IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

A Study of the Influence of Various Lateral Load Resisting System in Steel Building

1Vijendra singh tanwar, 2Dr Arvind Kumar Dwivedi

1M tech structural engineering, 2Professor

1 Rajasthan Technical University Kota,

2Rajasthan Technical University Kota

ABSTRACT

Most of the commercial and residential buildings in the country are RCC, which is a versatile material for construction possess up good properties in compression and tension. Also, it is a matter of common observation that due to variety of reasons there are delays in the construction of RCC structures render up to look for alternate construction as steel building for large infrastructure. Due to large open spaces/ spans the use of RCC beams can look architecturally bad. There is also not much of reusable value in cases of RCC structures. In view of these reasons as stated above steel buildings are becoming very common.

The present study discusses the influence of various lateral load resisting system in steel building of different height and existing in V earthquake zone. When it comes to lateral load majorly it will be either seismic or wind, so to resist that lateral forces effectively in steel building, bracing system is preferred. Buildings with steel are more ductile and can accommodate larger spaces and also good for tall buildings. The study involves analysing the building for different heights considering earthquake load as per IS 1893 (Part I):2002 using on STAAD V8i sticking to the IS 800:2007 guidelines. Different lateral load resisting systems are attempted keeping the other parameter constant. The study brings out effective lateral load resisting suitable for a particular height of building.

Chapter I

Introduction

1.0 Introduction

The dominance of steel in the multi-storey commercial sector is based on tangible client-related benefits including the ability to provide column free floor spans, efficient circulation space, integration of building services, and the influence of the site and local access conditions in the construction process. For inner city projects, speed of construction and minimum storage of materials on-site require a high level of pre-fabrication, which steel-framed systems can provide. [1]

There is a strong demand for high quality office space, especially in city centres. Corporate headquarters for banks and other high profile companies require that buildings are built to high architectural and environmental standards. Investment 'value' is the main criterion for choice of the building architecture, form and servicing strategy. [3]

In a typical building prime importance given to its safety, than cost employed in its construction finally decides the efficiency of the building. In regards to the cost of a building, steel buildings are more costly when compared to RC buildings. Hence a typical steel building can be made efficient by optimizing horizontal and vertical members by reducing their sections.

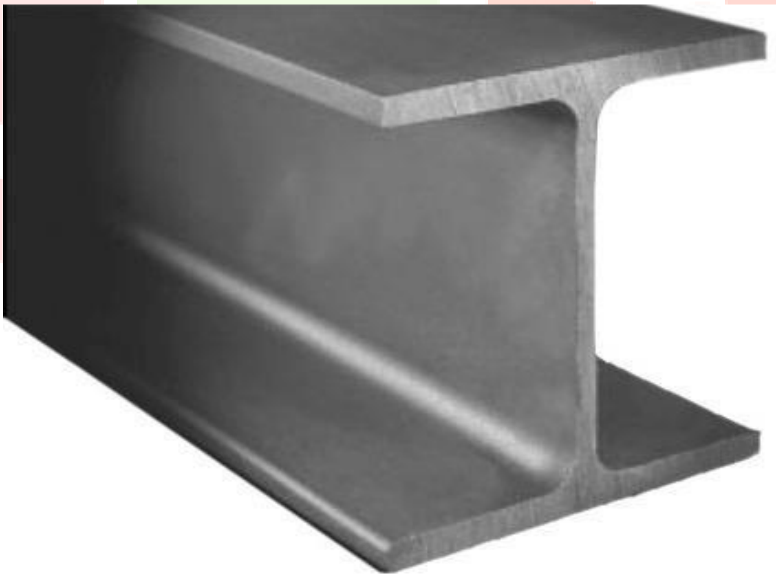


Fig 1.1 I-section [15]

Advantage of using steel in multi-storey

i) Speed of construction

All steel construction uses pre-fabricated components that are rapidly installed on site. Short construction periods leads to savings in site preliminaries, earlier return on investment and reduced interest charges. In many inner city projects, it is important to reduce disruption to nearby buildings and roads. Steel construction dramatically reduces the impact of the construction operation on the locality.

ii) Flexibility and adaptability

Long spans allow the space to be arranged to suit open plan offices, different layouts of cellular offices and variations in office layout throughout the height of the building. Where integrated beam construction is used, the flat soffit gives complete flexibility of layout allowing all internal walls to be relocated, leading to fully adaptable buildings.

