International Journal of Research
Available at https://edupediapublications.org/journals
e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 04 Issue14
November 2017

Seismic Performance Of A Regular And Irregular Structure With And With Out Setbacks

Ma.Shahabaaz & Ms. Shivangi Bharadwaj
Department Of Civil Engineering Bharat Institute Of Engineering And Technology
Assistant Professor Department Of Civil Engineering Bharat Institute Of Engineering And Technology

ABSTRACT:

A typical sort of vertical geometrical anomaly in building structures emerges from unexpected diminishment of the sidelong measurement of the working at particular levels of the rise. This building class is known as the difficulty building. Different specialists have examined the conduct of mishap structures by considering distinctive methodologies, which rotate for the most part around geometric, mass, solidness and diverse strategies for seismic investigation.. Seismic tremor is an imperative angle to be considered while outlining structures. Parcel of work has been accounted for by numerous analysts who attempted to think about the impact of structures with unpredictable arrangement. This paper presents impacts of plan and shape arrangement on sporadic molded structures. Structures with unpredictable geometry react diversely against seismic activity. Plan geometry is the parameter which chooses its execution against various stacking conditions. The impact of inconsistency (design) on structure has been done by utilizing basic examination programming ETABS for three unique sorts of soil considering the impact of soil structure association. There are a few variables which influence the conduct of working from which story float and sidelong uprooting assume a vital part in understanding the conduct of structure. Results are communicated in type of diagrams and bar outlines. In light of these conclusions have been exhibited.

INTRODUCTION

GENERAL:

Seismic tremors are the most eccentric and pulverizing of every cataclysmic event, which are exceptionally hard to spare over designing properties and life, against it. Henceforth keeping in mind the end goal to conquer these issues we have to distinguish the seismic execution of the manufactured condition through the advancement of different investigative strategies, which guarantee the structures to withstand amid visit minor tremors and deliver enough alert at whatever point subjected to significant quake occasions so it can spare however many lives as could be expected under the circumstances. The examination system evaluating the quake powers and its request contingent upon the significance and cost, the strategy for investigating the structure fluctuates from direct to non straight. The conduct of a working amid a seismic tremor relies upon a few variables, firmness, and sufficient horizontal quality, and pliability, basic and normal designs. The structures with customary geometry and consistently conveyed mass and solidness in design and in addition in height endure significantly less harm contrasted with sporadic setups. Be that as it may, these days need and request of the most recent era and developing populace has made the designers or specialists unavoidable towards arranging of sporadic setups.

In the last 25years, the globe has encountered numerous Earthquakes of bigger extents prompting gigantic loss of lives and broad physical decimation. Past encounters uncover that for similar sizes of tremors, the misfortune happened in creating and immature nations are substantially more. This might be ascribed to the absence of mindfulness and specialized learning identified with the parts of seismic danger appraisal and alleviation. Because of late serious seismic tremors, a considerable measure of study is required in the improvement of quake safe structures. Quakes exhibit a danger to open wellbeing and welfare in the noteworthy bit all around. We can't stop tremors yet we can keep ourselves from them, as seismic tremors don't slaughter people, yet the structures do. In the previous decade, India has seen significant seismic tremors on the planet. It is in this way real to inquire as to why

e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 04 Issue14
November 2017

developments powerless against tremors exist if individuals and organizations knew about the seismic perils. A few causes may have added to the formation of such a circumstance.

SEISMIC MAPS:

Seismicity pattern of India characterizes it as a very fluctuated nation regarding seismic exercises. Fig 1.1 demonstrates the seismicity guide of India, it can be seen that the Deccan level district being inclined to less seismicity. The primary seismic danger guide of India was gathered by the Geological Survey of India (GSI) in 1935. This was the main guide proposed by GSI, after this, all maps were arranged and proposed by India Standard Institute (ISI). The second guide was discharged in 1962 (see fig 1.2) by the Indian Standards Institute (ISI) by and by called as Bureau of Indian Standards (BIS). This guide was distributed in Indian Seismic Design Code IS 1893:1962. The guide partitioned India into 7 seismic zones from zone 0 (no harm) to zone VI (broad harm). This division depended on the Maximum Mercalli Intensities (MMI). In this guide, peninsular India is appeared as steady area. It accept that if at all there is a seismic tremor in PI area it won't influence structures. The third guide was distributed in 1966 (see fig 1.2) four years after second guide got distributed. This guide again separated India into 7 seismic zones from zone 0 to zone VI.

