International Academic Institute for Science and Technology

International Academic Journal of Science and Engineering Vol. 1, No. 1, 2014, pp. 10-19.
ISSN 2454-3896

International Academic Journal of Science and Engineering

www.iaiest.com

The behavior and performance level of structures with lateral bracing system based on frame geometry variations

Amir Khodavirdilo[a], Yosef Zandi[b]

[a] *M.Sc. in structural engineering, civil department, Tabriz branch, Azad University, Tabriz, Iran*

[a] *M.Sc. in structural engineering, civil department, Azerbaijane sharghi branch of olum tahghighat, Azad University, Tabriz, Iran*

[b] *Assistant Professor of Civil Department, Tabriz branch, Azad University, Tabriz, Iran*

Abstract

In the most cases strength based design does not provide a sufficiently accurate answer. In this method, the possibility of ideal assessment of the structure based on expected performance is remote. Therefore, Performance-based design has been proposed and strength based design has been replaced by performance based design. In this paper, by changing the geometric parameters of steel frames equipped with lateral bearing systems, we tried to check the performance level in these kinds of structures. The results indicate the superiority of the moment frame system.

Keywords: performance level, numerical modelling, lateral bearing system

1- Introduction:

In the most cases strength based design does not provide a sufficiently accurate answer. In this method, the possibility of ideal assessment of the structure based on expected performance is remote. Therefore in the recent years Performance-based design has been proposed and strength based design has been replaced by performance based design. This new design method, indicates three functional level of structural members. In this method, based on the expected performance level, performance point can be determined. Various methods are outlined in the bylaws to determine the performance point and the most important method is the response spectrum method and response spectra of displacement based on ATC. Some results which are displayed in this section are derived from the ATC. In this method destruction point of structure response spectra and decreased seismic demand spectra exposure are indicated as the performance point.

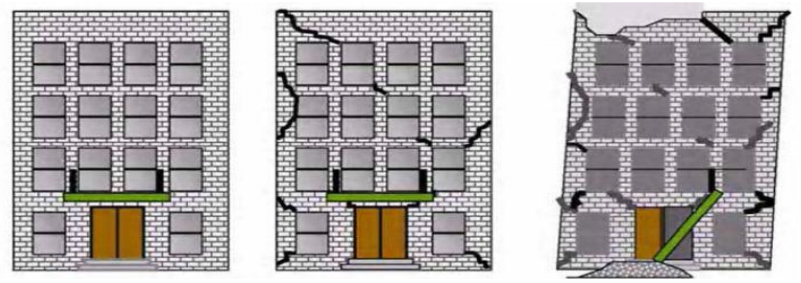


Fig1- structural performance points

2- Subject literature

Reza karami mohammadi 2005 [1] introduced a passive control method has been checked for steel framed structures. Ghelenoi 2008 [2] investigated on TADAS dampers. Ramin Ghoochi 2011 [3] worked on strengthening steel special moment frames by ADAS recreant metal dampers. A research about strengthening vulnerable restrained frames with persistent braces against buckling has been conducted and presented by Nader Abdoli 2008 [4] in the first strengthening international Conference. A paper about "studying behavior changes of slender columns in existing steel structures by various means after strengthening" [5] was presented in the Fifth International Conference on Seismology and Earthquake engineering. A paper regarding "damage investigation in Bam's steel structure building and classification of strengthening methods for earthquake damaged buildings" [6] was presented in the fourteenth civil engineering students conference in 2008. Farshad Habibi [7] presented his article with subject of "strengthening reinforced concrete columns using metal jacketing" in the first international conference of seismic strengthening. Hamidreza Vosooghifar and Ali Rahbar [8] provided an article regarding" providing an engineered solution to strengthening short columns using splitting methods for columns (Split column).

An article titled "seismic assessment and strengthening of steel bridges in Tehran" [9] was presented in the Second National Congress on Civil Engineering. Sayed Hashem Mousavi [10] presented an article titled "a comparison between resistance and performance based design methods in the study of vulnerability and strengthening steel buildings" at the Third National Congress on Civil Engineering. Sayed Hashem Mousavi [11] studied on steel structure vulnerability and the possibility of strengthening buildings in an article. Strengthening Steel buildings using steel shear wall is the subject of an article that Morteza zahedi [12] presented on the Third National Conference of Strengthening and rehabilitation in Iran. Sayed Hashem Mousavi [13] presented an article titled "studying on vulnerability and the possibility of strengthening steel structures" on the first National Conference of Strengthening and rehabilitation in Iran.