iii) Quality and safety

Off-site prefabrication improves quality by factory controlled production, and is less dependent on site trades and the weather. Working in a controlled, manufacturing environment is substantially safer than working on site. The use of pre-fabricated components reduces site activity for frame construction by up to 75%, thereby substantially contributing to overall construction safety.

iv) Sustainability

Many of the intrinsic properties of steel usage in construction have significant environmental benefits. For example, the steel structure is 100% recyclable, repeatedly and without any degradation. The speed of construction and reduced disruption of the site gives local environmental benefits and the flexibility and adaptability of steel structures maximise the economic life of the building as it can accommodate radical changes in use. [2]

Steel framed buildings can be designed to satisfy all these criteria. Some of the recognised sustainability benefits of steel are:

- Steel structures are robust, with a long life. Properly detailed and maintained, steel structures can be used indefinitely
- Approximately 10% of steel sections are reused.
- Steel products can potentially be dismantled and reused, particularly modular components or steel frames.
- Steel is manufactured efficiently in factory controlled processes.
- All waste is recycled in manufacture and no steel waste is produced on site.

1.1 Lateral load resisting system

High rise multi-storied steel buildings are subjected to different kinds of loads like gravity loads, seismic load, wind load etc. In high rise buildings with the increase in its height lateral load on the structure will increase the critical lateral load can be seismic load or wind load depending upon severity.

It was found that to resist lateral load there is need of lateral load resisting system. The present report is a study of different lateral load resisting system at different heights of structure like 9.0m, 18.0m, 27.0m, 36.0m and in earthquake zone V as per IS 1893 (Part I):2002 of India, all structure are analysed and designed as per IS 800:2007 guidelines using STAAD V8i software to deduce most effective lateral load resisting system depending upon height of building. There are two kinds of lateral load resisting system following are:

1.2.1 Rigid frames

Rigidly jointed frames or sway-frames are those with moment resisting connections between beams and columns. A typical rigid frame is shown in Fig.1.2 It may be used economically to provide lateral load resistance for low-rise buildings. [4] Generally, it is less stiff than other systems. However, moment resisting connections may be necessary in locations where loads are applied eccentrically with respect to centre line of the columns.

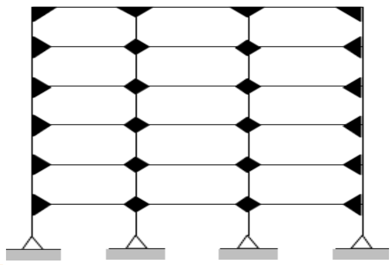
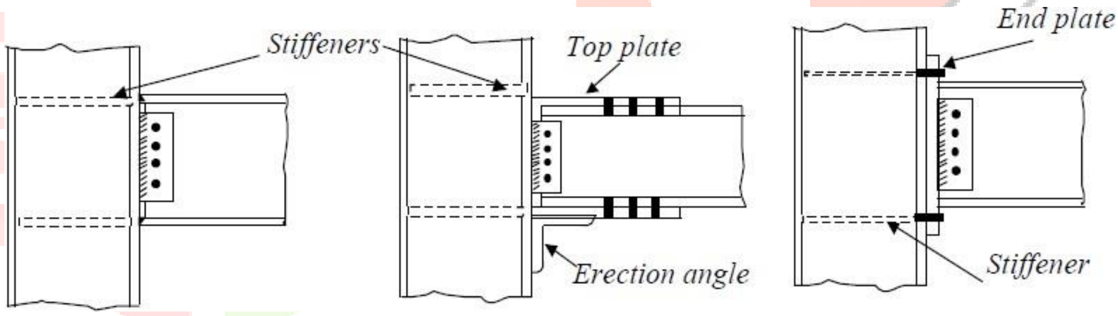


Fig 1.2 Moment resisting frame [4]

Three types of commonly employed moment resisting connections are shown in Fig. 1.3.The connection shown in Fig. 1.3(*a*) and 1.3(*c*) are more economical. However, the moment- rotation performance of the connection shown in Fig. 1.3(*b*) is likely to be superior to that of either Fig. 1.3(*a*) or Fig. 1.3(*c*).



