EXPLICIT DEMAND MODEL FOR MULTI- STORY STEEL MOMENT RESISTING FRAMES

Mehdi KIA
PhD Student at Department of Civil and Environmental Engineering, Amirkabir University of Technology, Tehran, Iran
mehdikia@aut.ac.ir

Mehdi BANAZADEH
Assistant Professor at Department of Civil and Environmental Engineering, Amirkabir University of Technology, Tehran, Iran
mbanazadeh@aut.ac.ir

Keywords: Probabilistic Models, Incremental Dynamic Analysis, Generic Steel Moment Resisting Frame, Bayesian Regression

Probabilistic structural demand models play important roles in next-generation Performance-Based Earthquake Engineering (PBEE). This concept is commonly developed using statistics which need collecting data in large quantities. Preparation of such a data-base is often costly and time-consuming. In this paper, explicit seismic drift demand model for multi-story steel moment resisting frames is presented to eliminate the need of time-consuming analyses. The demand model is defined as a linear function of intensity measure, the spectral acceleration at fundamental period $\left(Sa(T_1)\right)$, in logarithmic space. The logarithmic transformation is utilized to approximately satisfy the normality assumption (i.e., model error has normal distribution) and homoscedasticity assumption (i.e., Standard deviation of model error is constant). Following equation illustrates general form of the probabilistic model considered in this study:

$$Ln\left[D\left(Sa\left(T_1\right),\Theta\right)\right] = a + b\,Ln\left(Sa\left(T_1\right)\right) + \sigma\varepsilon \qquad (1)$$

Where $Ln\left[D\left(Sa\left(T_1\right),\Theta\right)\right]$ is a response that the model predicts and equal to natural logarithm of the overall maximum inter-story drift and $\Theta = \left(a, b, \sigma\right)$ is a vector of unknown random model parameters.

Albeit, the demand models have a same form for all SMRFs, but their parameters vary from on structure to another one. This is due mainly to differences in the structural characteristics. Computing statistical characteristics of demand model parameters for a real case needs data-base commonly provided by nonlinear dynamic analyses. Preparation of such a data-base is often costly and time-consuming. This motivates authors to develop relations in terms of building characteristics to estimate unknown mean and standard deviation of the model parameters without having to develop any data-base. In the following the relation that estimates mean value of the a is presented. The other relations will be presented in full paper.

$$\mu_a = \alpha_1 N + \alpha_2 \frac{N^2 \times T}{CY} + \frac{\alpha_3}{T \times CY} + \alpha_4 CY + \sigma\varepsilon \qquad (2)$$

T is structural fundamental period which is equal to $C_u T_a$ (Structural Engineering Institute, 2006), N denotes as number of stories and CY indicates yield base shear coefficient. Moreover, SSD illustrates stiffness and strength distribution pattern in height. Its value varies from one to three. It equals one if stiffness and strength distribution in height are proportioned to the story shear force obtained from subjecting the steel moment resisting moment (SMRF) to the ASCE-7-05 (Structural Engineering Institute, 2006), lateral load pattern. In other word, it is assigned one if SMRF has deformed shape as a straight line when subjected to the ASCE-7-05 lateral load pattern. It also equals three for uniform stiffness and strength distribution in height. For other situations, according to deformed shape of structures under lateral load patterns and engineering judgment, a value between one to three should be assigned to SSD. In developing the set of relations, Bayesian regression technique is applied to consider both statistical and aleatory uncertainties in the model. The posterior statistics of the model parameters, α_i , are also proposed in this paper. The main advantage of the proposed equation in particular places on developing demand models for a wide range of SMRFs without requiring time-consuming IDA. This can be appealing for probabilistic assessment such as seismic fragility analysis. To this end, it is only needed to defined demand model for an SMRF in the form of Eq. (1) with random parameters. Then, mean and standard deviation of the model parameters are calculated using proposed relations. As an application of the proposed relations, fragility analysis is performed for three example buildings. The results demonstrated in the form of fragility curves are compared with the results developed due to use of buildings-specific drift demand model. Building-specific demand models are referred to the models specifically developed for each of the sample buildings using IDA.

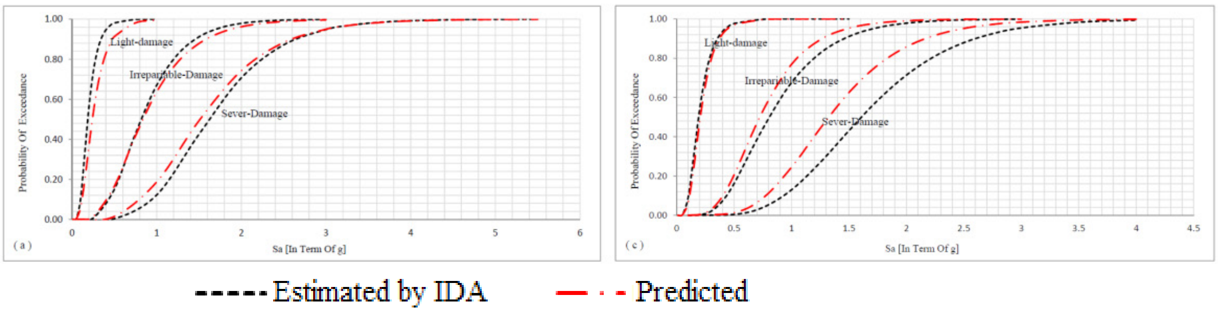

Figure 1. Fragility Curve of (a): four story- building, (c): seven story-building

REFERENCES

Structural Engineering Institute (2006) Minimum Design Loads for Buildings and Other Structures, 7(5), ASCE Publications

Tabandeh A and Gardoni P (2014) Probabilistic capacity models and fragility estimates for RC columns retrofitted with FRP composites, *Engineering Structures*, 74: 3-22