3- materials and methods

The performance of a structure can be assessed in five different damage limit states: elastic state or no damage, minor damage state, repairable damage state and finally the severe damage and close to collapse.

A strategy to sort out different damage scenarios and their occurrence possibility regarding ground displacement caused by different levels of earthquake (PGA) is provided. The performance levels have been defined and their relation to drift is shown using roof force-displacement curve that was obtained from a push over analysis. To assess the damage, a damage index is used.

The aim of this work is to present a strategy to link the various levels of damage and their possibility to happen to a structural response parameter (Drift) and an earthquake related parameter (PGA). Different levels of damage and five limit states that introduced before, is specified in figure.[16]

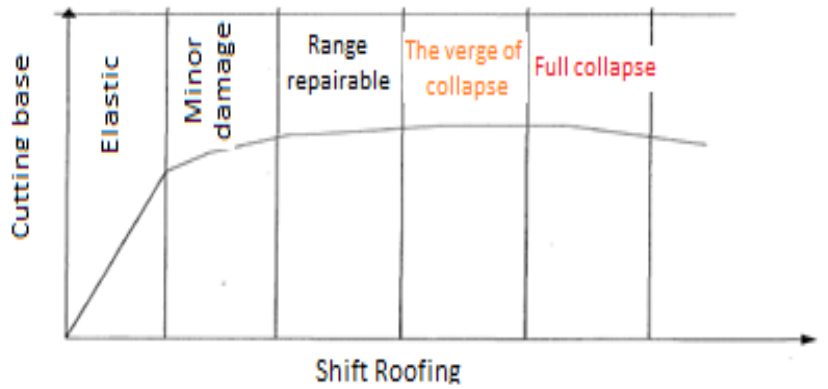


Fig2- performance and damage levels of a structure

Generally, for each group of structures that are classified by elasticity, a probability analysis can be performed to link the performance of the structure that specified by a pushover analysis to the dynamic performance that is defined by damage and it's occurrence possibility in 50 years. The relationship between drift and damage level can be stated based on the response of the structure and damage index. So the limit of specified damages can be expressed as floor or roof drift. These limits can be showed in a capacity curve that obtained from a pushover analysis. by the limit of specified damages can be liked to its happening probability in 50 years by PGA. This problem can be expressed that because each level of earthquake can be expressed based on an analysis by the PGA and Drift so PGA can be eliminated and find a relation between drift and happening probability in a specified period and finally we can use the relation between damage and happening possibility in 50 years for designing goals.

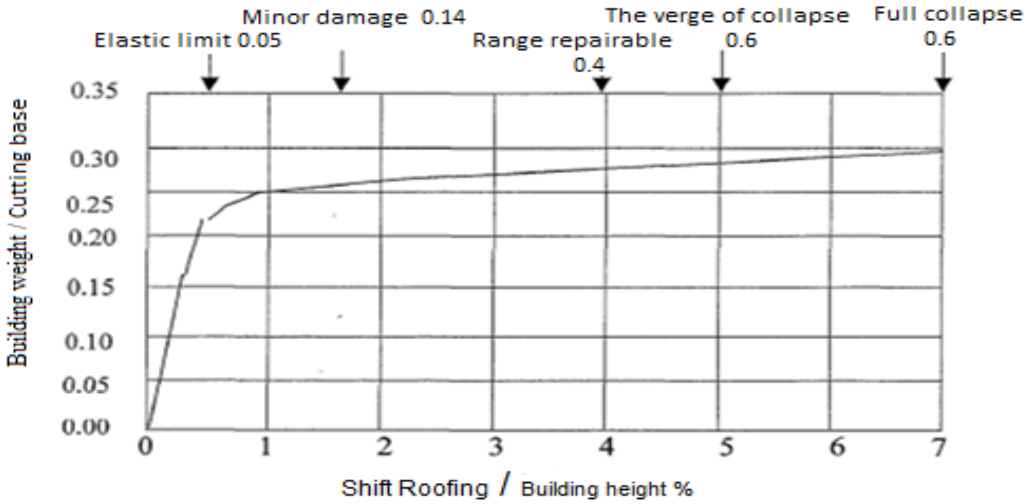


Fig3- performance levels and their relations to capacity curve

Based on the following curves, for each available model, the ratio of roof displacement to building height is calculated and its performance is determined. In order to display better the results of the various functions, they are divided into the following colours.

