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Seismic Analysis of RCC Structure with Change in Vertical Irregularities Floor Wise

[1]Gokulesh C. Chopde, [2]Dr. Abhinandan R. Gupta

[1]Research Scholar, College of Engineering and Technology, Akola, Maharashtra, India
[2]Professor, College of Engineering and Technology, Akola, Maharashtra, India

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ABSTRACT

Multi-storey RC Structure has subjected to most dangerous earthquakes. It was found that a main reason for the failure of RC building is irregular distributions of the mass, stiffness and strength or due to irregular geometrical configurations. In a reality, many existing buildings contain an irregularity due to functional and aesthetic requirements. However, past earthquake records show the poor seismic performance of this structure. This is due to an ignorance of the irregularity aspect in formulating the seismic design methodologies by the seismic codes The review of seismic design codes and reported research studies show that the irregularity has been quantified in terms of magnitude ignoring the effect of a location of an irregularity. In the present work vertical Irregularities were analysed at various floor levels and comparative results were plotted from this it is found that a more amount of research can be done on this topic.

1. INTRODUCTION

1.1 General

During an earthquake, the failure of the structure starts at points of a weakness. The structures are having this discontinuity is termed as irregular structures. Irregular structures are largely seen in an urban infrastructure. Vertical irregularities are one of the major reasons of failures of structures during earthquakes. For example structures with a soft storey which is liable to the collapse due to a large stress and a drift. Hence, the effect of vertically irregularities in the seismic performance of structures becomes very important. Height-wise changes in stiffness and a mass render the dynamic characteristics of these buildings different from the regular building. Many buildings in the present scenario have irregular configurations both in a plan and the elevation. They may subject to devastating earthquakes in a future. Therefore, it is necessary to identify the performance of the structures to withstand against the disaster for both new and existing one. The irregularities in the buildings namely plan an irregularity with geometric and a diaphragm discontinuity and a vertical irregularity with a setback and sloping a ground. In order to identify the most vulnerable model has among the above-mentioned the building therefore various analytical approaches.

If all the building elements are arranged with uniformity and the earthquake striking in the familiar direction are optimal. Due to lack of availability of land in big cities, architects usually go for the irregular building structures to make the effective use of an available area and to impart a provision of a proper light and a ventilation in the structures. However, the structural irregularity is a combined state of two types that are horizontal and vertical. The horizontal irregularity may be classified on the bases of Asymmetrical plan shapes, Re- Entrant corners, Diaphragm discontinuity and irregular distribution of mass stiffness along plan etc., and the vertical irregularity may be classified on the bases of Mass, Strength, Stiffness and Setback. Adequate to most of such asymmetries, the structure’s lateral resistance of earthquake is generally torsional uneven & thus creating great amount displacement, drift and high force concentrations within the resisting elements which cause severe damages and may lead to collapse of the structure

It is observed that the existing structures are frequently irregular as perfect regularity is an idealization that rarely occurred in the practice. Regarding buildings, for practical purposes, major seismic codes across the globe differentiate between an irregularity in the plan and in an elevation, but it must be realized that an irregularity in the structure is the consequence of a combination of both types. It is seen those irregular structural alignments in an elevation or in a plan were frequently recognized one of the major actions of the collapse through a precedent seismic motion.

1.2 Aim

The aim of this project is to study various parameters of a RCC building with irregularities on a various floor level.

1.3 Objectives

The objective of project are as follows: -

- To study Earthquake Resistant conceptual tips
- To accomplish comparative knowledge on the various seismic parameters for different irregularities
- To obtain the storey drifts & displacements at each one of the storey's using equivalent static analysis
- To analyse the building as per code IS 1893-2002 part I criteria for earthquake resistant structure

1.4 Need of Work

Now a days the structures with attractive architectural views are more popular and demanding among the Buyers, but at the same time the seismicity of our country is also changing day by a day. So, with planning and designing the structure which fulfill all architectural and an elevation requirement it is also mandatory that this structure will withstand during the earthquake and will help in saving the human life. This project will focus on the effect of vertical irregularities on a structural element of building Such as Beams, Columns which will help anyone to decide whether to go with a regular or Irregular Building.

2. LITERATURE REVIEW

Nilesh Sanjiv More et al(1) In this study, analysis of plan irregularity of building and consideration of soil structure interaction under seismic loading. Aimed with purpose, the plan irregular building (G+20) is analyzed by using Etabs subjected to the combination of gravity load and seismic load under specific zone. Compare the same building with equivalent strut approach and without equivalent strut approach consideration of different soil condition structure interaction; it is analyzed by using the Etabs software.

