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Seismic Analysis of Flat Slab Structures for Different Configuration of Bracings

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Abstract: *A few past examinations have shown that the level section building development has deficient horizontal burden obstruction due to seismic activity. Models for ordinary structure frameworks, as well as G+5, G+7, and G+9 story level chunk developments to work on seismic execution. A solid sidelong burden opposing framework is expected for level chunk development frameworks, were built as a feature of the current work. The undifferentiated from two method such as Equivalent Lateral Force (ELF) Analysis & Response Spectrum Analysis were completed utilizing IS 1893 2016 For horizontal burden opposition, a few kinds of steel propping were demonstrated on level section structures, and seismic examination was finished.. Greatest story dislodging, most extreme between story drift, base shear, and major regular time periods were analysed among propped and unbraced models. The study shows that use of steel bracings as a lateral load resisting system on flat slab building enhances the seismic performance of flat slab system.*

Keywords: Steel bracing, Seismic Analysis, Flat Slab, Story Drift, Equivalent Lateral Force (ELF) Analysis & Response Spectrum Analysis.

1. Introduction

1.1 Flat Slab

A beamless slab is a reinforced concrete flat slab. a slab supported directly by columns and without beams A part the slab is limited on all four sides by the central line of Panel refers to a column. The thickened part, often known as the Drop or drop panel is a protrusion beneath the slab. Flat slab is mostly utilized in commercial constructions. The aesthetic viewpoint is more significant, as is the ease of the Formwork construction A reinforced concrete flat slab directly supported by concrete columns without the usage of a series of beams A one-sided or two-sided flat slab is defined. The slab's shear load is supported by a support system. Focused on supporting columns and a square slab referred to as drop panels.

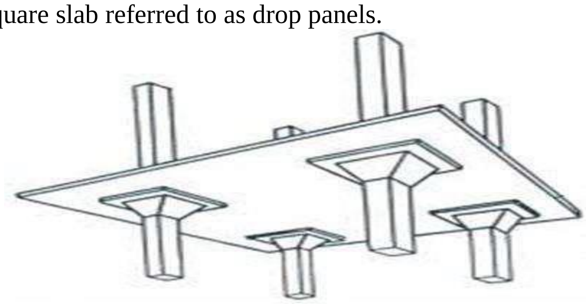

Figure 1 Flat slab

There are following types of flat slabs generally used during construction,
1. Simple flat slab
2. Flat slab with drop panels
3. Flat slab with column heads
4. Flat slab with both drop panels and column heads

1.2 Bracing system

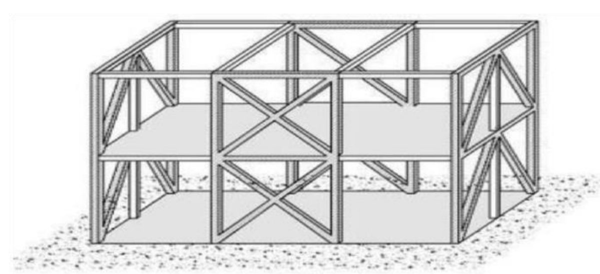

Figure 2 Bracing Systems

Bracing systems can be defined as members that can resist lateral loads through axial forces in the structural components. Bracing members usually carry the axial loads generated due to seismic activities, which could be either compression force or tension force. Bracings can be used on both steel as well as concrete structures and material of bracings members also be steel as well as concrete. In the structure, a braced frames performs like vertical trusses. Horizontal floor bracings can also be done in structure but in this study we discussing only about vertical bracings. There are three types of bracing system,

- Buckling-Restrained Braced Frame (BRB) system,
- Concentric Braced Frame (CBF) system and
- Eccentric Braced Frame (EBF) system.

Providing a bracing system on a laterally weak structure will improves the seismic performance of the whole system by increasing its lateral stiffness and capacity. Steel braced frames are efficient structural systems for buildings subjected to seismic or wind lateral loadings. In this study we are considering only concentric bracing system.

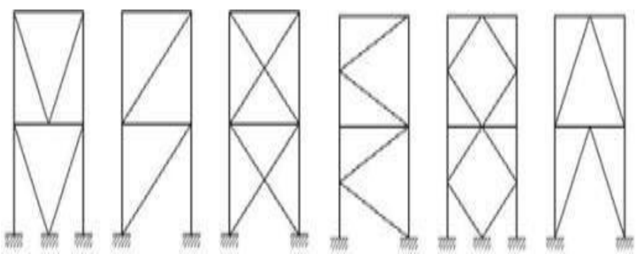

Figure 3 Different types of Concentric Braces

1.3 Objectives

The particular goals of this study are:

1. To acquire the best construction to oppose the lateral loads.
2. To distinguish the weakest structure among the models considered for seismic activity.
3. Proficiency of substantial designs with and without bracings with deference the story dislodging, float and Story firmness, overturning moment, time span.
4. The impact of bracings on conduct of substantial designs are summed up utilizing the acquired outcomes, by finishing up the variety of results in structures

2. Review of Literature

Md. Shahzar 2021 Tremor is the regular disaster, it produce solid ground movements which influence the structure. Little or frail movements that can or can't be felt by the people. Arrangement of shear walls and bracings are introduced to improve the sidelong solidness, pliability, least parallel relocations and wellbeing of the construction. Story float and parallel relocations are the basic issues in seismic plan of structures. Three sorts of casing models are created and assessed by static examination by ETABS. In the current work G+24 multistory structure is dissected by utilizing shear wall and supporting .Primary reason for this study is to look at the seismic reaction of the design.