Seismicity of India

SEISMIC METHODS OF ANALYSIS:

Equivalent static analysis

This approach defines a series of forces acting on a building to represent the effect of earthquake ground motion. It assumes that the building responds in its fundamental mode. For this to be true, the building must be low-rise and must not twist significantly when the ground moves. The response is read from a design response spectrum, given the natural frequency of the building (either calculated or defined by the building code). The applicability of this method is extended in many building codes by applying factors to account for higher buildings with some higher modes, and for low levels of twisting. To account for effects due to "yielding" of the structure, many codes apply modification factors that reduce the design forces (e.g. force reduction factors).

REVIEW OF LITERATURE

The seismic reaction of vertically sporadic structures, which has been the subject of various research papers, began getting consideration in the late 1970s. Countless have concentrated on design inconsistency bringing about torsion in auxiliary frameworks. Vertical inconsistencies are described by vertical discontinuities in the dissemination of mass, solidness and quality. Not very many research contemplates have been completed to assess the impacts of discontinuities in every last one of these amounts autonomously, and larger part of the investigations have concentrated on the flexible reaction. There have additionally been itemized considers on genuine unpredictable structures that fizzled amid seismic tremors (Mahin et al., 1976; Kreger and Sozen, 1989), however such investigations are little in number. Numerous scientists examined the reaction 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 dissemination of mass, solidness, and sometimes, quality. A set-back structure is thought of being comprised of two sections: a base (the lower part having many coves), and a tower (the upper part with less sounds).

IRREGULARITIES IN STRUCTURES

GENERAL:

The building design has been portrayed as consistent or unpredictable as far as size and state of the building, course of action of auxiliary components and mass. Normal building setups are practically symmetrical (in plan and height) about the hub and have uniform dispersion of the sidelong compel opposing structure to such an extent that, it gives a constant load way to both gravity and horizontal burdens. A building that needs symmetry and has brokenness in geometry, mass, or load opposing components is called "unpredictable". These inconsistencies may cause intrusion of drive stream and stress fixations. Topsy-turvy game plans of mass and firmness of components may cause a huge torsional drive (where the focal point of mass does not match with the focal point of unbending nature). The structures harm because of a few or alternate reasons amid seismic tremors. Notwithstanding every one of the shortcomings in the structure, either code flaws or mistake in investigation and plan, the basic design framework has assumed a fundamental part in calamity. The IS: 1893 (Part I):2002 has suggested constructing setup framework in area 7 for the better execution of RC structures amid quakes. The encounters from the past solid tremors demonstrate that the underlying applied outline of a building is critical for the conduct of the working amid a seismic tremor. It was indicated more than once that no unique examination could guarantee a decent dispersal of vitality and ideal conveyance of harm in unpredictable structures, such as, structures with huge asymmetry or misfortunes. Latest seismic tremors have demonstrated that the inconsistencies in design, height, dispersion of mass, solidness and qualities may cause genuine harm in auxiliary frameworks. In any case, a precise assessment of the seismic conduct of unpredictable structures is very troublesome and a confounded issue. There are various cases in the harm report of past quakes in which the reason for disappointment of multi-storied fortified solid structures is

nomalies in setups.

Buildings with irregular shape suffered an extensive damage in Bhuj (2001)

The duty regarding a "decent" beginning applied outline lies with the designer, and in addition with the auxiliary architect giving numerical evidence of the structure's security. The rules for a "decent" applied plan are incorporated into construction regulations; in any case, the codes are substantially more suited to the necessities of auxiliary specialists with regards to the necessities of planners, where numerous prerequisites identified with beginning outline incorporate formulae with parameters that could be acquired just by preparatory dynamic examination. Then again, same prerequisites are detailed just as suggestions and their satisfaction relies upon understanding and judgment of the architect. Starting here of view the participation amongst draftsman and auxiliary designer would be thusly vital likewise amid the underlying period of the outline of the building. By and by, it is hard to perform dynamic examination if, for instance, the floor design is still under dialog, so this collaboration is not working legitimately much of the time (particularly for less mind boggling structures). It is obvious that planners ought to be acquainted with the essential tenets of seismic tremor safe outline, so they can be consolidated in their building arrangement as of now from the principal draw.

