Extended Abstract Template for Amirkabir Journal of Science and Research

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ABSTRACT

Steel moment frame system is one of the conventional and practical systems in bearing lateral loads that is used individually or in combination with other systems in seismic areas and tall structures. The joints are The most important members of a moment frame system and The function of the connection varies according to the ductility of the moment frames. Therefore, research on the performance of these connection in steel structures is of particular importance, because low accuracy in its design and execution, in addition to the failure of the connection, will cause high damage to the entire structure. Today, the American institute of Steel Construction (AISC) and the Iranian National Building Code introduce patterns as pre-qualified acquisitions. Over the course of three decades, several studies have been conducted several times on steel flexural joints with side stiffeners. On the other hand, considering that fragility curves are a suitable tool for diagnosing vulnerability. This article tries to examine the adequacy of the steel moment frame using side stiffener connection and pre-qualified WUF-W connection and providing fragility curve then comparing them with each other. The result shows that the structure is less likely to fail using steel moment connection with side stiffener instead of pre-approved WUF-W connection.

KEYWORDS

Nonlinear Incremental Dynamic Analysis, Fragility curves, WUF-W connection, side stiffener plate connections, Pre-approved connections

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1. Introduction

Regarding the previous study of this steel moment connection, it should be mentioned that in 1991 Shanmugam and et al [1] evaluated the cyclic behavior of 7 samples of the I-shaped beam connection to the box column. Tow samples of connections were stiffened with continuity plate and the rest of the samples were reinforced with lateral stiffeners, and the resulting cyclic curve was constant in all the samples. The results showed that the side stiffeners (T-shaped stiffener) performed better than the other stiffeners even in the samples where the continuity plate was not used. In 2008 Deilami and Shiravand [2] investigated the connection of the I-shaped beam to the double-I column using top plate and seat plate. Due to the large deformation of the top plate, the column showed a semi-rigid, semi-resistant and brittle behavior, and therefore side plates were used to improve the connection's behavior in seismic areas. They studied seismic behavior of a number of experimental and numerical models under cyclic loading. The results showed that this new connection geometry has sufficient strength and ductility for using in special moment frames (SMF) in seismic areas. This new geometry eliminates all the uncertainties in the double I-shaped column and also the plastic deformation in the beam and the panel zone remains in the elastic state. The use of lateral trapezoidal reinforcement plates transfers the plastic hinge out of the connection onto the beam. Figure 1 shows the connection's components.

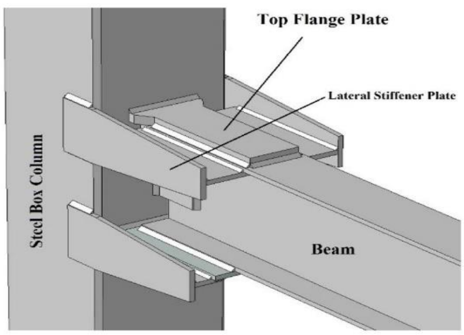

Figure 1. Steel moment connection with lateral stiffener plate

Since it was shown in the mentioned previous research that the steel connection reinforced with lateral plates has a high capability for seismic areas, therefore, in this research, an attempt was made to investigate the seismic behavior and determine the seismic level of performance of this connection with a more accurate tool such as the fragility curve under known earthquakes.

2. Methodology

First, in order to ensure the accuracy of the modeling results, the seismic behavior of the laboratory sample of Raftari and et al. [3] was analyzed and investigated by the finite element software ABAQUS. The hysteresis curves obtained from the laboratory results and the finite element analysis show good agreement between the two models where is shown in figure 2.

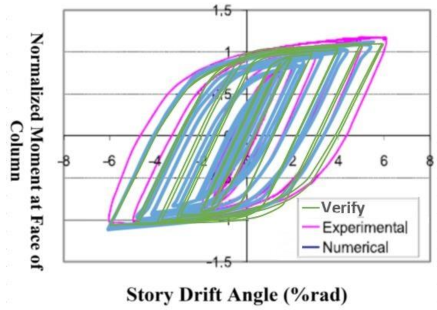

Figure 2. Comparing the results of the load-displacement curves of the experimental and the numerical models

Next, in order to check the connection's seismic response in different states and under seismic loading, the nonlinear time history analysis must be done thus a ten-story steel frame was modeled in ETABS software and subjected to the various intensity of seven scaled earthquakes wich were scaled to Sa(T1). Then the time history of shear forces of two connections which were located on the second and eighth floors were read from the software. Earthquakes were reflected on table 1.