Shridhar Chandrakant Dubule et al(2) The study is concerned with the effects of various vertical irregularities on the seismic response of a structure. The objective of the project is to carry out Response spectrum analysis (RSA) of vertically irregular RC building frames and to carry out the ductility based design using IS 13920 corresponding to Response spectrum analysis (RSA). Comparison of the results of analysis of irregular structures with regular structure is done. Three types of irregularities namely mass irregularity, stiffness irregularity and stiffness & mass irregularity were considered. According to our observation, the storey shear force was found to be maximum for the first storey and it decreases to minimum in the top storey in all cases. The mass irregular structures were observed to experience larger base shear than similar regular structures. The stiffness irregular structure experienced lesser base shear and has larger inter-storey drifts.

Zeynep Yeşim İlerisoy et al(3) In this paper the visual expression techniques necessary for architects to be able to understand earthquake codes, eight different seismic codes for countries on active fault lines with different seismic histories were discussed, and it was revealed that limit values for irregularity definitions differed among them. The design decisions that will cause irregularities in the plan are considered comprehensively, and the precautions that can be taken against these irregularities are explained to architects in order to create awareness. In addition, because of the improved comprehension of visual forms in human perception, the subject is illuminated with simple but descriptive drawings. In conclusion, this study can be considered as a source for understanding regulations for seismic design, revealing information about architecture in the face of the ever-changing reality of an earthquake, and the possession of the tools that architects can use effectively in this regard.

Piyush Mandloi et al(4) This paper analysed four different building models which are vertically irregular and each model is analysed for without mass irregularity, with mass irregularity increasing from bottom to top, and with mass irregularity decreasing bottom to top. Combinations of four models and three mass irregularities are then also analysed against four different time histories which are Chichi (1999), Petrolia (1992), Friuli (1976), Northridge (1994) and Sylmar respectively. All analysis are compared for outcomes such as story deflection, story drift, overturning moment and base reaction. It is concluded from results and discussion that the outcomes varies from time history to time history. The designers worked for seismic zones must consider time history data while designing vertical and mass irregular buildings. Building with irregularities may be designed with software applications effectively. It saves time and cost for designer.

Resmitha Rani Antony et al(5) The aim of this study is to evaluate the seismic behaviour of RC building having different types of irregularities, mainly vertical geometric irregularity and stiffness irregularity. For this study, 48 models which include vertical geometric irregular buildings (stepped buildings) with and without stiffness irregularities at different levels are modelled and analysed. To study the behaviour of the irregular structures, response spectrum analysis is conducted. The modelling and analysis are carried out using ETABS software. Parameters such as time period, lateral displacement and storey drift are studied. From modal analysis, it is clear that the fundamental time period of the stepped pyramidal structure is lesser compared to set-back buildings in X, Y and XY direction. And also torsional effect is predominant in the buildings with set-back along X, Y and XY direction as compared to the stepped pyramidal structure.

Abhishek Kumar Maurya et al(6) This paper studies about the multi-story regular reinforced building and their vibration parameters. It also deals with the comparison between the seismic behavior of fixed base building without damper to the proposed building in which dampers are linked at different location i.e. at Middle and at Corners.G+10 building is situated in zone V and the analysis is performed on them to obtain the difference in structural response of the fixed RC building without damper and the building incorporated with viscous damper at different locations. From the result, it is clear that Building having damper at Corner location gives satisfactory result under earthquake motion.

R Ismail et al(7) The case study of this research is to determine the stress and displacement in the seismic response under this type of irregular frame structures. This study is based on seven-storey building of Clinical Training Centre located in Sungai Buloh, Selayang, Selangor. Since the largest earthquake occurs in Acheh, Indonesia on December 26, 2004, the data was recorded and used in conducting this research. The result of stress and displacement using IMPlus seismic analysis in LUSAS Modeller Software under the seismic response of a formwork frame system states that the building is safe to withstand the ground and in good condition under the variation of seismic performance.

Chaitali Patel et al(8) Present study aims towards doing Nonlinear Static Pushover Analysis of G +20 high rise RCC residential building. This work shows that the comparison seismic performance and behavior of building frame with and without vertical irregularity in terms of parameter like story shear, storey displacement, and storey drift. Also comparison of seismic response of the structure in terms of base shear and displacement along with the location of the plastic hinges at the performance point of all the models are considered. The building with vertical irregularity undergoes maximum storey displacement as compared to the building without vertical irregularity. The maximum storey displacement is occurred for Combine irregularity building. Due to provision of vertical irregularity there is increase in storey drift and it is optimum for Mass Irregularity building.

