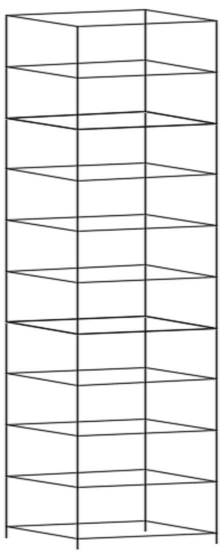
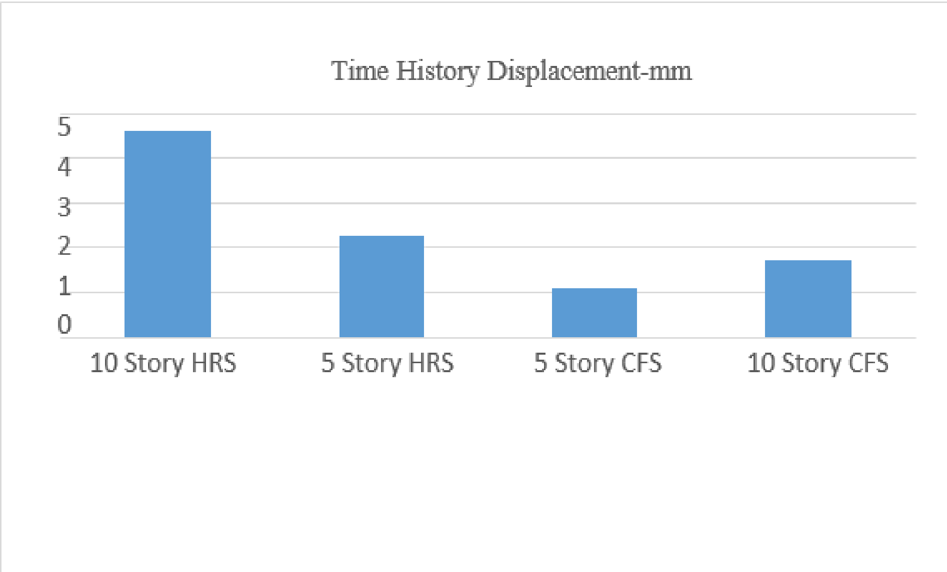


Fig.3D model of 5 Story 2×2 grid.Fig.3D model of 10 Story 2×2 grid.

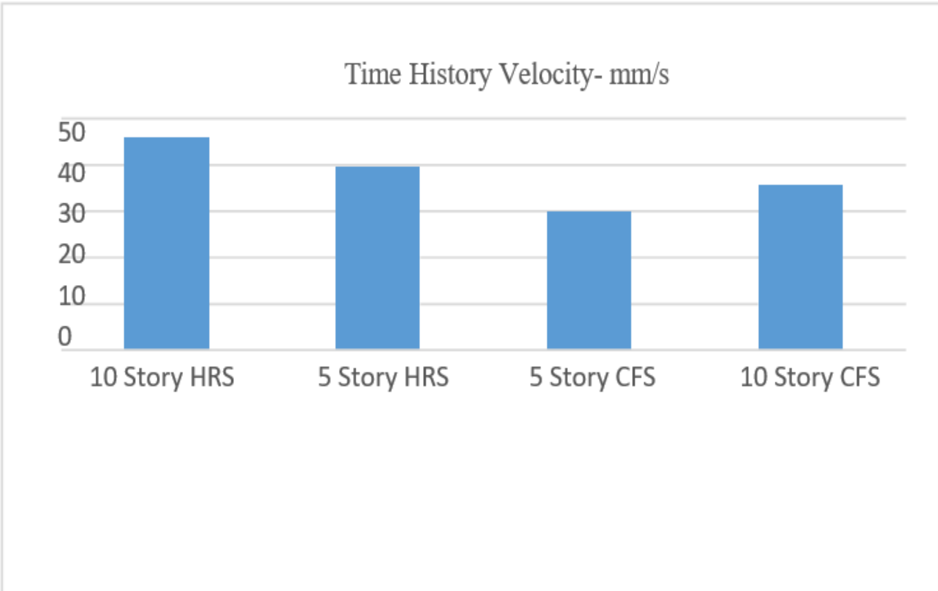
5. RESULT & DISCUSSION

From the problem statement mentioned in above chapter the following models are proposed for time history analysis for earthquake data of Bhuj data following models are prepared.

