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A REVIEW ON PERFORMANCE EVALUATION OF RC MOMENT RESISTING ASYMMETRIC FRAME DESIGNED USING INCREMENTAL DYNAMIC ANALYSIS

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Abstract—as the world move to the accomplishment of Performance Based Engineering philosophies in seismic design of Civil Engineering structures, new seismic design provisions require Structural Engineers to perform both static and dynamic analysis for the design of structures. There are so many methods are evolved to evaluate the seismic capacity and demand of the structure for different seismic excitation. One of the common method used for evaluation of the capacity of the structure is incremental dynamic analysis. Now a day, Incremental Dynamic Analysis (IDA) is emerging as an accurate tool to estimate the capacity of the structure. It involves subjecting a structural model to a number of ground-motion records, each scaled to low severity to high severity.

This parametric study involves safety consideration of RC frames with variation in demand. The behaviour and performance level of the structure in different seismicity have been studied. The results have been compared on basis of base shear versus roof displacement graph, inter-storey drift ratio and the hinge formation mechanism. The study will illustrate the behaviour of the structure for seismic actions and the performance and damages to structure will be acquired. The results will show the proper response of the structure under different seismic loads.

Keywords— Earthquake, Ground Motion, Incremental Dynamic Analysis, RC Moment Resisting Irregular Frames

I. INTRODUCTION

Structural design of buildings for seismic loads is primarily concerned with structural safety during major ground motions, but serviceability and the potential for economic loss are also of concern. Seismic loading requires an understanding of the structural performance under large inelastic deformations.

IDA (I*ncremental Dynamic Analysis)* is powerful mean to study the overall behaviour of structural earthquake of different intensity are applied on the model till the collapse. When slope of incremental dynamic analysis changes from linear to nonlinear yield is reached when incremental dynamic analysis curve become flat or slope less than 20% then we can say yield is reached. To start with incremental dynamic analysis earthquake applied from low intensity to high intensity. Structure collapse at very high intensity measure. Nonlinear dynamic analysis means combining ground motion records with the model.

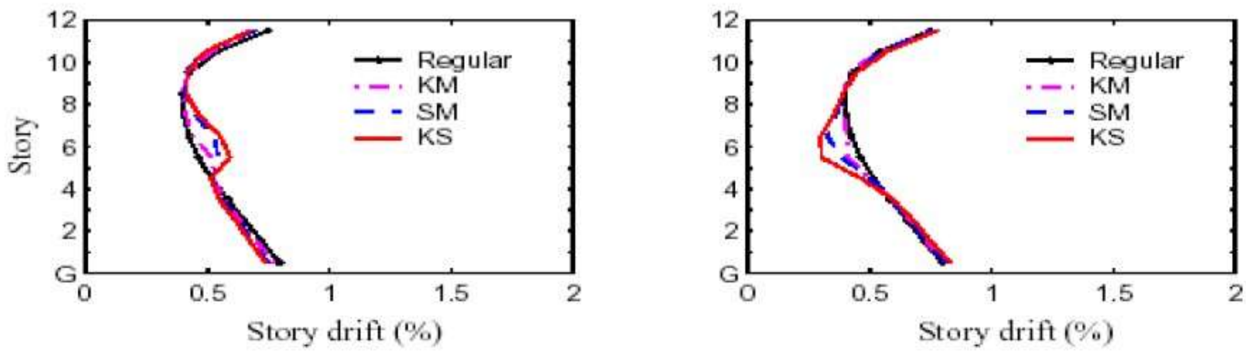
Asymmetric buildings constitute a large portion of the modern urban infrastructure. The group of people involved in constructing the building facilities, including owner, architect, structural engineer, contractor and local authorities, contribute to the overall planning, selection of structural system, and to its configuration. This may lead to building structures with irregular distributions in their mass, stiffness and strength along the height of building. When such buildings are located in a high seismic zone, the structural engineer's role becomes more challenging. Therefore, the structural engineer needs to have a thorough understanding of the seismic response of irregular structures. In recent past, several studies have been carried out to evaluate the response of irregular buildings.

A RC Asymmetric frame structure is modelled and designed according to IS-456:2000 and seismic load combinations are provided as per IS 1893:2002. The structure is designed for all four major seismic zones and checked for capacity under incremental dynamic analysis.