Ankita Narvekar et al(9) In this paper a 15 storey building on etabs assuming all the required information referring IS code 456:2000 and IS code 1893:2002 (for earthquake)is studied. This structure is further subjected to different damping ratios on a particular seismic zone giving us the optimum damping ratio for that seismic zone. In this paper, they have taken seismic zone 4 and subjected the structure to damping ratio 0.5%,5%,10% and 20% respectively. The optimum damping ratio is found to be 5% for seismic zone 4, as the difference in decrease in acceleration is marginally high for 5% damping. The storey displacement goes on increasing with the height of the structure. The maximum displacement is observed on the top floors which is to be 0.0169mm.

Snehal Ashok Bhoyar et al(10) The study subjected to seismic load includes the analysis of the G+5 regular as well as irregular plan with or without floating column for external lateral forces. The study is carried out based on three important parameter i.e. lateral distance, Story drift, Story shear. Based on result obtained using ETABS software, it can be concluded that The probabilities of failure of building (either regular or irregular in plan) with floating column is found to be more than without floating column. The present study focuses on presence of floating column at corner only. The performances of building may vary according to position and orientation of floating column.

Trupanshu Patel et al(11) In the present work is to study the behaviour of G+3 buildings having floating columns. However recent studies based on floating columns, which mostly concentrated on higher seismic zones and very few works is available for lower seismic zones Also to obtain the effects of mass variations and infill walls on behaviour of normal and floating column building, one forth portion of typical floor has been provided with higher mass compare to other portions and different building models were analysed with and without provisions of infill walls. corner provisions of floating columns should be considered as critical case. The incremental load considered in the model on one side amounts to about 5% increases in eccentricity. This small increase does not make any major changes in displacements etc., which may found if higher eccentricity is generated. Infill walls provide seismic strengthening of the floating column building. It also helps to reduce seismic response of the building.

R.S.S. Babitha Sri et al(12) In this study, the effect of floating columns on RC frame G+9 structure has been studied for zone III. This work is done to study the response of RC frame building with floating columns under earthquake loading. For all the models of the building, response spectrum analysis is carried out. The maximum storey drift values in both directions were not exceeded the allowable limit 0.004h. The building with floating columns has less stiffness compared to regular building. It is observed that the structure without floating column has maximum storey shear.

Pradeep Karanth et al(13) This study covers the effect of structural pounding on two building are of different structural system, in order to observe seismic pounding Time History analysis is carried out. This study also covers the prevention techniques of pounding by using introduction of RC wall and its optimization is proposed as possible mitigation techniques for pounding. The stiffness of the flat slab system is less in comparison with beam – column system and hence design engineer have to give more importance while the design of such type structures. The stiffness of the buildings can be increased by providing new RC wall so that lateral displacement can be reduced.

3. METHODOLOGY

The methodology will of work to be carried out to achieve the goals is as follows:-

- The very first step towards our project is to decide the Aim, objectives of this project.
- After that next step will be to find the need of this project for the current construction scenario.
- Various technical papers, Journals and Books will be studied and a review to decide the path of work which will be followed in the future work of this project.
- Along with the Literatures Various Indian Design Codes for Earthquake a resistant analysis and a design will be studied and various code provisions for an irregular building will be studied.
- The detail study will be done on all the parameters of building such as floating a column, types of irregularities in a building, effects of pounding on a structure, an effect of an earthquake on RC structureThen, at this stage case consideration will be done based on the above reviewed literatures.
- All general parameters are of a building like framing a material, their material constants, types and intensities of a loading and loading combinations will be decided.
- The manual calculation is for a base shear was by using the seismic coefficient method will be done
- A reliable software (STAAD PRO) will be selected and the modelling, an analysis will be done. After analyzing all the selected models with selected materials required results will be studied and compared.
- At last based on the various results obtained from analysis conclusions will be drafted.
- All the references will be listed at the last along with their all details.

4. DETAIL STUDY

4.1 Earthquake zones of India

The Indian subcontinent has a history of devastating earthquakes. The major reason for the high frequency and an intensity of the earthquakes is that the Indian plate is driving into Asia at a rate of approximately 47 mm/year. Geographical statistics of India show that almost 54% of the land are vulnerable to earthquakes. A World Bank and United Nations report shows estimates that around 200 million city dwellers in India will be exposed to storms and earthquakes by 2050. The latest version has of a seismic zoning map of India given in the earthquake resistant design code of India [IS 1893 (Part 1) 2002] assigning four levels of seismicity for India in terms of zone factors. In other words, the earthquake zoning map of India divides India into 4 seismic zones (Zone 2, 3, 4 and 5) unlike its previous version, which consisted of five or six zones for the country. According to the present zoning map, Zone 5 expects the highest level of seismicity whereas Zone 2 is associated with the lowest level of seismicity.

