

# Assessment the Effect of Setback in Height of Frame on Reinforcement Structures

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**Abstract**—Ambiguities in effects of earthquake on various structures in all earthquake codes would necessitate more study and research concerning influential factors on dynamic behavior. Previous studies which were done on different features in different buildings play a major role in the type of response a structure makes to lateral vibrations. Diagnosing each of these irregularities can help structure designers in choosing appropriate setbacks for decreasing possible damages. Therefore vertical setback is one of the irregularity factors in the height of the building where can be seen in skyscrapers and hotels. Previous researches reveal notable changes in the place of these setbacks showing dynamic response of the structure. Consequently analyzing 48 models of concrete frames for 3, 6 and 9 stories heights with three different bays in general shape of a surface decline by height have been constructed in ETABS2000 software, and then the shape effect of each and every one of these frames in period scale has been discussed. The result of this study reveals that not only mass, stiffness and height but also shape of the frame is influential.

**Keywords**—period, concrete frame, irregularity in height, decrease in plan surface, dynamic behavior

## I. INTRODUCTION

STUDYING various structures after earthquake shows that behavior of the structure during the earthquake is conspicuously under the control of different factors such as the total shape or feature [1, 2], which were discussed in books on building structures against earthquakes [3].

According to what have been mentioned previously different countries' earthquake codes have stated it in one way or another but they have not gone through details and ambiguities were left. Accordingly the earthquake code in Iran divides structures into regular and irregular and divides the irregulars into two subcategories: either irregular in plans or heights [4]. Afterwards they put forth characteristics leading to irregularities in buildings. And approaches have been taken into account for designing structures in this range. Amongst all the factors of irregularities in height, protrusion and setback more than 25% in a horizontal row shape of the frame is being mentioned vertically. As a result there is some vagueness which requires more study and research. One of these ambiguities is: would not the structure's response change if the above mentioned increase or decrease in any floor and any way in height was distributed? And if it makes difference how much it is and in which of the conditions should there be more research? And which of these shapes should be avoided?

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For this reason in this paper by studying 48 different models of 3, 6 and 9 floor concrete frames in different setback forms by height according to codes in Iran were designed and their periods which have a great share in the response of the structure to the dynamic strength were taken into account.

## II. MODELING

3, 6 and floor concrete frames having 3 mouths and height of 3 meters for floors and 5 meters for bays in different modes concerning setbacks by height as it is shown in Fig. 1 were modeled in ETABS 2000 software [5].

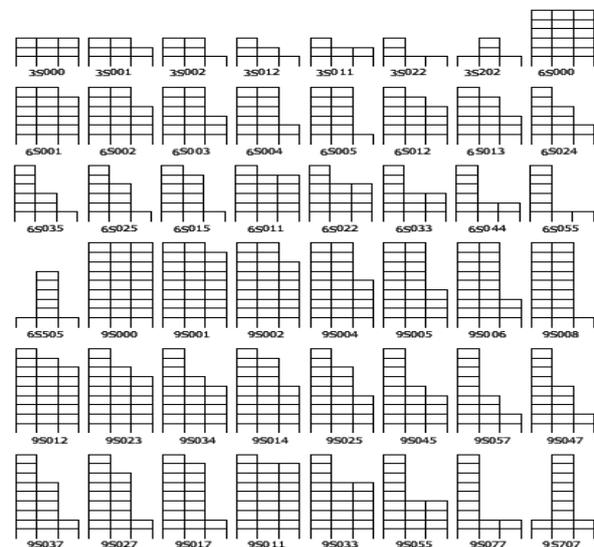


Fig. 1 Various modeled frames

## III. ASSESSING THREE FLOOR FRAMES

In modeling three floor, three bay frames columns and beams 40cm×40cm in size and concrete with compression resistance of  $f_c = 280 \text{ Kg/cm}^2$  were defined. Seven different shapes were modeled and after analysis and obtaining their period, results were demonstrated in Table I.

TABLE I  
PERIOD QUANTITY FOR THREE FLOOR FRAMES

Frame	3S000	3S001	3S002	3S012	3S011	3S022	3S202
Period	1.6	1.5	1.5	1.2	1.26	1.29	1.22

Regarding the effect of period on structure reflection ratio (ratio reflection as defined in standard code number 2800 Iran) there is a direct correlation between mass and period. In Fig. 2 frames in period order from left to right and from minimum to maximum frame are ordered.

As dedicated in Fig. 2 frame periods were not expanded because of mass expansion, for example although frame

3S012 is heavier than frame 3S022, it has less period up to 7.5%. It can be explainable due to the higher stiffness of frame 3S012. While comparing frame 3S022 and 3S202, having the same weight, height and stiffness these two have a variance of 6%.

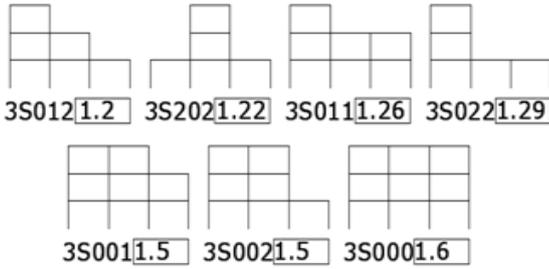


Fig. 2 Three floor building periods

IV. ASSESSING SIX FLOOR FRAMES

In modeling six floor frames and 3 bays, columns 50cm×50cm in size and beams are with 50cm across, and height of 40 cm and concrete with compression resistance of  $f_c = 280Kg/cm^2$  are defined. 18 different models were modeled and after analysis, obtaining period amounts Table (II) was presented.