ARCHITECT, CONSTRUCTOR AND INITIAL BUILDING DESIGN:

The underlying building is typically proposed by a designer who ought to fit the necessities of financial specialist with his own thoughts and ideas, and also with static and different advancements prerequisites. It is additionally important to adjust the usefulness of the working, to characterize the real measurements of the building and to propose the game plan of the rooms in the way that relate best to the given area, and also to the requirements of the financial specialist and additionally client. Obviously the modeler additionally tends to outline an unmistakable structure and endeavors to satisfy the design, urban and masterful criteria. On this premise the layout plan of the building is typically chosen. Commonly by then the structure is as of now all around characterized and regularly additionally affirmed by the speculator. The auxiliary examination, that takes after, might uncover a few mix-ups and for this situation it is important to redress the venture. This stage causes numerous inconsistencies amongst compositional and basic field. Clashes begin much of the time between the modelers, who does not have enough learning about development, and structural specialist who don't have the comprehension of many-sided quality of the designer's work and his masterful mission when planning a building and site. In the typical practice these days it appears that the decision of the structure design is left to the planner and the evidence of its wellbeing is left only to the basic designer. This approach is incapable and ought to be dealt with as antiquated. More mind boggling and self important compositional manifestations that we are seeing today request a dynamic collaboration among draftsmen and engineers from all fields. We trust the displayed outline will at any rate to some stretch out help to defeat the broad issue of so required shared collaboration.

Reasons for abnormalities in structures

1. Construction in Hilly ranges
2. Modern/new patterns in business edifices
3. Thickly populated ranges

CLASSIFICATION OF IRREGULARITIES:

The auxiliary abnormalities are sorted in three sorts as:

a) Plan Irregularities

b) Vertical Irregularities

c) Other Irregularities

Plan Irregularities

Plan Irregularities alludes to hilter kilter design shapes (e.g. L, T, U, F, +) or discontinuities in the level opposing components (stomachs, for example, cut-outs, huge openings, re-contestant corners and other sudden changes bringing about torsion, stomach misshapenings and stretch focus.

Table. Example of typical natural frequencies depending on building type

Type of Structure	Natural Frequency (Hz)
1 storey buildings	10
2 storey buildings	5
3-4 storey buildings	2
Tall buildings	0.5-1.0
High rise buildings	0.17

NUMERICAL STUDIES

GENERAL:

Most building codes prescribe the method of analysis based on whether the building is regular or irregular. Almost all the codes suggest the use of static analysis for symmetric and selected class of regular buildings. For buildings with irregular configurations, the codes suggest the use of dynamic analysis procedures such as response spectrum method or time history analysis. When the stiffness and associated strength are abruptly reduced in a storey along height, earthquake-induced deformations tend to concentrate at the flexible and/or weak storey. The concentration of damage in a storey leads to large deformations in vertical members. The excessive deformation in vertical members often leads to collapse of the storey. The experiences from the past strong earthquakes prove that the initial conceptual design of a building is extremely important for the behaviour of the building during an earthquake. It was shown repeatedly that no dynamic analysis could assure a good dissipation of energy and favourable distribution of damage in irregular

e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 04 Issue14
November 2017

buildings, such as, for example, structures with large asymmetry or setbacks. In the present work, the test structure is an eight storey re-entrant corner building with setback provided at every two levels. The building is compared with the normal building without any setbacks and building with setback at each level. Experimental observations of both buildings are supplied with series of analytical methods, response spectrum method (linear dynamic) and time history analysis (non-linear dynamic). ETABS 9 has been used to perform the above mentioned analysis. The effect of setbacks is studied considering the parameters such as Time period, Storey Drifts, Storey Shears, Displacements, Bending Moments and Shear Forces for identical columns of both the buildings for comparison.

DESCRIPTION OF SAMPLE BUILDING:

The plan layouts for the building modals with and without Setbacks are shown in figures.

