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A Procedure for Deriving Analytical Fragility Curves for Masonry Buildings

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***Abstract*: In this paper, a full discussion and clarification of the fragility curve and its application in building damage will shown in details. Also the types of fragility curve and how the can be plotted is discussed. How building damage is measured by fragility curve is discussed. One G+12 building model is analyzed on ETABS software n time history is carried out. And by that we can get fragility curve as well as building damage.**

***Keywords*: Fragility curves, Masonry buildings, Push over analysis.**

1. Introduction

Bridges in recent earthquakes have proven to possess the most threat to transportation system during and after earthquakes. In addition, well-being of bridges plays a major role in the post-earthquake emergency structures for earthquakes. Also the building performance is same in earthquake. To address the physical aspects of the seismic performance of bridges, or buildings fragility functions or damage probability matrices are developed and used for evaluation purposes. These fragility curves represent the probability of structural damage due to various ground shakings. And more so they describe a relationship between ground motion and level of damage.

Fragility curve: A curve which expresses the probability of failure of a defence as a function of the loading.

Fragility curves is a statistical tool representing the probability of exceeding a given damage state (or performance) as a function of an engineering demand parameter that represents the ground motion

Fragility function: the quality of being easily broken or damaged. fragility function as a mathematical function that expresses the probability that some undesirable event occurs (typically that an asset—a facility or a component—reaches or exceeds some clearly defined limit state) as a function of some measure of environmental excitation (typically a measure of acceleration, deformation, or force in an earthquake, hurricane, or other extreme loading condition). Some people use the term fragility curve to mean the same thing as fragility function. Some use fragility and vulnerability interchangeably. This work will not do so, and will not use the expression "fragility curve" or "vulnerability curve" at all. A function allows for a relationship between loss and two or more inputs, which a curve does not, so "function" is the broader, more general term.

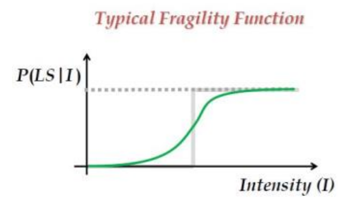

Fig. 1. Typical fragility functions

2. Formation of Fragility Curves

1. Identification of random input variables and hence likely scenarios of systems based on a prototype structure .
2. Quantification of potential earthquake ground motion(s)
3. Evaluation of structural response.
4. Comparison between demand, corresponding to the seismic hazard, and limit states of the sample structural system You can use any style for points.

Analytical relationship:

$$P(\Delta_D > \delta \mid IM = im) = 1 - \Phi\left[\frac{\ln(\delta) - \lambda_{D|IM=im}}{\beta_D}\right]$$

Lognormal	$f(x) = \frac{1}{\beta x \sqrt{2\pi}} \exp\left(\frac{-(\ln x - \mu)^2}{2\beta^2}\right)$ with $x > 0$	x = variable μ = mean β = standard deviation
Normal	$f(x) = \frac{1}{\beta \sqrt{2\pi}} \exp\left(\frac{-(x - \mu)^2}{2\beta^2}\right)$	x = variable μ = mean β = standard deviation

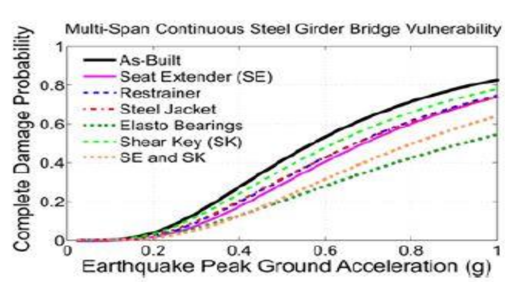

Fig. 2. Typical fragility curves

There are also two alternative approaches are available for deriving curves:

a) structure-specific - evaluating a curve for a particular structure;
b) category-based - creating a curve with the objective

to the representative for a broad category of structures (e.g. buildings of a particular height range and construction material). The techniques for deriving system-specific fragilities are generally based on a detailed structural analysis, while others are based on the statistical analysis of empirical data.

3. Case Study

A new analytical procedure for the derivation of fragility curves for masonry buildings, based on nonlinear static and dynamic stochastic analyses of the whole structure, is presented. The procedure is applied to a prototype building to illustrate all the steps nonlinear static (pushover) analyses of the structures are carried out to identify the probability distributions

Four mechanical damage states have been considered for the derivation of fragility curves, where they are identified on the global pushover curve of the structure. Two of these damage states can be identified from the response of a single masonry pier, while the other two are found from the global response of the building.

Building description and model:

G+16 Residential Building

1. Live load: 2KN/m²
2. Floor finish load: 1KN/m²
3. Thickness of slab: 125mm
4. Thickness of brick masonry: 230mm (all)
5. Density of R.C.C.: 25KN/m³
6. Density of masonry: 20 kN/m3
7. Seismic zone: III
8. Type of strata: Hard Strata
9. Linear damping in the structure: 5%
10. Grade of concrete: M2011. Grade of steel: Fe415
11.column size 300x300 mm
12. Beam size 250x450 mm

