

Comparative study of semiotic Behavior of Connective Porch Bracing and Connective Septet Bracing

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Abstract

Earthquake is one of the natural phenomena which always have wide damages in history for human society; therefor structure designers always seek to find a way to reduce the structural damages of earthquake. One of the most important elements of each structure, whether it is metallic or steel, is its connections. The plan of connections is depend on circumstance and special rules. Therefore, these connections are assembled into two types of bracing (Porch and Septet Bracing). Then the simulation Forces of earthquake inject to these two types of connections (Connective porch bracing and septet bracing). Then the displacement and changing of each connection should be considered and the finding were compared with simulation Abaqus and then according to architectural requirement and structural costs we observed that the connection of septet bracing are the most proper than porch bracing in metallic structures because of restriction in replacement.

Keywords: Semiotic Behavior, Connective Porch Bracing, Connective Septet Bracing

I- Introduction

Earthquake is as a result of sudden releasing of mass energy in the stores of earth surface. This energy release starts from a zone in earth depth which is called earthquake center and with energy releasing causes the earthquake as waves.

If the standards and statistics in buildings and elements have not been considered properly, these shakes make the damage to constructions and their destruction (McMarian 2002, Darvish Zade 2001, Tehrani 1991). The most important and main reason of earthquake is the movement of plates of earth crust. Energy release in existing breaks between earth plates occurs gradually or suddenly. Gradual releasing of energy has caused the great changes in lands location condition in long years. (Akashe). Sudden releasing of energy in the borders of plates and faults in earth crust is the main reason of earthquake. Iran is one of the countries that have many active and dangerous faults and most cities and residential centers or human constructions are located on faults or near to them. Faults are one of the most important geomorphological phenomena which caused by tectonic movements. In addition faults by their actions and movements could make shake and also horizontal and vertical movement of regions and have great destruction effects on buildings and other constructions (Zongi Abadi et al., 2008).

Intensive earthquakes such as Boin Zahra (1962) Tabas (1978), Golbaft (1981), Mangil & Kodbar (1991), Ghaen and Bojnord (1997), Bam (2003), and tens of such earthquakes show the importance of this issue (Negarehsh, 2003). Generally Iran has three seismic regions which include Zagros, Alborz and central Iran. The plates of Arabia from west south, India from east and east south and Sibri from east north impress Iran. And Iran's plate resistance against these pressures causes many faults and breaks in Iran plate. (Negarehsh 2003)

According to the history of earthquake in Iran and also the condition of constructions in past years and the possibility of earthquake in most populous cities in Iran, the construction designing in Iran and their resistance, earthquake should be studied seriously (Earthquake information base, 2017). Connections in constructions are so important. In fact it could be said that the total behavior of one construction against earthquake power is determined by connection type of construction. Therefore this identifies the importance of connection behavior of constructions against powers of earthquake.

Steel connections because of their simple and fast implement of shell and the resistance of steel profiles in public mind, have been used widely. But the lack of consideration in designing and implementing threats their softy. Loin and semi loin connections are used in most steel constructions. In connections with high resistance, the connection resistance is more important than beam resistance and when the plastic joint is created, this will done in beam, whereas in low resistance connection the joint is created in connection, therefore it could be said that except the joint connections which are used in limber resistant frames, four states of connections including loin connection with high resistance, high resistance semi loin connection, low resistance loin connection and low resistance semi loin connection, could be applied in limber resistant constructs (A). Among them semi loin connections for their high plasticity and high energy absorption show the better reaction against earthquake forces than loin connections. In addition to loin and semi loin connections, saddlebag connections are most common connection in Iran which more than 11% of metal frame buildings have used this type of connection (B). Unfortunately these connections have not acceptable solidity of limbering and in earthquake times with disjoining will used irretrievable vital and financial damages. One of the basic points which should be considered in construct designing is the controlling of elements movement and displacement in structure. More restricted the

displacement and movement of elements, is made less destructions is made. It could be said that the most effects of different element displacement of structure are done in external view and dedicated dements in internal parts of the building.

The breaks which are created in building face and also the breaks on the walls especially in internal walls of the building, and breaks in horizontal and vertical directions on wall plastering could be as result of this small displacement which is effective on structural elements especially in connections (c). In diagram 1 the effect of frame configuration in reducing of displacement is shown.

