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Evaluation of Behavior Factor of Concrete Precast Frames with Concrete Precast Shear Wall

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ABSTRACT

Although many researches have been conducted to investigate the behavior of concrete precast structures against seismic loadings, behavior factor of such structures, which is of significant importance in seismic design of structures, have received less attention so far. In this study, three typical concrete precast frames with precast shear walls, consist of 4, 8 and 12 stories with 3 and 5 bays have been investigated numerically to determine the behavior factors. Effects of two types of uniform and triangular loadings, vertical and horizontal connections between panels as well as pinned and fixed connections between beam and column have been investigated in this paper. To determine the behavior factor, nonlinear static (pushover) analysis approach has been used and Perform 3D software has been applied.

Results showed that parameters such as uniform and triangular lateral loadings, pinned and fixed connections of beam-column as well as horizontal and vertical connections between panels have minor effects on the behavior factor. Moreover, increasing the number of spans with shear wall decreases the behavior factor. Increasing the number of stories, increases the behavior factor. The results obtained in the present work for 4 and 8 story frames compare well with those proposed in the seismic code 2800 and NEHRP 2003.

KEYWORDS

Behavior Factor, Concrete Precast Frames, Concrete Precast Shear Wall, Reduction Factor, Pushover Analysis.

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1- INTRODUCTION

Various researchers conducted many investigations into the behavior of concrete precast structures against seismic loadings. However, determination of the behavior factor of such structures, which is of significant importance in seismic design of structures, has not come into sharp focus so far. In this study, we concentrated on three typical concrete precast frames with precast shear walls, which consist of 4, 8 and 12 stories with 3 and 5 bays. Effects of two types of uniform and triangular loadings, vertical and horizontal connections between panels as well as pinned and fixed connections between beam and column have been considered in this paper. To determine the behavior factor, the nonlinear static (pushover) analysis approach has been employed and to fulfill this aim, Perform 3D software has been applied.

2- METHODOLOGY

To obtain the base-shear force, a standard approach is in use, based on the definition of a force reduction factor. The force reduction factor of MDOF consists of the three following parts:

$$R = R_\mu \times R_S \times Y \qquad (1)$$

Where R_μ is the ductility factor that is the same as SDOF systems, R_S is the over-strength factor that is defined as the ratio of the actual to the design lateral strength, and Y is the allowable stress factor that is used to reduce the base shear force at the point that the first plastic hinge occurs, to the design force. Figure 1 shows a sample pushover diagram.

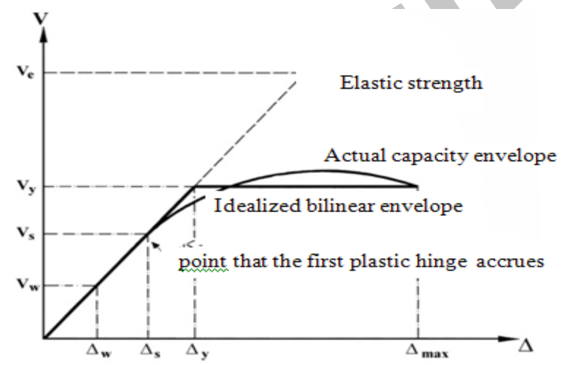

Figure 1: Pushover diagram

In fact, due to the ductility and inelastic behavior of structures, elastic force V_e can be reduced to V_y. T, ductility factor is defined as:

$$R_\mu = \frac{V_e}{V_y} \qquad (2)$$

Previous researches on the performance of buildings during severe earthquakes indicated that structural over strength plays a very important role in protecting buildings from collapse. The over strength factor (R_s) may be defined as the ratio of the actual to the design lateral strength:

$$R_S = \frac{V_y}{V_S} \qquad (3)$$

In the allowable stress design method, design codes reduce V_s to design force V_w. This reduction is considered using the allowable stress factor (Y) as follows:

$$Y = \frac{Vs}{V_W} \qquad (4)$$

3- RESULTS

Obtained results demonstrated that uniform and triangular lateral loadings, pinned and fixed connections of beam-column as well as horizontal and vertical connections between panels have a minor effect on the behavior factor. Moreover, increasing the number of spans with the shear wall decreases the behavior factor; conversely increasing the number of stories, and increasing the behavior factor. Table 1 briefly shows the results of pushover analysis.

Comparing the obtained behavior factor in this study with proposed ones in the seismic code 2800 and NEHRP 2003 revealed that presented values for four and eight story frames in this research are in proper accordance with that of these codes.

Table 1: Obtained behavior factors.

Number of bays	loading	Number of shear walls	RT connection						RS connection					
			Pinned Connections			Fixed Connections			Pinned Connections			Fixed Connections		
			Number of Story						Number of Story					
			4	8	12	4	8	12	4	8	12	4	8	12
			Behavior Factor											
3	Uniform loading	1	6.73	7.62	10.90	7.40	8.25	12.52	7.38	7.70	11.76	8.09	8.15	12.17
		2	-	6.57	5.94	-	6.33	6.75	-	6.19	6.00	-	6.25	7.41
	Triangular loading	1	7.38	8.09	10.96	7.54	8.30	12.49	7.46	9.39	11.81	7.87	8.27	11.77
		2	-	6.27	6.31	-	6.09	6.93	-	7.66	6.18	-	6.37	6.80
5	Uniform loading	2	6.19	-	-	6.71	-	-	6.16	-	-	6.76	-	-
		3	-	7.07	9.92	-	7.41	11.42	-	6.90	8.92	-	7.45	9.24
	Triangular loading	2	6.43	-	-	6.77	-	-	6.65	-	-	5.95	-	-
		3	-	7.33	10.60	-	8.20	10.26	-	6.95	9.41	-	9.86	9.86

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