TABLE II  
PERIOD QUANTITY FOR SIX FLOOR FRAMES

Frame	6S000	6S001	6S002	6S003	6S004	6S005
Period	3.85	3.53	3.38	3.36	3.44	3.57
Frame	6S012	6S013	6S024	6S035	6S025	6S015
Period	3.02	2.97	2.8	2.83	2.89	3.14
Frame	6S011	6S022	6S033	6S044	6S055	6S05
Period	3.19	2.82	2.76	2.91	3.12	3.03

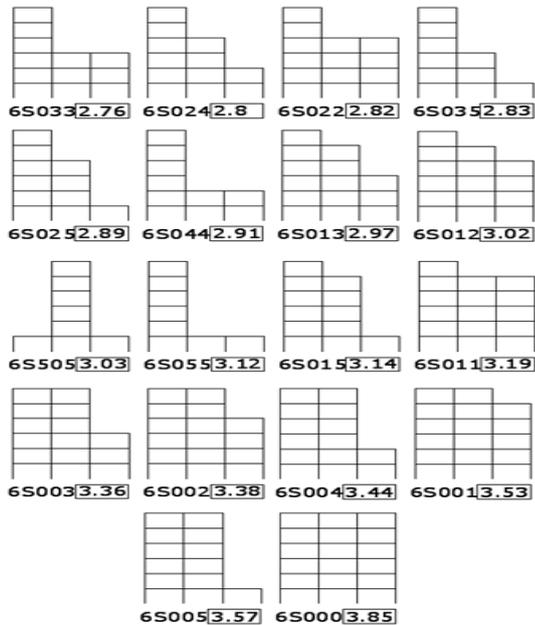


Fig. 3 Six floor frames according to the period

For a better understanding of the effect of shape on frame periods and the possibility of comparison among them in Fig. 3, this time, six floors in an orderly period are from left to right and from small to big.

Looking closely at Fig. 3 we can conclude that frames have not changed periods according to their mass. But a new point can be derived here: comparing frames 6S001, 6S002, 6S003, 6S004, 6S005 with frame 6S000 and also comparing 6S015, 6S025, 6S035, 6S045, 6S055 with 6S005 the highest effect on setback period was on the second floor.

V. ASSESSING NINE FLOOR FRAMES

In modeling nine floor frames and three bays, columns 70cm×70cm in size and beams 70cm across, 50cm in height and concrete with compression resistance of  $f_c = 280Kg/cm^2$  are defined. 23 shapes were modeled and after analyzing and obtaining period it resulted in Table 3. For studying more closely nine floor frames depending on their periods were ordered in Fig. 4. Scrutinizing Fig. 4 we reach the conclusion that frames did not change as their periods were expected. Exactly like six floor frames here we can state: comparing 9S001, 9S002, 9S004, 9S005, 9S006, 9S008 and 9S000 and also 9S017, 9S027, 9S037, 9S047, 9S057 and 9S077 the highest effect on setback period was on the seventh floor.

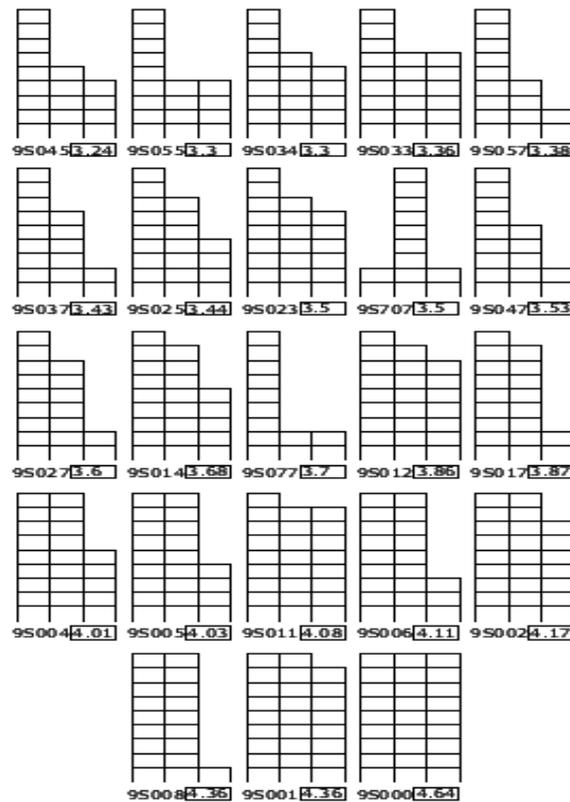


Fig. 4 Nine floor frames depending on the period

TABLE III  
PERIOD QUANTITY FOR NINE FLOOR FRAMES

Frame	9S000	9S001	9S002	9S004	9S005	9S006	9S008
Period	4.64	4.36	4.17	4.01	4.03	4.11	4.36
Frame	9S012	9S023	9S034	9S014	9S025	9S045	9S057
Period	3.86	3.5	3.3	3.68	3.44	3.24	3.38
Frame	9S047	9S037	9S027	9S017	9S011		
Period	3.53	3.43	3.6	3.87	4.08		
Frame	9S033	9S055	9S077	9S707			
Period	3.36	3.3	3.7	3.5			

## VI. CONCLUSION

*From this study and the field of preconception these conclusions were made:*

- Not only mass, stiffness and height but also shape of the frame is influential in the amount of period. Sometimes two same frames with the same height but different shapes have up to 20% variance (difference) in their periods.
- In frames with the condition of setback, what has turned out of these setbacks, (from the beginning point and the general shape) have an effect in the amount of period.
- In six floor frames, the highest variance in periods is seen when the setback starts from the middle floors. The amount is 14%.
- In nine floor frames, the highest variance in periods is seen when the setback starts from the third floor (one third of the height). The amount observed is 24%.
- And also this conclusion was reached: zip shaped frames such as 3S012 and 6S012 compared to frames with the same weight have fewer periods up to 8%.

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