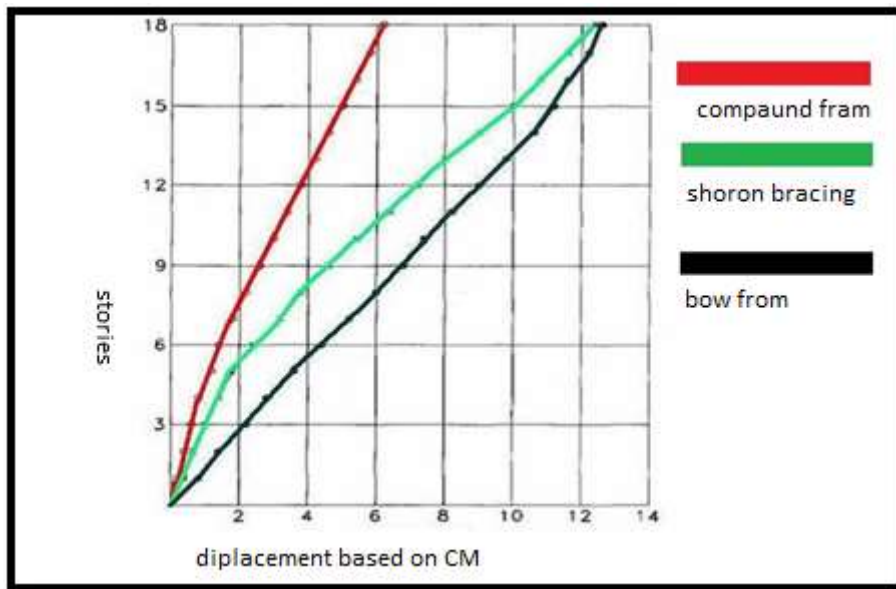


Diagram 1- The effects of frame configuration in reducing displacement

As this diagram shows the configuration and the type of frame system has special effect on displacement in metallic elements. This displacements and changes in place could be controlled whit changing in connection type, decrease or increase in element solidity, decrease or increase in beams and columns dimensions.

In this research one of earthquake effects on steel structures which is displacement or place change will be studied.

Our purpose is to observe the effects of changes the elements in structure on structure displacement.

2- Research method

The method of this research is restricted element method which is done by Abaqus software. The steps of this research are shown below.

2-1- Segmentation and Selection of Element Types

This includes segmentation of body into other systems of bound elements with linked knots and selection of most proper elements which is coincide to physical action and behavior as possible as the element should be small and applicable and on the other hand should be considered great which reduce the calculation of mass. The beam elements are in line and simplest elements which have two groups with

one node in the end.

2-2- Selection of Displacement Subordinate

Second step includes the selection of displacement subordinate in each element and internal subordinates of elements are determined with element node amounts. Generally in bound elements the linear comet sentences with 2 and 3 degree in problem formula are used.

2-3- Definition of Relationships of Displacement Strain and Stress Strain

In third step the bound element in relationships of strain, displacement and stress are obtained with below formula (Logan, 2010).

$$\varepsilon_x = \frac{d_u}{d_x}$$

d_u = Total differential of displacement

d_x = displacement differential in X direction

ε_x = Strain in X direction.

In addition stress amounts are obtained from strain-stress rule which is called compound rule and the simplest relationship of strain – stress is Hog rule. [logan, 2010]

$$\sigma_x = E\varepsilon_x$$

σ_x = Strain in X direction

E= Elasticity Modula

ε_x = Strain in X direction.

2-4- Extraction of relations and building Matrix of element

In forth step the equations of each element are provided as matrix based on the concept of rigidity coefficient. As an example one of the bounded element methods is to apply direct balance method which based on this method, rigidity matrix and equation of each element which relates each node force to the displacement, is obtained from balance condition and relations between simply force and element displacement. This method could be applicable for linear element or one dimension element such as girders. [Logan, 2010]

$$\begin{bmatrix} f_1 \\ f_2 \\ \vdots \\ f_n \end{bmatrix} = \begin{bmatrix} K_{11} & K_{12} & \dots & K_{1n} \\ K_{21} & K_{22} & \dots & K_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ K_{n1} & \dots & \dots & k_{nn} \end{bmatrix} \begin{bmatrix} d_1 \\ d_2 \\ \vdots \\ d_n \end{bmatrix}$$

K= rigidity

d= displacement

f= force

or as compressed matrix is [logan, 2010]:

$$\{f\}=[K]\{d\}$$

2-5- Interaction of element equations for obtaining total or basic equations and introduction of bordering condition

In this step the node balance equations of each elements which were extracted from step 1, are interacted in node equation frames in basic coordinates. The interaction principle which is called direct method and its base is balance in nodes, could be used in determining the total and basic equations of structure. The final extractive equations and general equation as a matrix is [Logan, 2010]:
 $\{f\}=[K]\{d\}$.

2-6- Determination of X freedom degree [Total displacements]

The above equations are modified according to border conditions and the set of equation system is written according to matrix extension as bellow. [Logan, 2010]

$$\begin{bmatrix} f_1 \\ f_2 \\ \vdots \\ f_n \end{bmatrix} = \begin{bmatrix} K_{11} & K_{12} & \dots & K_{1n} \\ K_{21} & K_{22} & \dots & K_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ K_{n1} & \dots & \dots & k_{nn} \end{bmatrix} \begin{bmatrix} d_1 \\ d_2 \\ \vdots \\ d_n \end{bmatrix}$$

K= rigidity

d= displacement

f= force

The border condition is as in a way that if it was homogeneous, the displacement in base is zero and according to above formula the X displacement could be obtained.

2-7- Calculation of element stains and stress

In seventh step of stain analysis in structure the secondary important quantities such as stain and stress could be displaced based on direct relations between them.