Model 1: Asymmetrical building with set backs

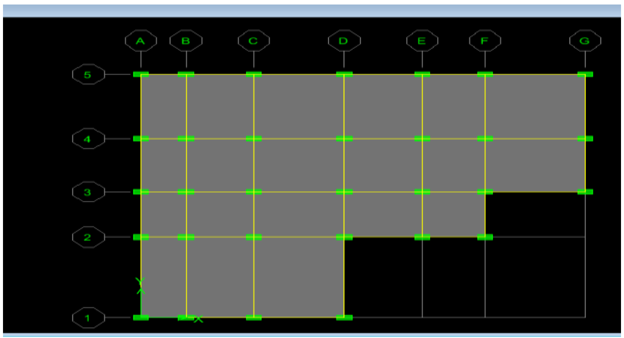


Fig: asymmetrical plan view with set backs

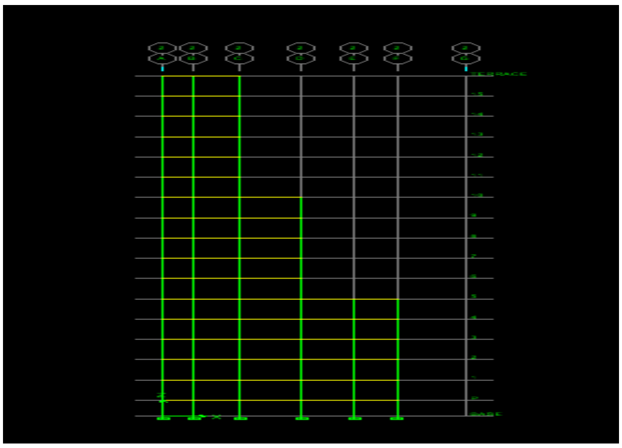


Fig: asymmetrical elevation view with set backs

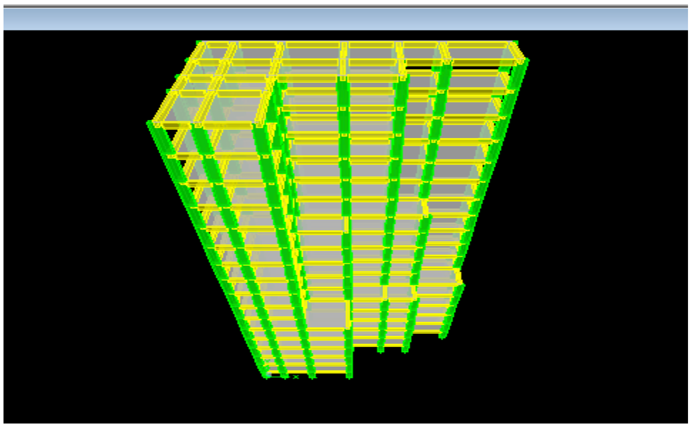


Fig: asymmetrical 3D view with set backs

Model 2: Asymmetrical building without set backs

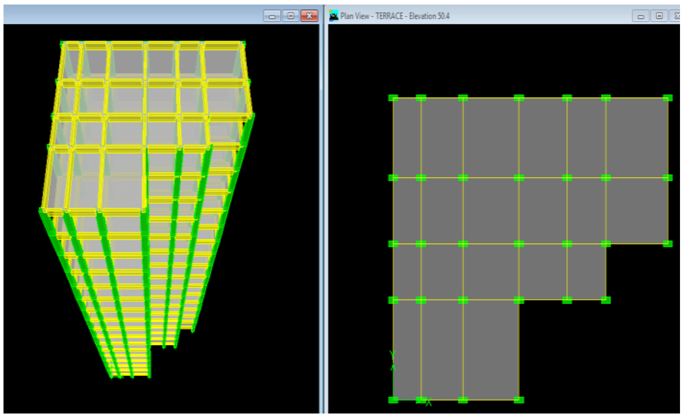


Fig: asymmetrical plan & 3D view for structure without set backs

Example Buildings Studied

The plan layout, elevation and 3D view of the reinforced concrete moment resisting frame building of 15 storied building for a symmetrical building with and without set back and an asymmetrical building with and without set back. In this study, the plan layout is deliberately kept similar for the buildings under study. The each storey height is kept 3 m for all the 4 building models. The buildings are considered to be located in the seismic zone-2 and intended for commercial (Hotel) use. In the seismic weight calculations only 25% of the floor live load is considered. The input data given for all the different buildings is detailed below.