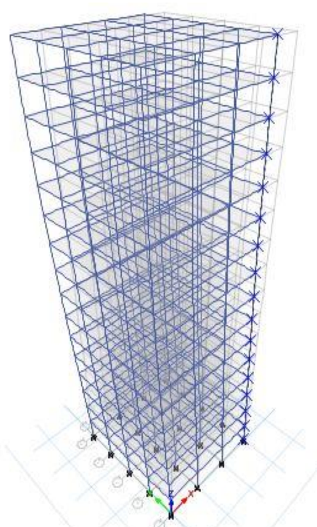

Fig. 3. Building model

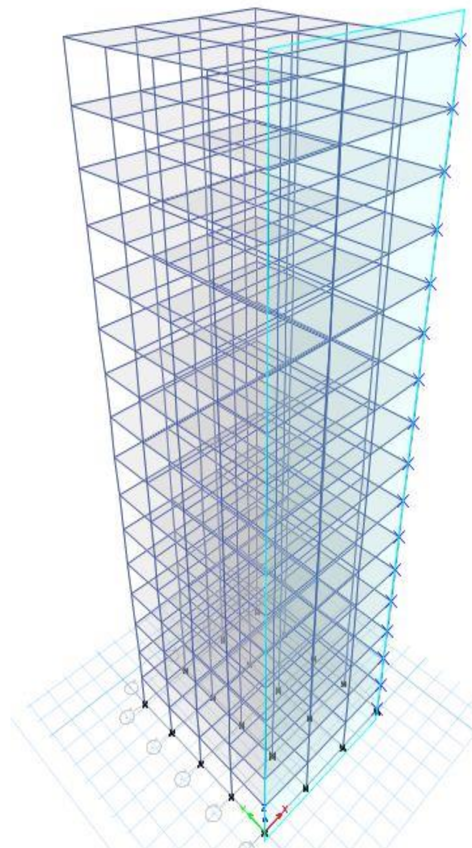

Fig. 4. Building model

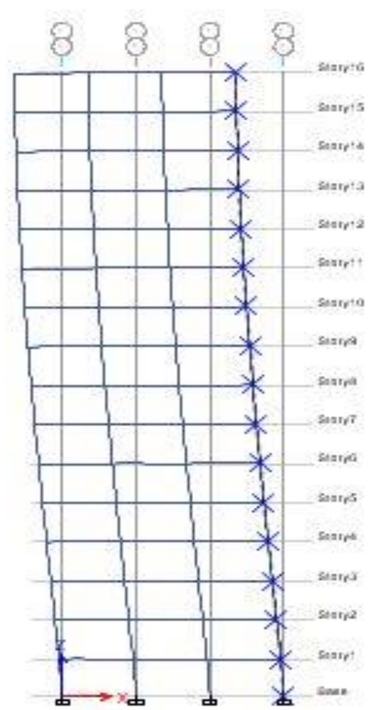

Fig. 5. Building model story view

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4. Results

Table 1

TABLE: Story Forces			
Story	Location	VX	VY
		kN	kN
Story16	Top	55.7684	28.6781
Story15	Top	102.4361	53.8976
Story14	Top	129.3304	70.4762
Story13	Top	134.5139	76.1658
Story12	Top	121.7464	70.37
Story11	Top	104.1071	68.7791
Story10	Top	93.3838	66.2461
Story9	Top	90.1984	57.6047
Story8	Top	82.0027	54.8822
Story7	Top	86.6041	48.0345
Story6	Top	90.4869	44.5579
Story5	Top	90.5116	50.8714
Story4	Top	95.7299	53.104
Story3	Top	129.1615	52.5139
Story2	Top	160.0814	57.471
Story1	Top	174.2358	61.5706

Table 2

TABLE: Joint Drifts		
Story	splacemen	splacement
	mm	mm
Story16	18	8.5
Story15	17.4	8.2
Story14	16.4	7.7
Story13	15.3	6.9
Story12	14.5	6
Story11	13.6	5
Story10	12.5	4.9
Story9	11.3	5
Story8	10.1	4.9
Story7	9	4.6
Story6	8.8	4.1
Story5	8.6	3.5
Story4	7.8	2.8
Story3	6.4	2.1
Story2	4.4	1.4
Story1	1.9	0.6

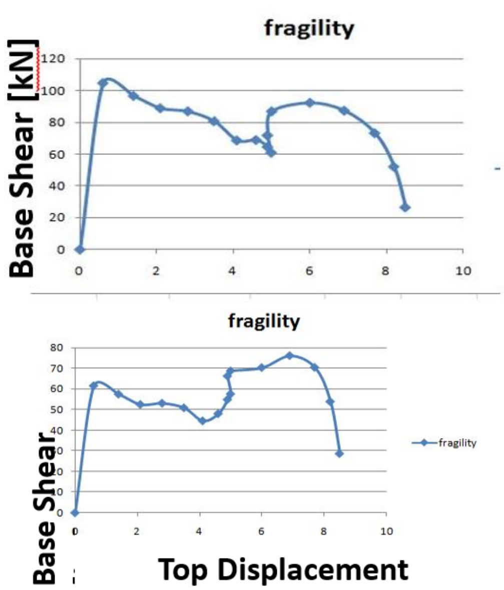

Fig. 4. Formed of fragility curves from actual results

5. Conclusion

At the end of this project, we have been derived the fragility curves. The proposed approach is based on the results of nonlinear stochastic analyses of a prototype building.

6. Future Work

We can determine the mechanical building damage from the fragility curves we get in this work

Also we can get fragility curves from time history analysis method.

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