Seismic Vulnerability Assessment of RC Building

AISWARYA T C, NIKHIL R

Abstract -Vulnerability is generally a term used to indicate the extent of the damage and losses that may probably occur as a result of accidents in buildings. Forecast of vulnerability of existing buildings towards future tremors is one of the most indispensable topics in structural engineering. This paper focuses on the development of fragility curves for a ten story reinforced concrete (RC) commercial building structure in India. Fragility curve is a statistical tool representing the changes in nature of the structural damage as the intensity of ground motion increases. For developing fragility curve a set of earthquake records were selected from pacific earthquake engineering research centre. Earthquake records were scaled in terms of spectral acceleration. Incremental dynamic analysis is carried out to different earthquake records with various intensities using SAP2000.

Key words- *Fragility Curve, Incremental Dynamic Analysis, Spectral acceleration, Scaling, Vulnerability*

1 INTRODUCTION

Earthquake is a quick discharging of energy in earth crust or upper mantle that create seismic wave which results shaking of the surface of earth. The distance from the epicenter, complex combination of the earthquake magnitude and the local geological and geomorphologic conditions are the factors depends on harshness of effects of earthquake. Ground motions are generally measure in terms of ground acceleration using seismograph. Tremor may causes excruciating pain of loss of lives, collapse or destabilization of building and road and bridge damage.

The first step of earthquake response reduction is seismic risk assessment of existing building. Risk assessment is the prediction of potential vulnerability of existing buildings due to future earthquakes to obtain the proper instruction for decreasing the impact of earthquake. The loss or damage of an existing building that may probably occur as a result of accidents in buildings is generally expressed in terms of vulnerability. The damageability of a structure under varying ground motion intensities can be understood from vulnerability assessment. The vulnerability generally expressed as percentage of loss of serviceability, strength or stability of structure for a given seismic intensity level. The aim of vulnerability assessment is to find out probability of damage of a structure due to scenario earthquake. The main objective of the study is to find out risk of a reinforced concrete building by developing fragility curve.

1.1 Fragility Curve

To estimate vulnerability of buildings we can use fragility curves. It is the curve showing intensity of ground motion (peak ground acceleration (PGA), spectral acceleration (S_a), and spectral displacement (S_d)) on X axis and probability of damage on Y axis. FIG 1 shows a typical fragility curve.

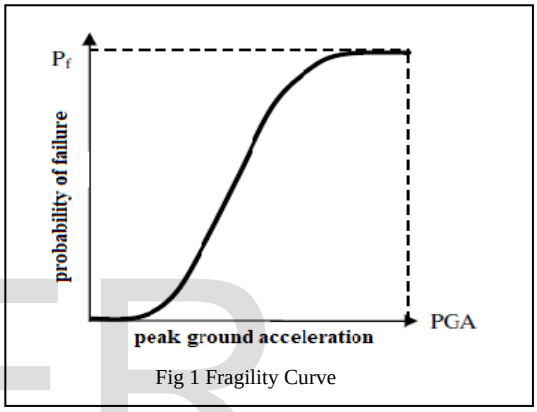

Fig 1 Fragility Curve

Each point of fragility curve shows probability of exceedance of damage parameters such as inter-drift ratio, lateral drift or base shear etc. information from the fragility curve can be utilized to improve the strength, serviceability or stability of the structures.

2 METHODOLOGY

Modeling and analysis is carried out using SAP 2000 v 19.2..2. Building is modeled as 3D framed RC structure. Fragility curve can be developed by using incremental dynamic analysis. Incremental dynamic analysis is basically "Nonlinear Dynamic Analysis". The only difference is that, multiple non linear dynamic analyses done for a single earthquake motion. It is a time consuming method but a more accurate method to evaluate response of the structure. IDA involves performing multiple nonlinear dynamic analyses of a structural model under a suite of ground motion records. Each earthquake data scaled to different levels of seismic intensity. IDA curve is a curve plot between seismic intensity versus maximum storey drift. Fragility curves obtained from the IDA curves.

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2.1 Structural Details of Building

The RCC The selected (G+9) RCC residential building of height 3m in each floor has 5 bays in X and Y direction. It is a symmetric building to avoid torsional effects. The building is assumed to be located in zone V as per IS: 1893-2002.The structure is of high importance due to its post-earthquake functional needs and therefore an importance factor of 1 is adopted. Structural details of building such as material property, section details etc are shown in Table 1.