Table 1. The relationship between presented index and levels of performance in models

0-0.05	0.05-0.14	0.14-0.4	0.4-0.5	0.5-0.7	Shift Roofing/ % Building height
Elastic limit	Minor damage	Range repairable	The verge of collapse	Full collapse	Level of performance
					Color Display

4- Results

4-1 performance level assessment in conversion models in numerous spans

In the following table, the results of different models with varying levels of performance in the in numerous spans is provided.

Table 2. Performance level of different models by changing in the numerous spans

model name	Shift Roofing	Building height	Shift Roofing/ Building height %	Level of performance
SM3	9.26	15	0.6173	Full collapse
SM4	9.66	15	0.6440	Full collapse
SM5	9.7617	15	0.6508	Full collapse
SB3	1.1354	15	0.0757	Minor damage
SB4	1.473	15	0.0982	Minor damage
SB5	1.7627	15	0.1175	Minor damage

Table 3. Calculation about changing Models of the numerous spans

model name	Cutting base	Building weight	Cutting base/ Building weight
SM3	184	1680	0.1095
SM4	245	2240	0.1094
SM5	307	2800	0.1096
SB3	210	1680	0.1250
SB4	280	2240	0.1250
SB5	350	2800	0.1250

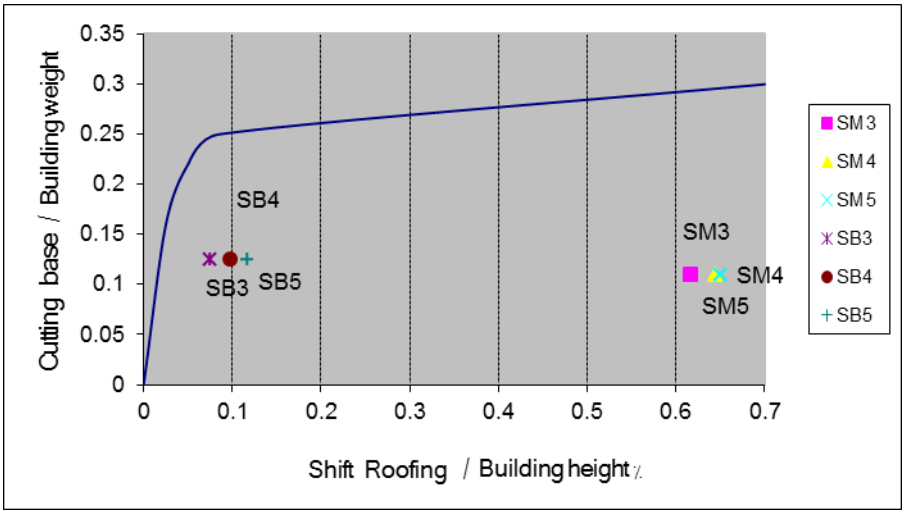


Fig 4- different models with varying levels of performance in a in numerous spans

The results indicates that the performance levels of moment frame models are in the complete collapse level. Increasing the number of span is leading index to be more critical. Therefore, reducing the number of spans would be more desirable.

Also increasing the number of spans in braced frame models increased specified index related to levels of performance. therefore, the reduction in the number of spans is recommended. Notice that for these models, performance level is in the partially damaged range.

Finally, if you need to increase the number of spans in steel frame, braced frame system is recommended.

4-2-performance level assessment in changing models over the span

In the following table the results of different models with varying levels of performance during the span is provided.