(b) Shop welded and field bolted (a) Field welded and field bolted connection (c) End plated connection Connection

Fig 1.3 Moment resistant connection [4]

1.2.2 Bracing system

Bracing is a highly efficient and economical method to laterally stiffen the frame structures against wind loads. A braced bent consists of usual columns and girders whose primary purpose is to support the gravity loading, and diagonal bracing members that are connected so that total set of members forms a vertical cantilever truss to resist the horizontal forces. Bracing is efficient because the diagonals work in axial stress and therefore call for minimum member sizes in providing the stiffness and strength against horizontal shear. The most effective and practical method of enhancing the seismic resistance is to increase the energy absorption capacity of structures by combining bracing elements in the frame. [5] The braced frame can absorb a greater degree of energy exerted by earthquakes. The braces are usually placed in vertically aligned spans. This system allows obtaining a great increase of stiffness with a minimal added weight, and so it is very effective for existing structure for which the poor lateral stiffness is the main problem. In the present study it was observed that there are three kinds of bracing system are used having a shape of hollow square tubular are

i) V – braci

ii) K- bracing

iii) Cross bracing [8]

iv) Cross bracing in core of building [9]

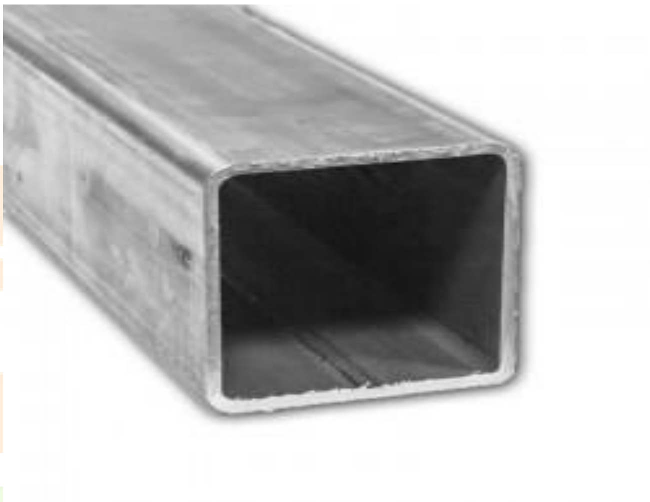


Fig 1.4 Hollow square tubular shape bracing [16]

Table 1.1 Models of bracing system

Bracing Model	Bracing system
Bracing System 1 (BS 1)	Cross bracing
Bracing System 2 (BS 2)	Cross bracing in core
Bracing System 3 (BS 3)	K- bracing
Bracing System 4 (BS 4)	V- bracing

Chapter II discuss the literature review based on the work on different types of lateral systems.

Chapter II

Literature Review

2.1. Introduction

This chapter gives a glimpse of the different types of lateral systems commonly adopted, their approximate locations and their influence on different buildings. **Jagadish J. S, Tejas**

D. Doshi (2013) [5]

In this paper **A Study on Bracing Systems on High Rise Steel Structures** was carried out.

This work presents effect of different types of bracing systems in multi storied steel buildings. For this purpose the G+15 stories steel building models was used with same configuration and different bracing systems such as Single-Diagonal, X bracing, Double X bracing, K bracing, V bracing is used. The property of the section is used was as per IS 800:2007 which incorporates Limit State Design philosophy.

The main objective of the analysis was to study the different types of bracings in building. The analysis was carried out in STAAD Pro V8i software. Different types of bracing system for buildings are modelled and analysed for gravity and wind loads. The comparison is made between the Without Bracing, Single-Diagonal brace, X Bracing, Double X Bracing, K Bracing and V Bracing.

In this paper wind analysis was carried out for different types of bracing system. After the analysis it was noticed that there was a significant changes in maximum lateral displacement, storey drift, base shear, axial, shear force and weight of the structure. Wind loading was applied as per IS 875-part3.

As per displacement criteria, bracings are good to reduce the displacement and in case of K and V-bracing, the displacement was higher than without bracing because of irregularity in shape of the structure. The reactions and weight of the structure are more in different types of bracing structures when compared to unbraced structure with same configuration of the structure.

Amol V. Gowardhan, Prof.G.D. Dhawale, Prof.N.P. Shende (2015)[6]

In this paper author discussed about the different types of bracing system in steel multi-storey frame building to resist the seismic load. The shear capacity of the structure can be increased by introducing steel bracings in the structural system. So there was a need of precise and exact modelling and analysis using software to interpret relation between brace frame parameters and structural behaviour with respect to conventional lateral load resisting frame. The type of bracing, location of bracing, bracing stiffness and bracing material, etc. have significant effects to the lateral load resisting capacity of the structure. If the bracing system was incorporated for resisting a lateral load it serves better than conventional lateral load resisting system when dynamic loads are acting to the structure. Bracing system also increases the stiffness and ductility of the structure on the application of the seismic force. Steel bracings can be used as an alternative to the other strengthening techniques available as the total weight of structure changes significantly. The shear capacity of the structure can be increased by introducing steel bracings in the structural system. Otherwise seismic performance of structure without bracing is weak. It is observed that due to providing of bracings in both direction, the base shear capacity increases up to 40-50% as compare unbraced building. The brace building was decreased the seismic parameters such as storey drift, base shear, displacement, bending moment, shear force & axial force, etc. as compare to the unbraced building with increasing the section use for bracing as well as selection of the correct or suitable types of bracing system.