TABLE 1
BUILDING DETAILS

Design data for all building		
Details of building		
Structure		OMRF
Number of storey		10
Storey height		3m
Seismic zone		V
Material properties		
Concrete grade		M25&M30
Steel grade		Fe 415
Member property		
Slab	Grade	M25
	Thickness	0.150
Beam	Grade	M25
	Size	0.45x0.23
column	Grade	M20
	Size up to 4th	0.60x0.60
	4th to 7th	0.55x0.55
	7th to 10th	0.50x0.50

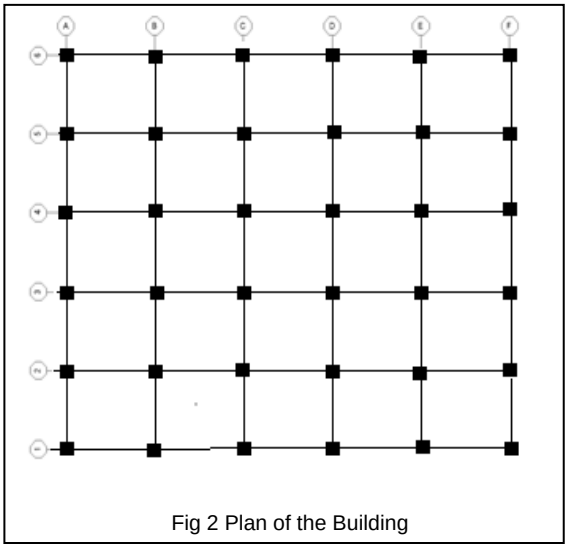

Fig 2 Plan of the Building

2.2 Ground Motion Data

One of the important task for seismic design and analysis is to select a proper real set of ground motions. It is a complex task because each earthquake has different characteristics such as PGA, PGV, distance from epicenter etc. for the present study 22 ground motion records are selected from pacific earthquake engineering research center, based on following criteria.6.5 was the lowest magnitude of the selected earthquake. Earthquake should also have peak ground acceleration and peak ground velocity of 0.2g and 15cm/sec respectively. Distance from source to site should be minimum 10km.

TABLE 2
SELECTED EARTHQUAKE

RSN	EVENT	YEAR	STATION
6	Imperial Valley-02	1940	El Centro Array #9
721	Superstition Hills-02	1987	El Centro Imp. Co. Cent
725	Superstition Hills-02	1987	Poe Road (temp)
767	Loma Prieta	1992	Gilroy Array #3
783	Loma Prieta	1992	Oakland - Outer Harbor Wharf
784	Loma Prieta	1992	Oakland - Title &Trust
802	Loma Prieta	1992	Saratoga - Aloha Ave
803	Loma Prieta	1992	Saratoga - W Valley Coll.
828	Cape Mendocino	1992	Petrolia
848	Landers	1992	Coolwater
864	Landers	1992	Joshua Tree
900	Landers	1992	Yermo Fire Station

RSN	EVENT	YEAR	STATION
960	Northridge 01	1994	Country - W Lost Cany
963	Northridge 01	1994	Castaic - Old Ridge Route
987	Northridge 01	1994	LA - Centinela St
993	Northridge 01	1994	LA - Fletcher Dr
1006	Northridge 01	1994	LA - UCLA Grounds
1111	Kobe, Japan	1995	Nishi-Akashi
1116	Kobe, Japan	1995	Shin-Osaka
1148	Kocaeli, Turkey	1999	Arcelik
1158	Kocaeli, Turkey	1999	Duzce
1602	Duzce, Turkey	1999	Bolu

