University of Tabriz

Journal of Civil and Environmental Engineering
Volume 51 (2022), Issue 4 (Winter), 161-170

EXTENDED ABSTRACT

Investigating Effect of Chevron Bracing on Coefficient of Behavior and Ductility Ratio of Reinforcement Concrete Structures

Masood Danesh[a*], Akbar Alizadeh[b]

[a] *Khoy Faculty of Civil Engineering, Urmia University, Khoy, 58159-14853, Iran*
[b] *Khoy Engineering System, Khoy, Iran*

Received: 05 March 2019**; Accepted:** 13 September 2020

Keywords:
Strengthening, Chevron Steel Brace, Concrete Frame, Coefficient of Behavior, Ductility Ratio

1. Introduction

Earthquake is an unpredictable and destructive event that affects most of the urban regions. It is a necessary job to reduce the earthquake damages to a minimum level. The supervision of an especial organization on design principles is an effective solution to minimize structures damages. On the other hand, there are plenty of buildings that have been constructed before the establishment of supervision organizations. Two solutions can be introduced to these structures. The first is demolition and reconstruction; the second is retrofitting. The first is not satisfactory because of its high cost, however, the second is usually preferred. The second solution is cost-effective and has been proved that can be useful to minimize the seismic risks. One of the methods to retrofit concrete structures is using steel bracings. Chevron bracings were used in this paper to retrofit the concrete structure. The changes in seismic parameters like the coefficient of behavior, initial stiffness, absorbed amount of energy, and ductility ratio were calculated.

2. Methodology

The coefficient of the behavior of concrete structures braced with steel chevron bracings was assessed in this paper to investigate damaged buildings under earthquakes, to retrofit the buildings that have not been designed in accordance with today codes, and to assess the number of changes in increasing strength, stiffness, and ductility ratio. A three-story and a six-story structures in a region with high seismic risk were analyzed and designed via using the commercial software ETABS. One frame was extracted from both of these structures and then simulated and push-over analyzed using SEISMOSTRUCTURES code. Then capacity diagrams of both of them were extracted. The diagrams converted to the state of two-lineation using the Young method, and then the coefficient of behavior and other parameters were calculated. The results showed that the coefficient of behavior and ductility ratio of the studied structures were improved by using steel bracings in the concrete structures.

3. Results and discussion

3.1 Capacity curve and calculated parameters

This curve converted to the state of two-lineation using the Young method.

* Corresponding Author
E-mail addresses: m.danesh@uut.ac.ir (Masood Danesh), akbar2019alizadeh@yahoo.com (Akbar Alizadeh).

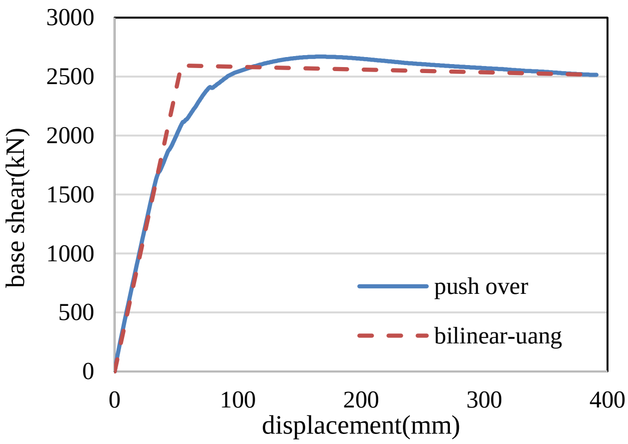

Fig. 1. The capacity curve for one of the models

The coefficient of behavior (R) and ductility ratio (μ) for different models are as follows:

Table. 1. The 3-stories

	Frame under uniform lateral load without Chevron steel brace	Frame under Triangular lateral load without Chevron steel brace	Frame under uniform lateral load with Chevron steel brace	Frame under Triangular lateral load with Chevron steel brace
R	3.26	3.42	5.79	5.79
μ	3.30	3.36	10.06	8.78

Table. 2. The 6-stories

	Frame under uniform lateral load without Chevron steel brace	Frame under Triangular lateral load without Chevron steel brace	Frame under uniform lateral load with Chevron steel brace	Frame under Triangular lateral load with Chevron steel brace
R	4.20	4.14	5.53	5.72
μ	4.59	4.68	6.70	7.22

3.2. Comparison between absorbed energy of moment frame and frame retrofitted with steel chevron bracing

3.2.1. The 3-stories model:

Under uniform lateral loading without steel chevron brace = 112126.6 mm^2
Under triangular lateral loading without steel chevron brace = 92141.03 mm^2
Under uniform lateral loading with steel chevron brace = 500609.2 mm^2
Under triangular lateral loading with steel chevron brace = 454179.4 mm^2

3.2.2. The 6-stories model:

Under uniform lateral loading without steel chevron brace = 271395.9 mm^2
Under triangular lateral loading without steel chevron brace = 208808.7 mm^2
Under uniform lateral loading with steel chevron brace = 855158.5 mm^2
Under triangular lateral loading with steel chevron brace = 930713.4 mm^2

4. Conclusions

The pattern for the type of lateral loading has little effect on seismic parameters.

The amount of increase in the Coefficient of behavior (R) and ductility ratio (μ) for different models are as the following:

- Three-story model under uniform lateral loading: 77.6% , 204.84%
- Three-story model under triangular lateral loading: 69.29% , 161.30%
- Six-story model under uniform lateral loading: 31.66% , 45.96%
- Six-story model under triangular lateral loading: 38.16% , 54.27%

- The improvement in seismic parameters of the three-story model was better than that of the six-story model.

5. References

Asgarian B, Shokrgozar HR, “BRBF response modification factor”, Journal of Constructional Steel Research, 2009, 65, 290-98.

Bush TD, Jones EA, James O, Jirsa JO, “Behavior of RC frame strengthened using structural steel bracing”, Journal of Structural Engineering, 1991, 117, 1115-26.

Code, Uniform Building, “Uniform building code”, International Conference of Building Officials, Whittier, CA., 1997.

Dai H, Ai Q, “Analysis of performance of reinforced concrete frame structure with staircase based on ETABS”, Journal of Earthquake Engineering and Engineering Vibration, 6, 2009.

Goel Subhash C, Lee H, “Seismic strengthening of RC structures by ductile steel bracing system”, Proc. 4th US NCEE, 1990, 12, 645-666.

Jones, Elizabeth A, James Otis Jirsa, “Seismic strengthening of a reinforced concrete frame using structural steel bracing (Phil M. Ferguson Structural Engineering Laboratory, Department of Civil …), 1986.

Ohishi H, Masatsune T, Yoshitoshi Y, “A seismic strengthening design and practice of an existing reinforced concrete school building in Shizuoka city”, Proceedings of the Ninth World Conference on Earthquake Engineering, 1988, 415-420.

Shah, Mrugesh D, Sumant B Patel. “Nonlinear static analysis of RCC frames (software implementation ETABS 9.7)”, National Conference on Recent Trends in Engineering & Technology, 2011, 1-6.

Transportation, California Department of. “Caltrans seismic design criteria”, Caltrans Sacramento, CA., 2006.

Uang, Chia-Ming. “Establishing R (or R w) and C d factors for building seismic provisions”, Journal of Structural Engineering, 1991, 117, 19-28.

Whittaker, Andrew S, Chia-Ming Uang, Vitelmo Victorio Bertero. “Earthquake simulation tests and associated studies of a 0.3-scale model of a six-story eccentrically braced steel structure (Earthquake Engineering Research Center”, College of Engineering, University, 1987.