CFRP-RETROFITTING OF REINFORCED CONCRETE FRAMES CONSIDERING NONLINEAR SOIL-STRUCTURE INTERACTION

Mahboobeh YARAHMADI
M.Sc. of Earthquake Engineering, Shiraz University of Technology, Shiraz, Iran
m.yarahmadi@sutech.ac.ir

Abdol Hossein BAGHLANI
Assistant Professor, Shiraz University of Technology, Shiraz, Iran
baghlani@sutech.ac.ir

Behtash JAVIDSHARIFI
Construction Superintendent, Fars Regional Electricity Company, Shiraz, Iran
b.javidsharifi@sutech.ac.ir

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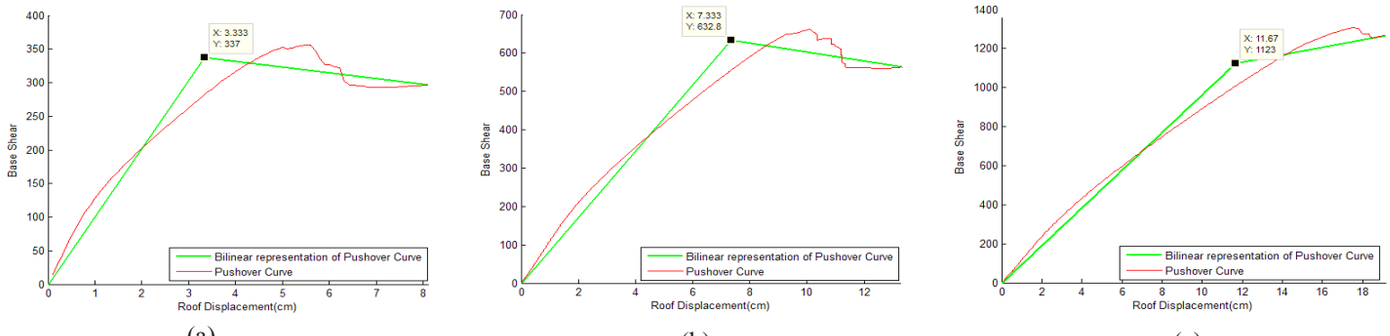
To adjust existing structures with necessities of new versions of codes for safety of buildings against earthquake, several common methods can be taken up. One relatively economic and easy-to-perform way is making use of FRP composites, CFRP's to be exact. The reason of choosing this specific type of material is its reasonable price, accessibility in the region in addition to its proper workability. Structures need to technically satisfy regulations in local codes in order to be reliable and deemed safe in case an earthquake in the region happens.

In this work of study, three frames, namely a 3-story, a 5-story and an 8-story reinforced concrete (RC) frame, are inspected and analysed under pushover loading based on the Iranian no. 360 Code of Retrofitting of Existing Structures. Plastic hinges are observed and tried to be retrofitted. Pushover curves and their bilinear representations are depicted in Figure 1.



(a) (b) (c)

Figure 1. Bilinear presentation of pushover curves (a) 3-story frame, (b) 5-story frame and (c) 8-story frame

Equation 1 from the Iranian no. 360 Code of Retrofitting of Existing Structures is made use of to calculate target displacements of the structures in order for pushover analyses:

$$S_t = C_0 C_1 C_2 S_a \frac{T_e^2}{4\pi^2} g \qquad (1)$$

Terms of the equation are calculated based on physical and dynamic characteristics of each frame using equations in the mentioned code. S_t, which is the target displacement, is the amount the control point of the structure should be pushed in order for plastic hinges to be recorded.

Analyses and retrofits are performed once considering no soil-structure interaction and once considering the interaction to exist. It is observed that destruction patterns may be at times very different for each two cases and the amount of FRP needed varies. The location of plastic hinges can be different as well when the structure interacts with the soil, which is usually the case in practice. Rotations of plastic hinges and base shears before and after retrofitting of the structure are monitored too and the numbers of CFRP layers required to reach the desired performance level (life safety in this study) via retrofitting are determined. Table 1 is a sample of such results.

Table 1. Numbers of layers of CFRP required for the 3-story frame

Pushover (SSI)	Pushover (no SSI)	Analysis / Element number
3	1	1
1	1	3
3	3	4
2	1	5
-	-	6
3	3	7
1	1	8
-	-	9
3	3	10
3	1	11
1	1	12

It is observable that for some elements the number of FRP layers when no SSI is assumed to exist differs from when it is present and affect structural responses. The difference in the amount of CFRP needed to retrofit the member may shadow the difference in stiffness distribution when the soil-structure system behaves simultaneously at the time a quake occurs. The schematic view of the 3-story building is shown in Figure 2.

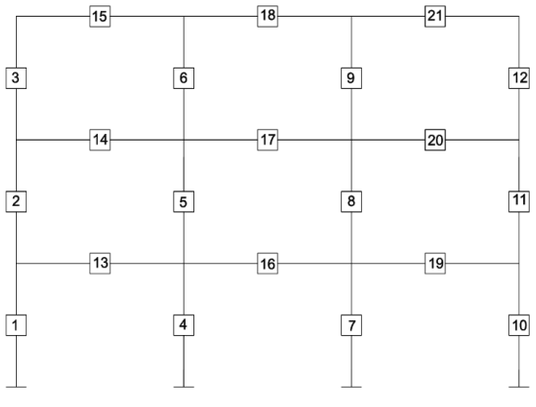


Figure 2. Schematic view and the numbering of the 3-story frame

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The Iranian Code of Retrofitting of Existing Structures no. 360