Table 4. different models with varying performance levels during span

model name	Shift Roofing	Building height	Shift Roofing/ Building height %	Level of performance
LM5	1.335	15	0.0890	Minor damage
LM6	1.762	15	0.1175	Minor damage
LM7	2.243	15	0.1495	Range repairable
LB5	1.39	15	0.0927	Minor damage
LB6	1.37	15	0.0913	Minor damage
LB7	1.38	15	0.0920	Minor damage

Table 5. Calculation of changing models in the span

model name	Cutting base	Building weight	Cutting base/ Building weight
LM5	306	2800	0.1093
LM6	368	3360	0.1095
LM7	429	3920	0.1094
LB5	350	2800	0.1250
LB6	420	3360	0.1250
LB7	490	3920	0.1250

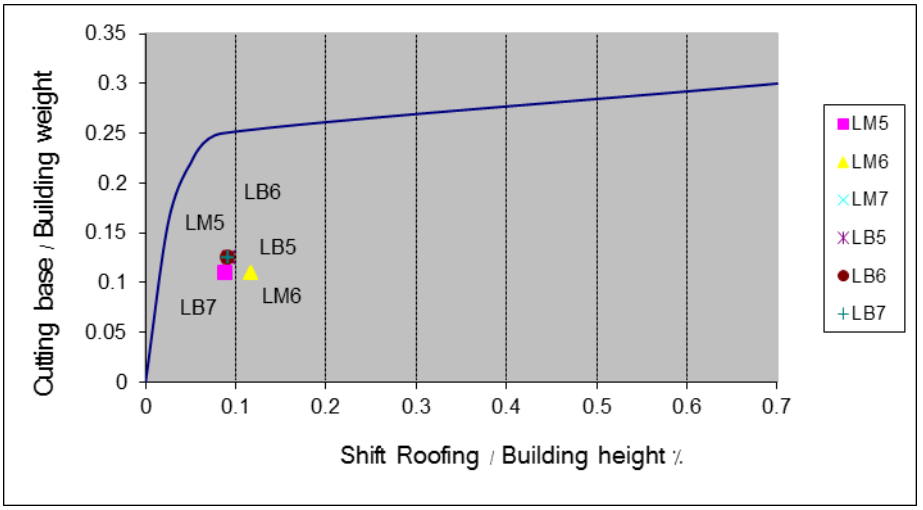


Figure 5- different models with varying levels of performance during the span

Based on the results of the performance level of various models with different span length in moment frames observed that models

With span length between 5 and 6 meters are on the partially damaged level of performance. By increasing the span length to 7 meters, the range of performance levels has been transferred to repairable level and more critical situation for the structure have been proposed. Therefore increasing span length of moment frames causes increasing in the related performance level index and becoming more critical in structural behaviour against lateral loads. results showed by increasing the frame spans length, the performance index doesn't impact and all made models situated within the specified partially damaged limits.

It can be said that if it is necessary to extend the frame's span, it is better to use steel braced frame system.

4.3 performance level assessment of varying models in floors height

In the following table, results of the performance level in different models with varying floor height is explained.

Table 6. performance level of different models with varying floors height

model name	Shift Roofing	Building height	Shift Roofing/ Building height%	Level of performance
HM4	1.725	20	0.0863	Minor damage
HM5	2.71	25	0.1084	Minor damage
HM6	3.869	30	0.1290	Minor damage
HB4	3.14	20	0.1570	Range repairable
HB5	5.37	25	0.2148	Range repairable
HB6	8.08	30	0.2693	Range repairable

Table 7. Calculation of the changing models in floors height

model name	Cutting base	Building weight	Cutting base/ Building weight
HM4	213	2240	0.0951
HM5	190	2240	0.0848
HM6	170	2240	0.0759
HB4	280	2240	0.1250
HB5	257	2240	0.1147
HB6	237	2240	0.1058

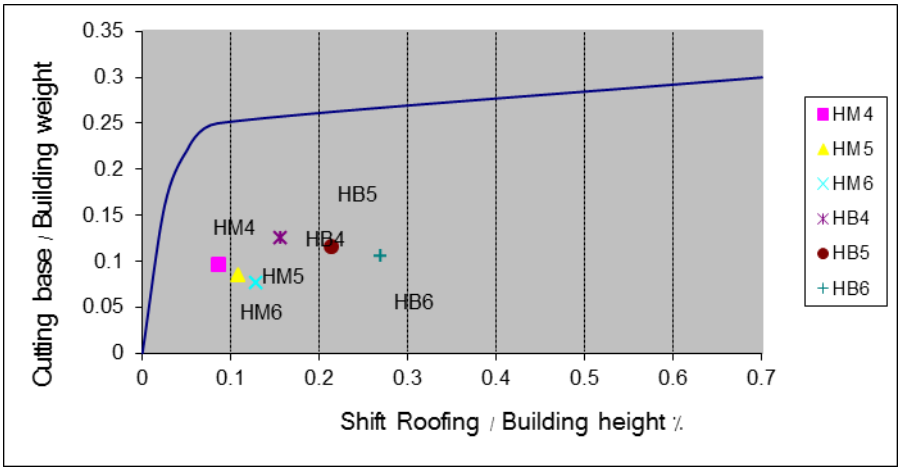


Figure 6- the performance level of different models with varying in the floors height

According to the performance level index for models with changes in the height of the frame, it has been achieved partially damage in level of performance in moment frame model.