Table 1. Selected accelerogram for the analysis

Number	Record's Name	Duration (sec)	PGA(g)
1	Tabas	39.98	0.104
2	Northridge	34.98	0.25
3	Kobe	40.95	0.225
4	Manjil	60.42	0.183
5	Kokaeli	17.185	0.364
6	Elcentro	39.995	0.1385
7	Loma	39.99	0.511

After that, finite element models for two types of connection were made in Abaqus software and to conduct the Dynamic Implicit analysis, the time history of the shear force is the input of the analysis and the displacement history of the top of the column is taken as the output of the software. The maximum displacement of the top of the column is obtained from the output results. The IDA curve of each connection is obtained by using the maximum displacement at the top of the column and calculating the acceptance criteria values of the two performance levels of IO and CP which are shown in table 2.

Table 2. Acceptance Criteria of Connections

	Stiffened Side Plate connection		WUF-W connection	
	IO level	CP level	IO level	CP level
2nd story	0.0075	0.0253	0.0103	0.041
8th story	0.0086	0.0284	0.0103	0.041

To draw the fragility curves, a log-normal distribution is assumed for each seismic response at each earthquake motion intensity. To estimate the probability of exceeding a certain limit, the average and standard deviation of each answer are evaluated for the total effect of earthquake records. In this paper, the probability function with the standard log-normal distribution based on the earthquake intensity index Sa(T1) is used against the values of the probability function obtained from the output data of the nonlinear dynamic analysis of interstory drift. To beter clarify the improved performance of the connection, fragility curve of WUF-W is determined and compared. Figure 3. Shows the copmarison.

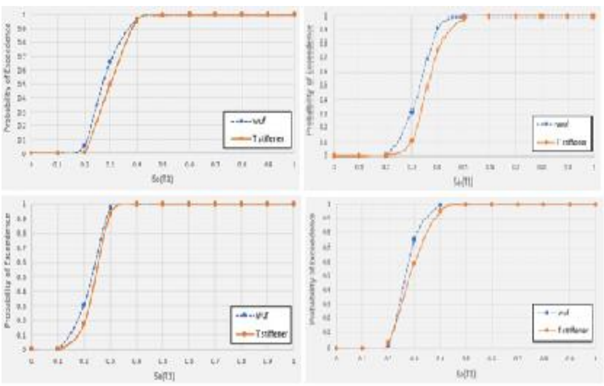

Figure 3. Comparison of fragility curves

3. Discussion and Results

By comparing both connections on the second floor in both IO and CP performance levels, the reliability of the steel moment connection with lateral stiffener is higher than the WUF-W connection, and the probability of exceeding a limit state in the WUF-W connection occurs earlier than the moment connection with Lateral stiffener plate.

In the comparison of both connections in the eighth floor, the same results of the second floor are repeated, but the difference is less. In other words, due to the reduction of the shear force in the upper floors of the structure, the difference between the fragility curves of the two joints has decreased.

4. Conclusions

Connections should be designed in such a way that in addition to sufficient resistance against gravity loads, they do not suffer brittle failure against lateral loads. In different countries during the past years, several methods have been proposed for all types of beam-to-column connections. According to the codes, common steel connection with top and seat plates is allowed only in intermediate steel frames, while the connection considered in this research provides the ability to be used in special moment frames for this connection due to the presence of side stiffener sheets.

5. References

[1] N.E.Shanmugam, L.C.Ting, S.L.Lee, Behaviour of I-Beam to Box-Column Connections ,Stiffened Externally and Subjected to Fluctuating Loads, J. Construct. Steel Research, (1991) 129-148.

[2] A. Deylami, M.R. Shiravand, the exprimental study on built-up column seismic resistant moment connections using side plates, World Conference on Earthquake Engineering, (2008).

[3] M.Raftari, R.Mahjoub, Evaluation of indicators of weld and cyclic response of steel Moment Frame Connection Using Side stiffener Plates, AUT J.Civil Eng, 1 (2017) 57_76.