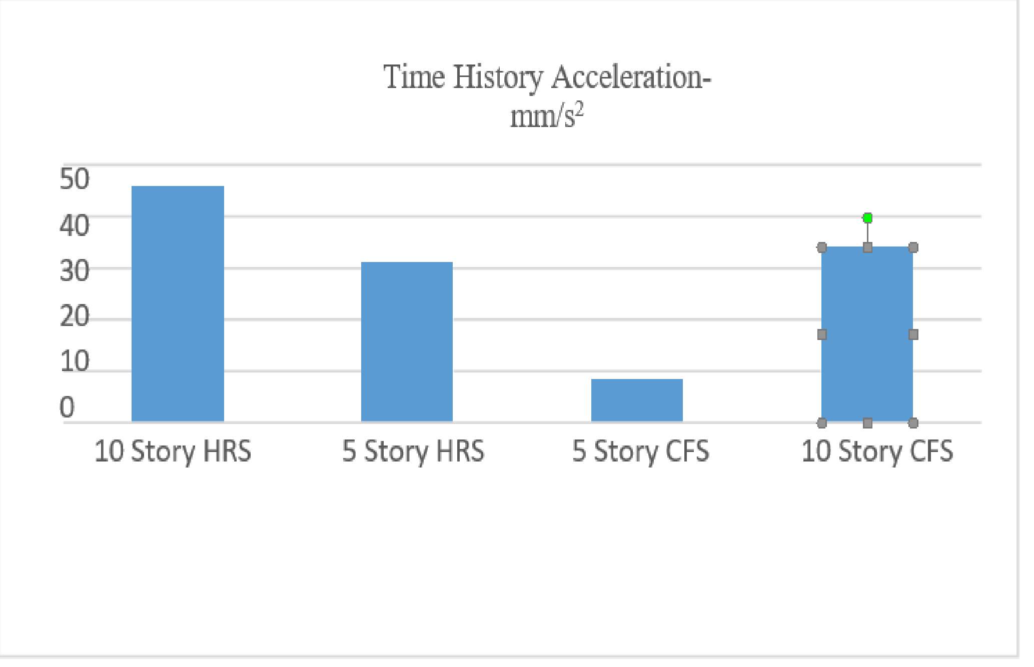
Model No.1	10 Story Hot Rolled Steel Frame
Model No.2	5 Story Hot Rolled Steel Frame
Model No.3	5 Story Cold Formed Steel Frame
Model No.4	10 Story Cold Formed Steel Frame



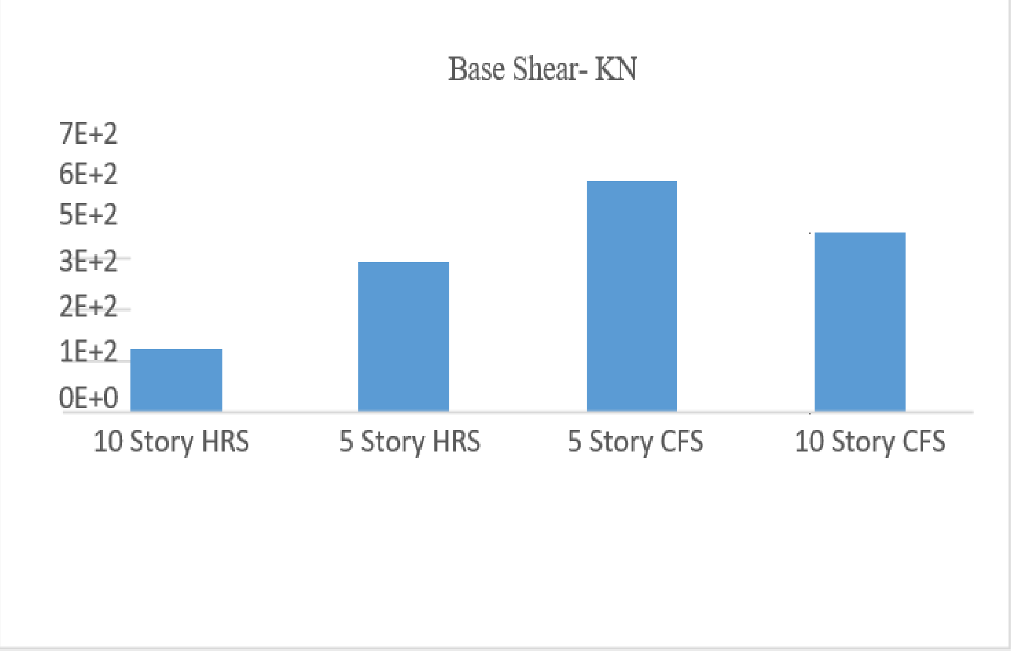
Graph 1. Time History Displacement



Graph 2. Time History Velocity



Graph 3. Time History Acceleration



Graph 4. Base Shear

6. CONCLUSIONS

Four frames from which two frame with cold formed steel frame and two with hot rolled steel, were analysed using E-Tabs 2015 software to see the seismic behaviour of frames. The conclusions drawn based on the analysis Cold formed steel (which was of higher dimension) minimizes the displacement and drift of the structure during the seismic activity as compare to that of hot rolled steel frame. Comparing results of Cold Formed steel and hot rolled steel, cold formed steel (which was of higher dimension)show more promising result it reduces displacement and drift of storey.

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