Also by increasing the height of the frame floors the index will increase.

Also observed that in braced steel frame models, all models were in the repairable range of performance level. Trend of the index that is related to performance level has been more intense than steel moment frames.

Therefore, moment frame system is recommended to increase the floor height in case of need.

5- conclusion

According to the research, results are presented as follows:

• Increasing the number of spans doesn't have a great influence on swing in roof's displacement and amounts derived approximately equal.

• By increasing floors, the differences between displacement of models with varies span length is not so noticeable.

• Braced models are more sensitive to changes in floors height and displacement growth percentage due to height increasing is more than a moment frame.

• Finally, the moment frame system has resulted a 25% reduction in displacements.

• If you need to increase the number of spans in steel frame, braced frame system is recommended.

• If you need to extend the spans length in a frame, it is better to use steel braced frame system.

• If you need to increase the floor height in steel frame, moment frame system is recommended.

References:

[1] Reza karami mohammadi(2006). using braced frames by frictional dampers to lighten structure, first earthquake and lightening conference.

[2] Mansour ghalenoi, Mohammad amin pordel(2009). Strengthening steel intermediate moment frames by TADAS dampers, national conference on strengthening, Iran.

[3] Ramin ghoochi, Mohammad karami(2012). strengthening steel special moment frames by ADAS recreant metal dampers, first national conference on crisis management, earthquake and places vulnerability, Iran .

[4] Nader abdoli yazdi, Masoud abooei mehrizi(2007). strengthening vulnerable restrained frames with persistent braces against buckling, first seismic strengthening international Conference, Iran.

[5] nima taghi bek loo(2006). studying behaviour changes of slender columns in existing steel structures by various means after, Fifth International Conference on Seismology and Earthquake engineering .

[6] Mansour torabi zadeh, Hamed safari(2008). damage investigation in Bam's steel structure building and classification of strengthening methods for earthquake damaged buildings, fourteenth civil engineering students conference .

[7] Farshad habibi, Reza abbas nia(2006). strengthening reinforced concrete columns using metal jacketing, first international conference of seismic strengthening .

[8] Hamidreza vosooghifar, Ali rahbar(2007). providing an engineered solution to strengthening short columns using splitting methods for columns (Split column), earthquake and strengthening national conference .

[9] Fakhroddin danesh, Mohsen ghaderi(2005). seismic assessment and strengthening of steel bridges in Tehran, Second National Congress of Civil Engineering .

[10] sayed hashem mousavi, Tohid aghaei(2007). a comparison between resistance and performance based design methods in the study of vulnerability and strengthening steel buildings, Third National Congress of Civil Engineering .

[11] sayed hashem mousavi, Tohid aghaei(2006). investigating on structure vulnerability and the possibility of strengthening buildings, first earthquake and rehabilitation conference .

[12] Morteza zahedi, Marzieh mahtab(2008). Strengthening Steel buildings using steel shear wall, third earthquake and rehabilitation conference .

[13] Mohsen gerami, Amin ghaznavi oskooei(2006). strengthening existed steel structures using flange section reduction, first National Congress of Civil Engineering .

[14] Amir khodavrdiloo(2015). seismic assessment of moment steel structure and restricted based on performance, Master's dissertation, Azad university, Tabriz.

[15] Yousef Zandi(2013). comparison of dual system of steel moment frame and thin steel plate shear walls with dual system of steel moment frame and cross bracing or chevron with a design method based on performance levels, Bulletin of environment, pharmacology and life sciences, vol 2 (10), September 2013: PP 51-57

[16] FEMA-273, 274 (1996) NEHRP guideline for the seismic rehabilitation of building, Federal emergency management agency.