Reinforcement of steel moment frame with linked beam to column (LCF) system by nonlinear static and time history analysis

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ABSTRACT

Based on the SAC building plan, three, six, and nine-story buildings have been taken into consideration for this purpose. After verifying the models presented by the researchers, 4, 8, and 16-floor bending frames were designed according to the 1st and 4th editions of the codes for the Design of Buildings against Earthquakes (Standard 2800) and then the frames designed with the 1st edition were designed by the frame and column system until reaching Changing the location of the target was reinforced. After that, the reinforced and designed frames with 1st and 4th editions were analyzed under 7 pairs of near and far field accelerograms. According to the results of non-linear static analysis and dynamic analysis of the time history of the force difference percentage in the target displacement of the structure designed according to the 1st and 4th editions, the target is 27 to 50%, the percentage difference in the yielding deformation of the structure designed according to the 1st edition to the retrofitted one is about 5 Up to 42%, the percentage difference of the behavior coefficient of structures designed according to the 1st edition and retrofitted is from 4 to 40%. In a 4-floor structure, it causes a 13.34% reduction in displacement and a 14.06% reduction in IDR. Similarly, in the case of 8-floor structures, this reduction is measured as 20.92% for displacement and 20.81% for IDR, respectively. In the evaluation of the 16-floor structure designed based on the 1988 edition and adding the extension system, it was found that the addition of the extension system to the 16-floor structure causes a decrease of approximately 51.43% in displacement and approximately 26.89% in IDR. Adding the extension system to the 4-floor structure has significant changes. It generates 59.99% in displacement and 24.53% in IDR. Similarly, in the 8-floor structure, we experience a 59.99% reduction in displacement and 22.82% in IDR. In addition, in the 16-floor structure, displacement is reduced by 59.99% and IDR is reduced by 23.96%.

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KEYWORDS

Frame system with connected column, connected beam, retrofitting, far and near field acceleration, steel bending frame.

1. Introduction

Salar Mariya et al investigated the effect of the height of the structure on the changes in the behavior coefficient of the link column frame at the performance level of the collapse threshold. The samples analyzed include 1, 3, 5, and 7-floor structures, and their results show that with the increase in the height of the structure, the demand for ductility and, accordingly, the coefficient of behavior of the 3-floor structure is about 3.3 times the coefficient of behavior of the 7-floor structure. Therefore, considering this huge difference, it is recommended to use the coefficient of behavior related to the same structure in the designs and not to use the average value as the design criterion. [1]

Jabri and Asghari investigated the seismic performance evaluation of simple frame system with connected columns as a new structural system. The results of their investigation show that the behavior factor value of 8, the additional resistance factor of 2.7 and the displacement magnification factor of 5.5 are suitable for this system. The results of the dynamic analysis of their nonlinear time history show that the average value of the maximum relative lateral location change of the floors, under 14 earthquake records scaled to the design earthquake, is always lower and close to 2%, which is for buildings with a height of less than 20 m. It is very suitable. Also, this system has the ability to quickly repair buildings immediately after an earthquake by replacing several members. So that the building will be able to withstand the next earthquake after a quick and simple repair. [2]

Asghari and Jabri investigated the performance of the bonded column as a single system against seismic loads. The results of their investigation showed that the average value of the maximum relative lateral displacement of the floors, under 14 earthquake records scaled to the design earthquake, is always lower and close to 2% and this system has sufficient inelastic capacity. [3]

Moscouchi et al investigate the effect of the seismic sequence phenomenon on the link column frame system and compare the results of the analysis of these frames with the bending frame. The results of their investigation show that the phenomenon of seismic sequence leads to an increase in the relative lateral displacement of the floor in both types of structural systems. However, the LF system shows a better performance against the seismic sequence phenomenon. [4]

2. Methodology

In this part, there are 3 steel bending frame structures with aspect ratios equal to π, $\pi/3$ and $\pi/2$ which were selected based on the aspect ratios in the book Analysis and Design of Tall Structures. The structures include 8, 4, and 16-floor structures, where the height of each floor is 3.5 m. Each frame has 4 openings with a length of 4.5 m.

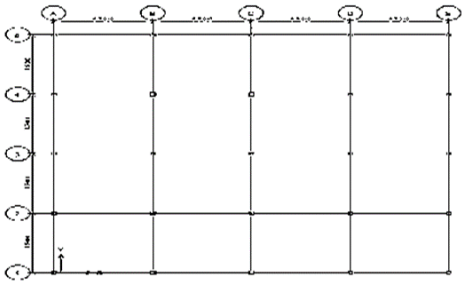
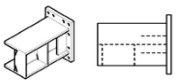


Figure (1) Plan of the studied structures

Table (1) characteristics of graft beam in laboratory sample

	End Plate Thickness (in)	Stiffener Thickness (in)	Stiffener Spacing (in)	e (in)
W12x96	1.5	0.63	13.3	53



3. Results and Discussion

In the examination of the graphs of IDR changes - the relative height of the floors of the 4-floor structure under accelerograms far from the fault, it has been observed that in the Kocaeli earthquake, the highest value of IDR for the structure designed according to the revision of 1988 is equal to 0.683, which is for the extension structure, it is equal to 0.58, which represents a decrease of 15.08%, which shows the largest decrease. For other earthquakes, the value of IDR in the extension system has decreased compared to the structure designed according to the 1988 edition, which percentages of reduction for the Cape Mendocino earthquake is 40.72%, for the Landers earthquake it is 21.66%, for the Chichi earthquake it is 21% 34/3, for Manjil earthquake is equal to 13.29% and for Hector and Duzce earthquakes it is equal to 33.33% and 13.44%, respectively.

In the examination of the graphs of changes in IDR - the relative height of the floors of the 8-floor structure under accelerograms near the fault according to Figure (36), it has been observed that in the BAM earthquake,

the highest value of IDR for the structure designed according to the revision of 1988 is equal to 0.735, which is for the supplementary structure is equal to 0.673, which indicates a decrease of 8.43%. For other earthquakes, the value of IDR in the additional system has decreased compared to the structure designed according to 2017, which percentages of reduction for the San Simeon earthquake is 21.73%, for the Montenegro earthquake it is 26.40%, and for the Loma earthquake it is 60%. 18/1, for the Duzce earthquake it is equal to 35.22% and for the Kobe and Northridge earthquakes it is equal to 14.54% and 21.56%, respectively.

4. Conclusions

1. Comparing the current deformation of old structures to retrofitted structures, it can be concluded that the percentage difference in the current deformation of retrofitted structures varies from about 5% to 42%, with the most significant decrease in 4-floor structures. In addition, in examining the current changes in the shape of new structures and retrofitted old structures, it can be concluded that retrofitted old structures have less current changes than new structures according to the fourth edition, with a percentage reduction of about 4.37% to 37%.

2. In examining the ductility of the structures designed according to revision one and four, it was observed that the new structures seem to have more ductility. The difference in ductility between 4, 8, and 16-floor structures designed according to revision one and four is 4%, 19%, and 32%, respectively. In addition, in examining the ductility of new structures compared to retrofitted old structures, it can be concluded that the retrofitted old structures have more ductility than the structures designed according to the fourth edition, and the increase percentage is in the range of 0.17% to 70%. has it.

3. In the analysis of the coefficient of behavior of old, new and retrofitted 4, 8, and 16-floor structures with a frame system with a link column, it was observed that the highest coefficient of behavior in retrofitted old structures of 5, 10, and 15 floors is 5.17, 7/47 and 6.9 respectively.

5. References

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