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A STUDY ON SOME DAMAGE ASSESSMENT METHODS BASED ON THE DYNAMIC CHARACTERISTIC CHANGES

Maryam RAHMATI SELKISARI
M.Sc. Student of Structural Engineering, Kharazmi University, Tehran, Iran
m.rahmati.ss@ut.ac.ir

Ali MASSUMI
Associate Professor in Structural Engineering, Kharazmi University, Tehran, Iran
massumi@khu.ac.ir

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In recent years many researchers have studied on the damage assessment based on dynamic characteristics. Alongside these researches, a lot of damage indices were proposed by researchers to locate and quantify the damage of the structures or to rank their vulnerability relative to each other. The variation of frequency is one of the methods to assess the damage of the structures. It means:

$$\Delta\omega = \omega_d - \omega_0 \tag{1}$$

where ω_0 is the initial frequency of the structure and ω_d is the frequency of the structure after the damage.

Another method to assess the damage based on dynamic characteristics is Softening Indices (DiPasquale and Cakmak, 1987), (DiPasquale and Cakmak, 1989), (DiPasquale et al., 1990). The final softening is based on fundamental period of the structure. It is defined by the following equation:

$$FS = 1 - \frac{{T_0}^2}{{T_d}^2} \tag{2}$$

where T_0 is the initial period of the structureand T_d is the final period of the strucure after the damage.

This paper studies on the performance of the frequency changes and Softening indices to assess the damage. In the paper three RC frames are modeled and nonlinear dynamic analyses are done. To identify the performance of the methods, the damage intensities which are measured by $\Delta\omega$ and FS, are compared to the damage intensities measured by Park-Ang indices. Park-Ang indice is one of the most widely used damage indices (Park and Ang, 1985). It incorporates deformation and hysteretic energy absorption and defined as:

$$D = \frac{d_m}{d_f} + \beta \frac{\int_{E=E_1}^{E=E_M} dE}{F_y d_f} \tag{3}$$

where the integral represents the accumulation of hysteretic energy absorbed. d_m is the maximum displacement and d_f is the final displacement. β is a strength degradation parameter which is proposed 0.1 for well reinforced concrete (Park and Ang, 1985). F_y is the yield strength of the structure. Park-Ang is not based on the dynamic characteristics, but it can be a reliable indice to compare the results.

The correlation between $\Delta\omega$ or FS with Park-Ang is identified by Pearson coefficient (Spiegel, 1992). Pearson correlation coefficient between two sets of variables X and Y is defined as:

$$\rho_{Pearson} = \frac{\sum_{i=1}^{n}(X_i-\bar{X})(Y_i-\bar{Y})}{\sqrt{\sum_{i=1}^{n}(X_i-\bar{X})^2 \sum_{i=1}^{n}(Y_i-\bar{Y})^2}} \tag{4}$$

where $\overline{X}$ and $\overline{Y}$ represent the mean values of X_i and Y_i and n represents the number of pairs (X_i, Y_i).

The results show that in all the frames there are very strong correlations between $\Delta\omega$ or FS with Park-Ang. So it can be concluded that both of the methods are acceptable. Although the Pearson coefficients between $\Delta\omega$ and Park-Ang is a little more than the coefficients between FS and Park-Ang, but the difference is negligible. The difference may be for inaccuracy calculations of the final periods.

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