Shivnarayan Malviya1 2020 , The interest of multi-story Building is increments step by step. The structure might be private or private in addition to business. The recent fad presented the utilization of various sorts of sections and underlying specialists have the huge test to work on it. The utilization of cutting edge sections in building overwhelmingly for the need of enormous range. The Level chunk, Waffle sections and ribbed piece is fundamentally liked in the construction having huge ranges. The advantage is it covered least conceivable number of sections. Hence it is important to learn about its primary way of behaving. The paper comprises of rundowns report on various exploration papers based on utilization of various sorts of section like level chunk, waffle piece, ribbed section idea by various specialists. A few scientists moreover utilized the auxiliary shaft with the typical chunk to move the heap of the design successfully to the section. The survey paper presumed that level chunk can be successfully utilized for the multistorey structure. The utilization of waffle and ribbed can likewise be utilized with skyscraper and tall design development because of seriously opposing second limit of the sections. The utilization of optional pillar is embraced for enormous range necessity.

Dr. K NARESH 2019, As the progression period started practice of level piece turns out to be very normal. In the current paper work a G+14 business multistoried structure having level piece what's more, regular piece has been investigated for the boundaries like base shear, story float, Story solidness, and dislodging. The presentation and conduct of both the designs in seismic zones II and V of India has been considered. Uprooting of modern and business structure built utilizing level chunk framework is more than the ordinary piece framework. Here we can say that level chunk with shear wall gives better relocation standing up to. With the expansion in level of design dislodging is likewise continues expanding. It is seen that story float is most extreme for the ordinary chunk contrasted with level piece and exceptionally less for the level section with shear wall. Story firmness of traditional piece building is stiffer than Level section building. As the story no diminishes firmness continues expanding.

3. Modelling

3.1 General

Three different stories level are taken i.e. G+5, G+7, G+9 Storey. A similar type conventional building having beam column system also modelled. Application of four different types of steel braces i.e. Diagonal, X are done at different locations i.e. Corner bays, middle bays, alternate bays and all peripheral bays. Again combination of two different bracings also done and the effect of bracings on flat slab building was analysed.

3.2 Modelling Data

Plan and Configuration

A simple square shaped plan is taken for study. Number of bays is four and the bay size is 5m. Typical storey height is taken 3m and three different storey levels i.e. G+5, G+7, G+9 stories are modelled for study purpose.

This chapter provides model geometry information, including items such as story levels, point coordinates, and element connectivity.

Story Data

Table 1 A Story Data

Name	Height mm	Elevation mm	Master Story	Similar To	Splice Story
Story5	3000	18000	Yes	None	No
Story6	3000	15000	Yes	None	No
Story4	3000	12000	Yes	None	No
Story3	3000	9000	No	Story4	No
Story2	3000	6000	No	Story4	No
Story1	3000	3000	No	Story4	No
Base	0	0	No	None	No

3.3 Grid Data

Table 2 Grid Systems

Name	Type	Story Range	XOrigin m	Y Origin m	Rotation deg	Bubble Size mm	Color
G1	Cartesian	Default	0	0	0	1250	ffa0a0a0

Table 3 Grid Lines

Grid System	Grid Direction	Grid ID	Visible	Bubble Location	Ordinate m
G1	X	A	Yes	End	0
G1	X	B	Yes	End	5
G1	X	C	Yes	End	10
G1	X	D	Yes	End	15
G1	X	E	Yes	End	20
G1	Y	1	Yes	Start	0
G1	Y	2	Yes	Start	5
G1	Y	3	Yes	Start	10
G1	Y	4	Yes	Start	15
G1	Y	5	Yes	Start	20

3.4 Material Properties

The Concrete grade of M30 is used with an elastic modulus of 25000MPa according to IS 456:2000. The concrete weight per unit volume is taken as 30 KN/m3 with Poisson's ratio 0.2. Reinforcement bar HYSD 500 TMT with elastic modulus of 200000MPa is used for structural design. Unit weight of bar is taken 76,900 KN/m2 with Poisson's ratio 0.3. For bracings Fe 345 steel grade is used and a standard heavy weight I beam ISHB 350-1 is used for all models.

