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ESTIMATION OF MULTIPLE STRIP ANALYSIS CURVE USING IDEALIZED TRILINEAR MODAL PUSHOVER ANALYSIS CURVE

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Multiple Strip Analysis (MSA) is among the most accurate analysis procedures for evaluating nonlinear responses of structures against earthquake excitations (Baker, 2013; Jalayer et al., 2017). Despite the accuracy of the nonlinear response history analysis (RHA) like MSA, needs to significant and time-consuming computational efforts are the negative aspects of this methods. The objective of this research is to present a simplified method for estimating the results of time-consuming multi-strip analysis method. For this object, instead of analyzing a full building model, an equivalent single-degree-of-freedom system will be used and nonlinear dynamic analysis performed under the suits of selected earthquake records for each intensity bin. To estimate the accuracy of simple method, the results compared with the results of full MSA. The MSA performed on selected building models using OpenSees software with parallel computing capability. To evaluate the accuracy of the proposed method, the 9-story 2D model of SAC building that takes place in Los Angeles is considered (Ohtori et al., 2004). The first three natural periods of the structure are 2.24, 0.84 and 0.48 second. P-Δ effects are considered in this analysis by leaning columns. Plastic hinges are defined for two ends of the columns and beams. At the first step, the 9-story building is analyzed by Multi-Strip Analysis under scaled natural earthquake records. The adopted intensity measure in the MSA was the pseudo acceleration at the fundamental period of building under consideration. For each strip, the selected records are scaled to the same spectral acceleration relate to the fundamental period of the buildings under consideration at the mid-level of each strip. Earthquake records are selected using Conditional Mean Spectrum (CMS) as the targeted spectrum (Baker, 2010). The building model also evaluated by Modal Pushover analysis (MPA) procedure (Chopra & Goel, 2001) and its pushover curves were generated for each mode under consideration. MPA could estimate the effect of higher modes on building responses; therefore, the results of MPA are more accurate in comparison with traditional Nonlinear Static procedures. The pushover curve of the model for each mode is simplified by adopting a trilinear idealization. The resulted force-displacement relationship is used for generating single degree of freedom models with unit mass. This SDOFs analyzed using selected earthquake records and the maximum displacement of models was evaluated, then using appropriate relationship the displacement results of SDOFs converted to the roof drift of multistory model. Using these results the MSA percentile curves of nine stories model are estimated (Figure 1). To evaluate the accuracy of the proposed method the resulted MSA curves compared with equivalent method. As it was demonstrated in Figure 1, the participation of higher modes in 16 percentile curve lead to dispersion of responses while participation in 50% is lower than 16%. For 84 percentile the contributions of higher mode are less in comparison to other percentiles. The responses of the estimation for 84 percentile curves are the most accurate among other percentiles and the next accurate estimation could be considered in 50 percent fractile curves.

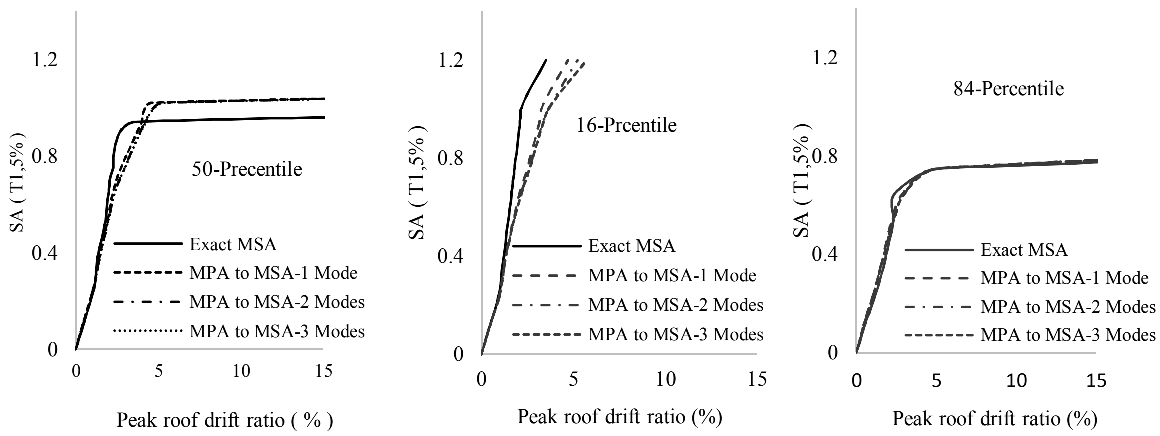

Figure 1. 16, 50 and 84 percent fractile MSA curves for 9 story model versus SDOF curves.

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