Design Data

Material Properties

Model 1:

Young's modulus of (M30) concrete, E = 27.386×10^6 KN/m²

Young's modulus of (M25) concrete, E = 25×10^6 KN/m²

Density of Reinforced Concrete = 25KN/m³

Assumed Dead load intensities

Floor finishes = 1.5KN/m²

Live load (Rooms) = 3 KN/ m²

Member properties

Thickness of Slab = 0.125m

Column size for all floors = (0.6mx0.6m),(0.3mx0.60m)

Beam size = (0.23m x 0.575m)

Earthquake Live Load on Slab as per clause 7.3.1 and 7.3.2 of IS 1893 (Part-I) - 2002 is calculated as:

IS: 1893-2002 Equivalent Static method

Design Spectrum

Zone – II

Zone factor, Z (Table2) – 0.10

Importance factor, I (Table 6) – 1.0

Response reduction factor, R (Table 7) – 5.00

Vertical Distribution of Lateral Load, $f_i = V_B \frac{w_i h_i^2}{\sum_{j=1}^{n} w_j h_j 2}$

IS: 1893-2002 Response Spectrum Method: Spectrum is applied from fig.2 of the code corresponding to medium soil sites. The spectrum is applied in the longitudinal and transverse directions.

CALCULATIONS:

Natural periods and average response acceleration coefficients:

For Eight – Storied building with Setback:

Fundamental Natural period, Ta= $0.075*h^{0.75}$ (For Bay Frame)

$= 0.075*50.4^{0.75}$

= 1.4186sec

For medium soil sites, Sa/g = $\frac{1.36}{T}$ (Because 0.55 ≤ T ≤ 4.00)

$= \frac{1.36}{1.4186} = 0.9586$

Design horizontal seismic coefficient,

$$A_h = \frac{Z}{2} x \frac{I}{R} x \frac{Sa}{g}$$

$A_h = \frac{0.10}{2} x \frac{1}{5} x\ 0.9586 = 0.00956$

Design Seismic Base Shear for Model 1 = V_B = -------- KN

PERFORMED ANALYSIS IN ETABS:

The analysis and design of the building is carried out using ETABS computer program. The following topics describe some of the important areas in the modelling. The innovative and revolutionary new ETABS is the ultimate integrated software package for the structural analysis and design of buildings. Incorporating 40 years of continuous research and development, this latest ETABS offers unmatched 3D object based modelling and visualization tools, blazingly fast linear and nonlinear analytical power, sophisticated and comprehensive design capabilities for a wide-range of materials, and insightful graphic displays, reports, and schematic drawings that allow users to quickly and easily decipher and understand analysis and design results. From the start of design conception through the production of schematic drawings, ETABS integrates every aspect of the engineering design process. Creation of models has never been easier - intuitive drawing commands allow for the rapid generation of floor and elevation framing. CAD drawings can be converted directly into ETABS models or used as templates onto which ETABS objects may be overlaid. The state-of-the-art SAP Fire 64-bit solver allows extremely large and complex models to be rapidly analyzed, and supports nonlinear modelling techniques such as construction sequencing and time effects (e.g., creep and shrinkage). Design of steel and concrete frames (with automated optimization), composite beams, composite columns, steel joists, and concrete and masonry shear walls is included, as is the capacity check for steel connections and base plates. Models may be realistically rendered, and all results can be shown directly on the structure. Comprehensive and customizable reports are available for all analysis and design output, and schematic construction drawings of framing plans, schedules, details, and cross-sections may be generated for concrete and steel structures. ETABS provides an unequalled suite of tools for structural engineers designing buildings, whether they are working on one-story industrial structures or the tallest commercial high-rises. Immensely capable, yet easy-to-use has been the hallmark of ETABS since its introduction decades ago, and this latest release continues that tradition by providing engineers with the technologically-advanced, yet intuitive, software they require to be their most productive.