3- Results and Discussion

The purpose of step eight is to explain and interpret findings and to apply them in analysis and design steps. In above process the information by using bounded component program was entered to computer system. This information includes the coordinates of element node, the order of elements connections, material characteristics of element, acted loads, border condition or constraints and types of survey. Then according to the information for solving required equations the computer was used to analyze the data.

3-1- Results

Using semi tight connection in bracing totally reduces the base cutting and displacement in frames. These connections in loin frames reduce considerable amounts of base cutting and as the solidity of total frame reduce the displacement increases barely.

In fact the amount of reduction of base cutting in further in loin frames. The bellow results were obtained from modeling the porch and septet brace clamped connection and simulation of lateral forces of earthquake on them. By studying the result of test on porch and septet brace clamped connection we conclude that in porch bracing has %5 displacements more than septet bracing in similar loading. In table,

1 and 2 the data about force displacement of porch bracing connection and septet bracing connection have been shown respectively.

Table 1- The force and displacement of porch bracing connection

Force	Displacement
0	0
0.025	0.21168
0.05	0.42336
0.075	0.63504
0.11	1.058
0.125	1.3236
0.15	2.96352
0.16	4.2336
0.17	6.3504
0.175	7.4088
0.18	8.4672
0.19	10.584

Table 2- The force and displacement of septet bracing connection

Force	Displacement
0	0
0.025	0.21
0.05	0.44
0.075	0.61
0.11	1.002
0.125	1.24
0.15	2.86
0.16	4.2
0.17	6.8
0.175	7.2
0.18	8.2
0.19	10.3

In diagrams 2 and 3 the force – displacement in septet and porch bracing connections is presented.

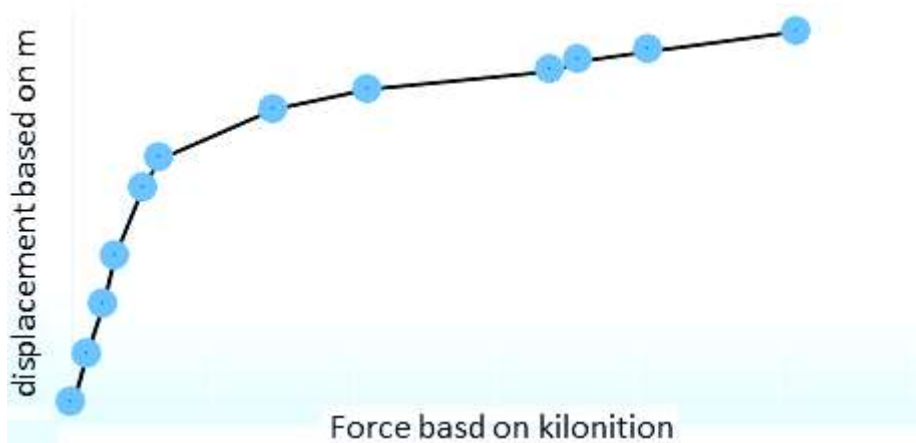


Diagram 2: Force – Displacement diagram in septet bracing connection



Diagram 3: Force – Displacement diagram in parch bracing connection]

2-3- Conclusion

In this study to kinds of connections, septet and porch bracing connections were considered. After entering lateral force of earthquake the amounts of displacement of structure elements were calculated and we observed that the displacement in using porch bracing connection was more than using septet bracing connection (%5) in the same loading. Ghale Noi et al (2010) studied the seismic behavior of steel frames with crisscross bracing and semi loin connection. Their result showed that in loin frame with crisscross bracing by using this method with small increase in displacement the considerable amounts of base cutting will reduce, and also in joint from with crisscross bracing the displacement and base cutting will reduce. Taghi pur et al (2011) in their research studied the comparison between seismic behavior of Shoran bracing from and zipper special convergent. Their research was done on different samples of bracing frames with 5, 10 and 15 stories and nonlinear dynamic analysis and by using 30 performs

software. Meysam Salali et al (2010) studied the effects of different parameters of structures on seismic behavior of bend bracing frames by using 5 nonlinear bound element analyses. In addition one mathematical model was provided for estimation of non-elasticity solidity of frame. The results of analysis showed that, as the distraction of concrete and metallic constrictions usually is less than 5%, the maximum destruction of balancing viscosity of bracing from with bend element reaches 30%. Also these frames show the favorite reactions without weakness on hysteresis cycles and could write-down the considerable amounts of earthquake energy without and decreasing in solidity and resistance. Taghipur et al (2014) provided a new types of energy write downing which includes one ring that increases the plasticity and absorption of earthquake energy in bracing structures. Also when earthquake occurs the write-downing element will reduce considerable amount of energy in structure with changing the steps to non-linear step and forming the bending pasty connections and avoids the entrance of other members of structure in non-linear steps and buckling of bracing elements or postpones them. The performance of proposed element was studied in two dimensions frame with convergent bracing under non-linear static analysis and results show the decrease on base cutting and increase on plasticity of structure [17]. The researcher study shows that this research is new topic and according to its importance which is felt in current situation of constriction in country we studied this issue. It suggests that in future researches other types of metallic connation for calculation of displacement influenced by earthquake load, according to earthquake condition of Iran, could be studied.

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