4. Results and Discussions

Top Storey Displacement

The comparative study of top storey displacement values among G+5, G+7 and G+9 stories building together with braced and unbraced models shows that, after providing a steel braces the story displacement values decrease significantly. Among the various types of bracings, X and Chevron type bracings are more efficient in decreasing displacement values while placing at corner bays. Braces after providing on alternate bays shows somehow closer towards corner bays bracings. On middle and peripheral bays, X type braces significantly reduces the storey displacement values than other bracings. The minimum reduction is done by diagonal type steel braces. On comparison to bare models, nearly 42% to 58% top storey displacements values are reduced by providing corner bracings in G+5 Stories building. Likewise, for G+7 stories building, nearly 35% to 44% values decreases. Similarly, for G+9 Stories building 30% to 39% displacement values reduced by providing corner bracings. On comparison to bare models, about 41% to 58% in ESA and 39% to 56% in RSA, the top storey displacements values are reduced by providing bracings at corner bays in G+5 Stories building. Likewise, for G+7 stories building, about 35% to 44% (ESA) and 32% to 41% (RSA) values decreases. Similarly, for G+9 Stories building, about 30% to 39% (ESA) and 28% to 37% (RSA) displacement values reduced by providing corner bays bracings. On comparison to bare models, about 52% to 67% (ESA) and 51% to 67% (RSA) top storey displacements values are reduced by providing middle bays bracings in G+5 Stories building. Likewise, for G+7 stories building, about 44% to 52% (ESA) and 42% to 49% (RSA) values decreases. Similarly, for G+9 Stories building, about 41% to 47% (ESA) and 39% to 44% (RSA) displacement values reduced by providing middle bays bracings. On comparison to bare models, about 43% to 57% (ESA) and 42% to 56% (RSA) top storey displacements values are reduced by providing alternate bays bracings in G+5 Stories building. Likewise, for G+7 stories building, about 37% to 44% (ESA) and 35% to 41% (RSA) values decreases. Similarly, for G+9 Stories building, about 33% to 39% (ESA) and 31% to 38% (RSA) displacement values reduced by providing alternate bays bracings. On comparison to bare models, about 76% to 88% top storey displacements values are reduced by providing peripheral bays bracings in G+5 Stories building. Likewise, for G+7 stories building, about 65% to 81% values decreases. Similarly, for G+9 Stories building 58% to 74% displacement values reduced by providing peripheral bays bracings.

Base Shear

The plot of base shear values for G+5, G+7 and G+9 stories braced as well as unbraced building models indicates that Base shear values for pure flat slab building is lower than the conventional building. After providing bracings on flat slab building the base shear values increased significantly, which indicates the increase in stiffness of structure. Maximum base shear is obtained by providing X- type bracings. Minimum base shear is obtained from diagonal type bracings. After providing bracings on flat slab system, base shear increases nearly about 150 to 300% depending upon types and number of bays braced. Among various types of bracings, the X and Chevron type braces plays a remarkable role to increase base shear. And minimum base shear is for diagonal type brace. On comparison to bare model, nearly 174% to 204% base shear increase on G+7 Storied building by providing different bracings on corner bays. Likewise, for G+9 Stories building 164% to 188% base shear values increases by providing corner bracings. On comparison to bare model, nearly 193% to 235% base shear increase on G+7 Storied building by providing different bracings on middle bays. Likewise, for G+9 Stories building 183% to 218% of base shear value increases by providing middle bays bracings. On comparison to bare model, nearly 177% to 204% base shear increase on G+7 Storied building by providing different bracings on alternate bays. Likewise, for G+9 Stories building 167% to 290% of base shear value increases by providing alternate bays bracings. On comparison to bare model, nearly 245% to 250% base shear increase on G+7 Storied building by providing different bracings on peripheral bays. Likewise, for G+9 Stories building 263% to 296% of base shear values increases by providing peripheral bays bracings. With the increase of height of building, the corresponding increase in base shear was observed clearly. Increasing the number of braced bays will ultimately increase the stiffness of structure and base shear correspondingly.

5. Conclusion and Future Scope

Both linear static and linear dynamic analysis is carried out for conventional building and flat slab building having three different stories level. In flat slab building, different types of steel braces are provided at different bays. Various configurations of two different shaped braces are also modelled and analysis is carried out. Based on result and discussion, the following conclusions have been established.

- Application of steel braces on flat slab building reduces the overall response of the structure and structure becomes more stiff.
- The storey displacement and drift ratio of flat slab is decreased after the application of steel braces due to increase in stiffness of structure.
- The most effective braces for reduction in displacement and drift ratio is X and Chevron type brace placing at corner bays and alternate bays. For middle and peripheral bays bracing, X brace shows most effective result.
- The application of braces increases the base shear of structure due to increase in stiffness. X and Chevron brace are highly susceptible towards increasing the base shear values.
- Fundamental natural time period of flat slab structure decreases due to the application of braces. X and Chevron type braces reduces the most among the considered braces.
- Different Configurations of bracing shows that reduction in displacement, drift ratio and time period of the structure. Maximum reduction is obtained by Configuration-3A and minimum reduction is obtained by Configuration- 2C.
- The steel braces could be an alternative for lateral load resisting system in flat slab building to enhance the seismic parameters.

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