II. LITREATURE REVIEW

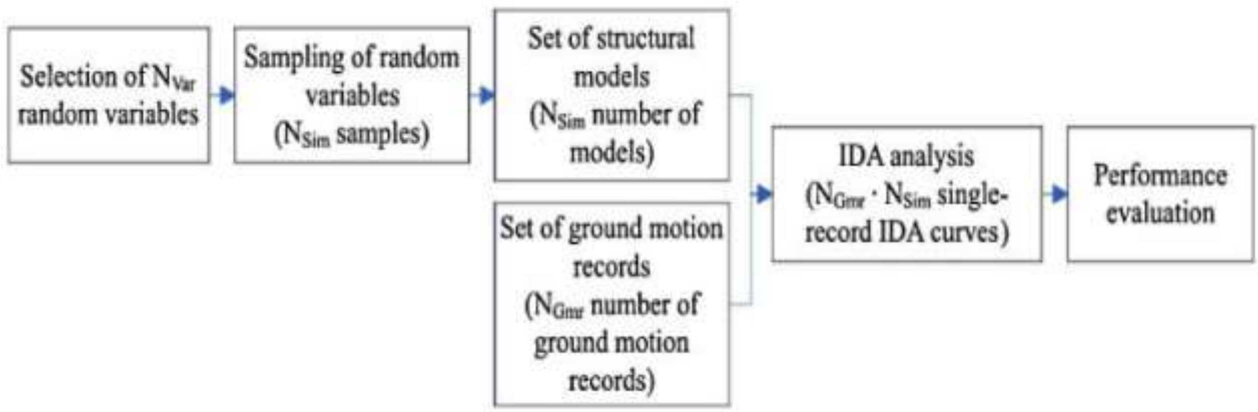
A. Qualitative Review of Seismic Response of Vertically Irregular Building Frames.

Devesh P. Soni, Bharat B. Mistry; "The seismic response of vertically irregular building frames, which has been the subject of numerous research papers, started getting attention in the late 1970s. A large number of papers have focused on plan irregularity resulting in torsion in structural systems. Vertical irregularities are characterized by vertical discontinuities in the distribution of mass, stiffness and strength. Very few research studies have been carried out to evaluate the effects of discontinuities in each one of these quantities independently, and majority of the studies have focused on the elastic response. There have also been detailed studies on real irregular buildings that failed during /earthquakes (Mahin et al., 1976; Kreger and Sozen, 1989), but such studies are small in number. Many researchers studied the response of set-back structures (Humar and Wright, 1977; Aranda, 1984; Moehle and Alarcon, 1986; Shahrooz and Moehle, 1990; Wong and Tso, 1994). In set-back structures there is a sudden change in the vertical distribution of mass, stiffness, and in some cases, strength. A set-back structure is thought of being made up of two parts: a base (the lower part having many bays), and a tower (the upper part with fewer bays)."



B. Incremental Dynamic Analysis with Considerations of Modelling Uncertainties.

Matjaz Dolsek; The goal of the extended incremental dynamic analysis (extended IDA) is to consider the effects of epistemic uncertainty on the structural response parameters in addition to record-to-record
Variability, which in the IDA analysis is introduced through a set of Ground Motion Records (GMR). In the proposed methodology, this goal is achieved by introducing a set of structural models, which reflect the
Epistemic uncertainty. This set of structural models has to be defined in such a way that it describes the epistemic uncertainty in the best possible manner, provided that important uncertainties are considered in the set of structural models, and that the number of structural models is reasonably low. In this case, the result of the extended IDA analysis is the EDP, which depends on the intensity measure (IM), the selected set of GMR, and the selected random variables *Xi*, through which epistemic uncertainty is introduced into the structural models.

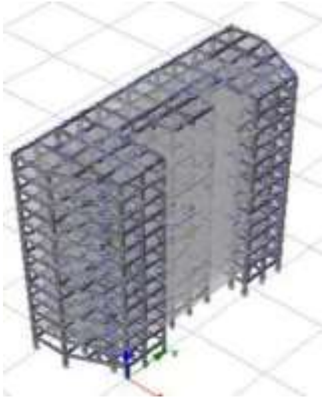


The main steps of the extended IDA analysis

C. Incremental Dynamic Analysis and Static Pushover Analysis of Existing RC Framed Buildings Using the SeismoStruct Software.

Rahul Rashke, Dr. Uttam Kalwane; Incremental dynamic analysis is quite accurate and actual response of the structure of the structure from the particular considered earthquake can be obtained by this method. It involves performing a series of nonlinear dynamic analyses in which the intensity of the ground motion selected for the collapse investigation is incrementally increased until the global collapse capacity of the structure is reached. In this chapter, building capacity is found out by using incremental dynamic analysis. Graph of base shear to top displacement from incremental dynamic analysis is plotted. Capacity base shear from Incremental dynamic analysis method for G+11 building is calculated. Which is carried out in SeismoStruct software.

(a)



(b)

Model Of the Building (a) Staad-Pro Model (b) SeismoStruct Model

Yield and Collapse Base Shear Of G+11 Building

Time History	Station	Yield Base Shear) X direction	Collapse Base Shear (kN) X direction	Yield Base Shear (kN) Y direction	Collapse Base Shear (kN) Y direction
2001 Bhuj	Bhuj L	1400	1990	1450	2100
1991 Uttarkashi	UttarkashiT	1370	1920	1410	2080
1967 Koyna	Koyna L	1500	2190	1575	2210
1991 Uttarkashi	BhatwariT	1450	1880	1480	1930
1967 Koyna	KoynaT	1380	1890	1400	1930
1986 Dharmshala	DharmshalL	1510	1920	1575	1980
1986 Dharmshala	DharmshalaT	1280	1820	1350	1870
1995 Chamba	ChambaL	1345	1830	1360	1900
1995 Chamba	ChambaT	1330	1850	1390	1880
Median		1375	1885	1405	1950
Base Shear (IS:1893)		850		880	