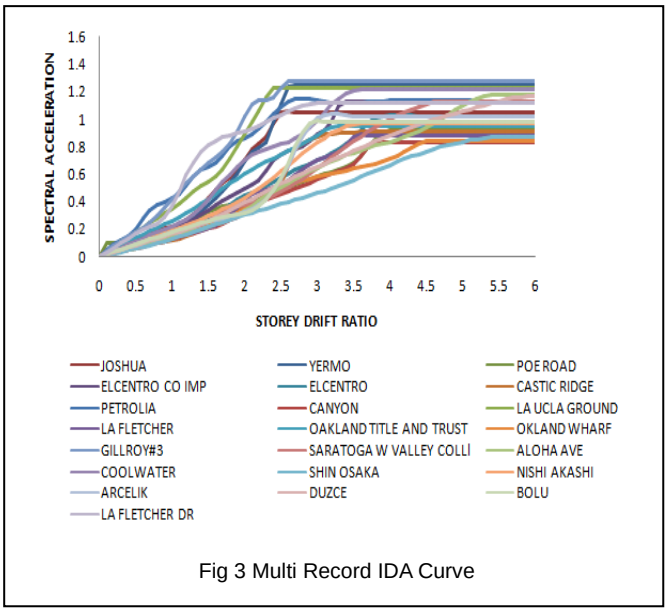

Fig 3 Multi Record IDA Curve

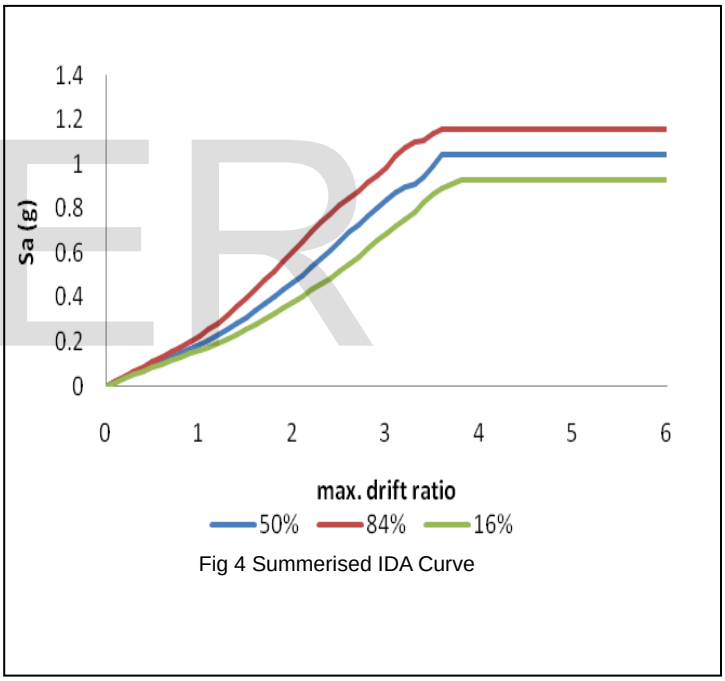

Fig 4 Summerised IDA Curve

3 RESULTS

In this study seismic behavior is studied. Time period and peak storey drift were computed. Seismic vulnerability is studied by using developing fragility.

3.1 Time Period

Time period of undamped free vibration is known as natural time period of the structure. Fundamental time period of the building is 2.037s.

3.2 IDA Curve

IDA curve for 22 earthquakes are drawn below. Ida curve is the curve drawn between max storey drift vs spectral acceleration. A series of Nonlinear Direct Integration Analysis has been carried out under a set of ground motions scaled to a specific level of intensity to achieve IDA curve of 22 earthquakes.

3.4 Fraility Curve

Fragility function gives a relationship between spectral acceleration and probability of damage of the building. Fragility curves are developed from the IDA based on the concept probability.

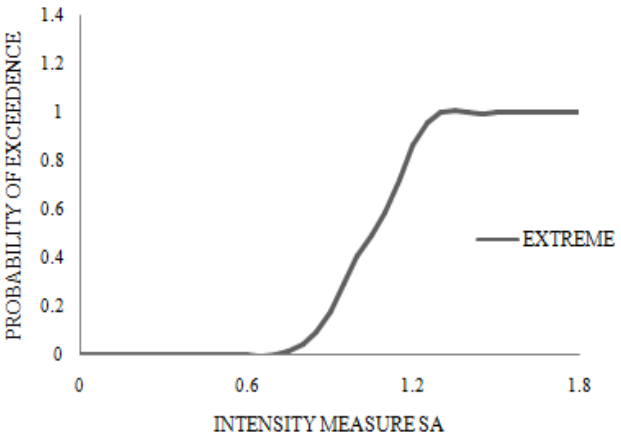

Fig 5 Fragility Curve

4 Conlusion

Seismic vulnerability assessment of RC building has been studied for different intensities of earthquakes. This methodology is an efficient method to evaluate response of building in different intensity levels.IDA curve helps to understand the changes in nature of the structural response as the intensity of ground motion increases.Fragility curve is used to identify seismic performance of the building.Probability of exceedence of damage corresponding to intensity of earthquake can be obtained from fragility curve.To improve seismic performance of the structure, retrofitting like friction damper, viscous damper etc can be used.

5 References

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