RESULTS

MODEL 1: ASYMMETRICAL L SHAPED BUILDING WITH SET BACKS:

Model 1:

Young's modulus of (M30) concrete, E = 27.386×10^6 KN/m²

Young's modulus of (M25) concrete, E = 25×10^6 KN/m²

Density of Reinforced Concrete = 25KN/m³

Assumed Dead load intensities Floor finishes = 1.5KN/m²

Live load (Rooms)= 3 KN/ m²

Member properties

Thickness of Slab= 0.125m

Column size for all floors= (0.6mx0.6m),(0.3mx0.60m)

Beam size= (0.23m x 0.575m)

Earthquake Live Load on Slab as per clause 7.3.1 and 7.3.2 of IS 1893 (Part-I) - 2002 is calculated as:

IS: 1893-2002 Equivalent Static method

Design Spectrum

Zone – II

Zone factor, Z (Table2) – 0.10

Importance factor, I (Table 6) – 1.0

Response reduction factor, R (Table 7) – 5.00

Vertical Distribution of Lateral Load, $f_i = V_B \frac{w_i h_i^2}{\sum_{j=1}^{n} w_j h_j 2}$

IS: 1893-2002 Response Spectrum Method: Spectrum is applied from fig.2 of the code corresponding to medium soil sites. The spectrum is applied in the longitudinal and transverse directions.

CALCULATIONS:

Natural periods and average response acceleration coefficients:

For Eight – Storied building with Setback:

Fundamental Natural period, Ta= $0.075*h^{0.75}$ (For Bay Frame)

$= 0.075*50.4^{0.75}$

= 1.4186sec

For medium soil sites, Sa/g = $\frac{1.36}{T}$ (Because $0.55 \leq T \leq 4.00$)

$= \frac{1.36}{1.4186} = 0.9586$

e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 04 Issue14
November 2017

Design horizontal seismic coefficient, $A_h = \frac{Z}{2} x \frac{I}{R} x \frac{Sa}{g}$

$A_h = \frac{0.10}{2} x \frac{1}{5} x\ 0.9586 = 0.00956$

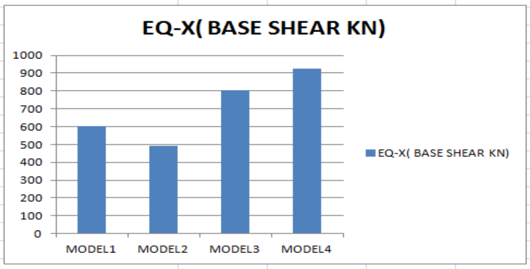
Design Seismic Base Shear for Model 1 = V_B = -------- KN

CENTRE OF MASS AND CENTRE OF RIGIDITY: due to EQ-X &EQ-Y direction

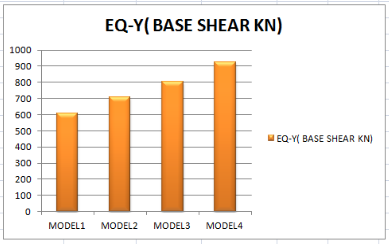
	A	B	C	D	E	F	G	H	I	J
1	Story	Diaphragm	MassX	MassY	XCM	YCM	XCR	YCR	XCM-XCR	YCM-Y
2	TERRACE	D1	244.304	244.304	6.329	9.718	5.85	10.155	0.479	-0.
3	15	D1	333.8797	333.8797	6.224	9.689	5.952	10.028	0.272	-0.
4	14	D1	333.8797	333.8797	6.224	9.689	6.062	9.9	0.162	-0.
5	13	D1	333.8797	333.8797	6.224	9.689	6.18	9.77	0.044	-0.
6	12	D1	333.8797	333.8797	6.224	9.689	6.305	9.637	-0.081	0.
7	11	D1	333.8797	333.8797	6.224	9.689	6.44	9.502	-0.216	0.
8	10	D1	366.3229	366.3229	6.525	9.483	6.562	9.378	-0.037	0.
9	9	D1	369.0495	369.0495	6.557	9.46	6.654	9.271	-0.097	0.
10	8	D1	369.0495	369.0495	6.557	9.46	6.761	9.157	-0.204	0.
11	7	D1	369.0495	369.0495	6.557	9.46	6.888	9.03	-0.331	[illegible]
12	6	D1	369.0495	369.0495	6.557	9.46	7.042	8.889	-0.485	0.
13	5	D1	445.9256	445.9256	7.344	8.76	7.161	8.789	0.183	-0.
14	4	D1	451.3788	451.3788	7.409	8.708	7.178	8.758	0.231	-
15	3	D1	451.3788	451.3788	7.409	8.708	7.192	8.734	0.217	-0.
16	2	D1	451.3788	451.3788	7.409	8.708	7.205	8.712	0.204	-0.
17	1	D1	451.3788	451.3788	7.409	8.708	7.218	8.689	0.191	0.
18	P	D1	442.9263	442.9263	7.412	8.709	7.236	8.663	0.176	0.