D. **The Incremental Dynamic Analysis and its application to performance-based earthquake engineering.**

Dimitrious Vavastsikos, C. Allin Cornell; "In order to assess the performance evaluation a methodology was developed, based on inelastic static pushover (SPO) analysis, following an initial design and a series of failure Limit Criteria (LC) evaluations in order to establish the limiting deformability of the structure. This methodology is applicable to both modern and existing RC frames of interest herein. The details of the evaluation process, the modeling conventions and the LC adopted were described in this paper. The results are presented, concerned with the evaluation of the structural over-strength, the global ductility and the available behavior factor of existing reinforced concrete (RC) buildings designed and constructed according to past generations of earthquake resistant design codes in Greece. A collection of 85 typical building forms is considered. The influence of various parameters is examined, such as the geometry of the structure (number of storeys, bay width etc.), the vertical irregularity, the contribution of the perimeter frame masonry infill walls, the period of construction, the design code and the seismic zone coefficient. The results from inelastic pushover analyses indicate that existing RC buildings exhibit higher over-strength than their contemporary counterparts, but with much reduced ductility capacity. The presence of perimeter infill walls increases considerably their stiffness and lateral resistance, while further reducing their ductility. Fully infilled frames exhibit generally good behavior, while structures with an open floor exhibit the worst performance by creating a soft storey. Shear failure becomes critical in the buildings with partial height infills. It is also critical for buildings with isolated shear wall cores at the elevator shaft. Out of five different forms of irregularity considered in this study, buildings with column discontinuities in the ground storey exhibit the worst performance. Furthermore, buildings located in the higher seismicity zone are more vulnerable, since the increase of their lateral resistance and ductility capacity is disproportional to the increase in seismic demand."

SET OF GROUND MOTION RECORDS

No	Event	Station	ϕ^{o} [1]	Soil[2]	M[3]	R[4] (km)	PGA (g)
1	Loma Prieta, 1989	Agnews State Hospital	090	C,D	6.9	28.2	0.159
2	Imperial Valley, 1979	Plaster City	135	C,D	6.5	31.7	0.057
3	Loma Prieta, 1989	Hollister Diff. Array	255	–,D	6.9	25.8	0.279
4	Loma Prieta, 1989	Anderson Dam Downstream	270	B,D	6.9	21.4	0.244
5	Loma Prieta, 1989	Coyote Lake Dam Downstream	285	B,D	6.9	22.3	0.179
6	Imperial Valley, 1979	Cucapah	085	C,D	6.5	23.6	0.309
7	Loma Prieta, 1989	Sunnyvale Colton Ave	270	C,D	6.9	28.8	0.207
8	Imperial Valley, 1979	El Centro Array #13	140	C,D	6.5	21.9	0.117
9	Imperial Valley, 1979	Westmoreland Fire Station	090	C,D	6.5	15.1	0.074
10	Loma Prieta, 1989	Hollister South & Pine	000	–,D	6.9	28.8	0.371
11	Loma Prieta, 1989	Sunnyvale Colton Ave	360	C,D	6.9	28.8	0.209
12	Superstition Hills, 1987	Wildlife Liquefaction Array	090	C,D	6.7	24.4	0.180
13	Imperial Valley, 1979	Chihuahua	282	C,D	6.5	28.7	0.254
14	Imperial Valley, 1979	El Centro Array #13	230	C,D	6.5	21.9	0.139
15	Imperial Valley, 1979	Westmoreland Fire Station	180	C,D	6.5	15.1	0.110
16	Loma Prieta, 1989	WAHO	000	-,D	6.9	16.9	0.370
17	Superstition Hills, 1987	Wildlife Liquefaction Array	360	C,D	6.7	24.4	0.200
18	Imperial Valley, 1979	Plaster City	045	C,D	6.5	31.7	0.042
19	Loma Prieta, 1989	Hollister Diff. Array	165	–,D	6.9	25.8	0.269
20	Loma Prieta, 1989	WAHO	090	–,D	6.9	16.9	0.638

[1] Component [2] USGS, Geomatrix soil class [3] moment magnitude [4] closest distance to fault rupture

III. CONCLUSION

From the above literature we conclude that

1) When Gypsum Wall Board was included in the IDA performance of the structure was very good until a spectral acceleration of 1.2g was reached.
2) We can conclude that Yield and collapse peak ground acceleration of Building is 0.73 from IS:1893-2002
3) Conclusion is justified through the IDA of an 11-storeyed frame using far-field and near-field earthquakes and found that there is considerable increase in base shear demand, maximum roof displacement and inter - storey drift due to near-field earthquake.
4) We can conclude that Yield and collapse Base shear of Building is in X-direction is 850 KN and in Y- direction 880 KN from IS:1893-2002

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