Sachin Dhiman, Mohammed Nauman, Nazrul Islam (2015)[7]

This work showed that steel braced structural frame was one of the structural systems used to resist earthquake loads in multi-storeyed buildings. In the present study, the seismic performance of steel buildings under braced and unbraced system was investigated. The bracings are provided in the peripheral columns. A fourteen story building was analysed for seismic zone IV as per IS 1893:2002 using STAAD V8i software. The performance of different types of bracing system has been examined. Steel bracing for steel frames is used to reduce drift demands. Bracing can either be implemented from inside the frame or applied from outside of the system.

The objective of this paper was to evaluate the response of braced and unbraced structure subjected to seismic loads and to identify the suitable bracing system for resisting the seismic load efficiently.

After the analysis of the structure with different types of structural systems, it has been concluded that the displacement of the structure decreases after the application of bracing system. The maximum reduction in the lateral displacement occurs after the application of cross bracing system. Bracing system reduces bending moments and shear forces in the columns. The lateral load is transferred to the foundation through axial action. The performance of cross bracing system was better than the other specified bracing systems. For gravity loads, there is no change in the axial force for all the specified structural systems.

Manish S. Takey [8]

In this work the author analysis the response of unsymmetrical building with braces subjected to seismic loading using SAP and to identify the suitability of the bracing system to resist the seismic loads efficiently and also to compare the response of braced and unbraced building which subjected to horizontal or lateral loading system. This synopsis describes the analysis of high-rise steel building frame with different bracing section. For present work equivalent static analysis is carried out for steel moment resisting building frame having (G+9) storey situated in zone III. Modelling will be done by using Response spectrum method. The steel moment resisting building frame is analyse by with and without steel bracing system.

The braced building of the storey drift decreases as compared to the unbraced building which indicates that the overall response of the building decreases. The braced building of the storey drift decreases as compared to the unbraced building which indicates that the overall response of the building decreases.

K.K.Sangle, K.M.Bajoria, V.Mhalungkar[11]

Bracing element in structural system plays vital role in structural behaviour during earthquake. The pattern of the bracing can extensively modify the global seismic behaviour of the framed steel building. In this paper the linear time history analysis was carried out on high rise steel building with different pattern of bracing system for Northridge earthquake. Aim of study was to compare the results of seismic analysis of high rise steel building with different pattern of bracing system and without bracing system. The result of the present study shows that bracing element will have very important effect on structural behaviour under earthquake effect and it is observed that the displacements at roof level of the building with different bracing style is reduces from 43% to 60.

2.2 Gaps Observed in above literature

From the literature review observed gaps is

Above literature review didn't discuss about the kind of bracing is most preferable for a particular height of building in terms of cost and permissible limits of deflections.

This chapter gave an idea about the different types of bracing. On the basis of present literature review, objective and scope work is discussed in chapter III.

Chapter III Objective and Scope

3.1 Objective and scope of present work

The objective of present work is to study the influence of various lateral load resisting system on steel building, which includes

- **Modelling and study**

  To study the influence of the load on steel building as height of building increases. Four models of different heights are considered for study such as 3 storey (9.0m), 6 storey (18m), 9 storey (27m), 12 storey (36m) are subjected to dead load, live load, wind load as per IS 875 (Part III):1987 and earthquake load of zone V as per IS 1893 (Part I):2002 and analysed using principle of IS 800:2007 using software STAAD V8i.

- **Requirement of Bracing system**

  To arrive at the requirement of lateral load system for a particular height for all four keeping the same configuration and same loading on all models.

- **Effective Bracing system**

  To identify the best bracing system for particular height and for a particular zone of earthquake

3.2 Scope

The present study focuses on different types of lateral load resisting system on typical steel frame models, to arrive at best and efficient combination of lateral load resisting system in considered heights of buildings.

The process of design and analysis of typical steel buildings with lateral load resisting system follow a methodology that is discussed in chapter IV.