GRAPHS

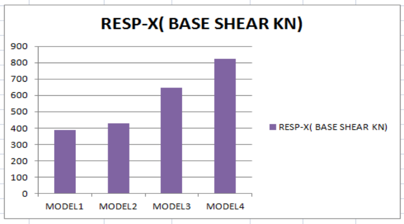
BASE SHEAR (KN)	MODEL1	MODEL2	MODEL3	MODEL4
EQ-X(BASE SHEAR KN)	604.81	491.62	803.37	926.95



BASE SHEAR (KN)	MODEL1	MODEL2	MODEL3	MODEL4
EQ-Y(BASE SHEAR KN)	606.46	709.18	804.37	926.95



BASE SHEAR (KN)	MODEL1	MODEL2	MODEL3	MODEL4
RESP-X(BASE SHEAR KN)	390.31	428.39	647.41	824.12



CONCLUSIONS

1. Concluded that the difference in elastic and inelastic story drifts between set-back and regular structures depends on the level of story.
2. Critical setback ratio RA=0.25 and RH=6/5 shows the variation in story drift which signifies the jumping of the forces due to unequal distribution of mass along the plan as well as along the height.
3. Higher ductility demands for set-back structures than for the regular ones and found this increase to be more pronounced in the tower portions.
4. When the mass of one floor increases by 50%, the increase in ductility demand is not greater than 20%. Reducing the stiffness of the first story by 30%, while keeping the strength constant, increases the first story drift by 20-40%, depending on the design ductility (μ).
5. The excessive deformation in vertical members often leads to collapse of the storey.
6. Regular buildings: Those greater than 40m in height in zones IV and V, and those greater than 90m in height in zones II and III.

7. Irregular buildings: All framed buildings higher than 12m in zones IV and V, and those greater than 40m in height in zones II and III.
8. Mass and stiffness are evenly distributed with building height, thus giving a regular mode shape.

REFERENCE

1. K. Chopra – structureal dynamics

2. S.k. duggal – eartquke analysis of structure

3. Pankaj agrawal & manish shrikhande – repair and retrofiting of structure

4. Aranda, h., g. R. (1984). "ductility demands for r/c frames irregular in elevation."proc, eighth world conf. On earthquake engrg., iv, san francisco, calif.,559-566.

5. Arnold, c. (1980). "building configuration: characteristics for seismic design." proc,seventh world conf. On earthquake engrg., 4, istanbul, turkey, 589-592

6. Arnold, c , and elsesser, e. (1980). "building configuration: problems and solutions." proc, seventh world conf. On earthquake engrg., 4, istanbul, turkey, 153-160.

7. Blume, j. A., and jhaveri, d. P. (1969). "time-history response of buildings with unusual configurations." proc, fourth world conf. On earthquake engrg., ill,session a3, santiago, chile, jan., 155-170.

8. Clough, r. W., and penzien, j. (1975). Dynamics of structures. Mcgraw-hill, newyork, n.y,

9. Gardis, p. G., et al. (1982). "the central greece earthquakes of feb.-march 1981." a reconnaissance and engrg. Rept., nat. Academy press, washington, d.c.

10. Humar, j. L., and wright, e. W. (1977). "eathquake response of steel-framed multistory buildings with setbacks." earthquake engrg. And struct. Dynamics, 5(1), 15-39.

. On earthquake engrg., 2, rome, italy, 1744- 1747