4.2 National Centre for Seismology

National Center for Seismology, Ministry of Earth Sciences is a nodal agency of a government of India dealing with various activities in the field of a seismology and allied disciplines. The major activities are currently being pursued by the National Center for Seismology include, a) an earthquake monitoring on the 24x7 basis, including real time a seismic monitoring for an early warning of tsunamis, b) an operation and a maintenance of the national seismological network and local networks c) Seismological data centre and information services, d) the seismic hazard and a risk related studies e) Field studies for an aftershock / swarm monitoring, a site response studies f) earthquake processes and modelling, etc. The MSK has (Medvedev-Sponheuer- Karnik) an intensity broadly associated with the various seismic zones is VI (or less), VII, VIII and IX (and above) for Zones 2, 3, 4 and 5, respectively, corresponding to Maximum Considered an earthquake (MCE). The IS code following a dual design philosophy: (a) under a low probability or extreme earthquake events (MCE) the structure damage should not result in a total collapse, and (b) under more frequently occurring earthquake events, the structure should suffer only minor or moderate structural damage. The specifications have given in the design code (IS 1893: 2002) are not based on a detailed assessment of a maximum ground acceleration in each zone using a deterministic or probabilistic approach. Instead, each zone factor represents the effective period peak ground accelerations that may be generated during the maximum considered an earthquake ground motion in that zone.

Each zone indicates the effects of an earthquake at a particular place based on the observations of the affected areas and can also be described using a descriptive scale like Modified Mercalli intensity scale or the Medvedev–Sponheuer–Karnik scale.

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4.3 Zones

4.3.1 Zone5

Zone 5 covers the areas with the highest risks zone that suffer earthquakes of an intensity MSK IX or greater. The IS code assigning a zone factor of 0.36 for Zone 5. Structural designers use this factor for an earthquake a resistant design of structures in Zone 5. The zone factor of 0.36 is indicative of effective (zero period) a level earthquake in this zone. It is referred to as the Very High Damage Risk Zone. The region of Kashmir, the Western and Central Himalayas, North and Middle Bihar, the North-East Indian region, the Rann of Kutch and the Andaman and Nicobar group of islands fall in this zone. Generally, the areas are having trap rock or basaltic rock are prone to earthquakes.

4.3.2 Zone 4

This zone is called the High Damage Risk Zone and covers areas liable to MSK VIII. The IS code assigning a zone factor of 0.24 for Zone 4 Jammu and Kashmir, Himachal Pradesh, Uttarakhand, Sikkim, the parts of Indo-Gangetic plains (North Punjab, Chandigarh, Western Uttar Pradesh, Terai, North Bengal, Sundarbans) and the capital of the country Delhi falls in Zone 4. In Maharashtra, the Patan area (Koynanagar) is also in a zone no-4. In Bihar the northern part of the state like Raxaul, Near the border of India and Nepal, is also in a zone no-4.

4.3.3 Zone 3

This zone is classified as Moderate Damage Risk Zone which is liable to MSK VII. and also 7.8 The IS code assigns zone factor of 0.16 for Zone 3.

4.3.4 Zone 2

This region is liable to MSK VI or less and is classified as the Low Damage Risk Zone. The IS code assigns zone factor of 0.10 (maximum horizontal acceleration that can be experienced by a structure in this zone is 10% of gravitational acceleration) for Zone 2.

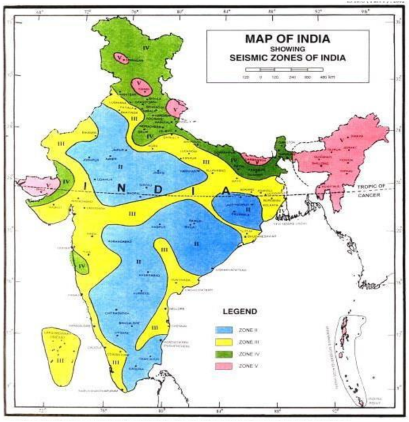

Fig. 4.1 Seismic Zoning map of India

4.4 Effect of Earthquake on RCC Structure

A typical RC building is made of horizontal members (beams and slabs) and vertical members (columns and walls), and supported by foundations that rest on a ground. The system consisting of RC frame. The RC frame participates in resting the earthquake forces. An earthquake was shaking generates inertia forces in the building, which is proportional to the building mass. Since most of the building mass is present at floor levels, an earthquake induced inertia forces primarily develop at the floor levels. These forces travel downwards — through slabs and beams to columns and walls, and then to foundations from where they are dispersed to ground. As inertia forces accumulate downwards from the top of the building, the columns and walls had at lower storey experience the higher earthquake- induced forces and are therefore designed to be stronger than those in the storey above.

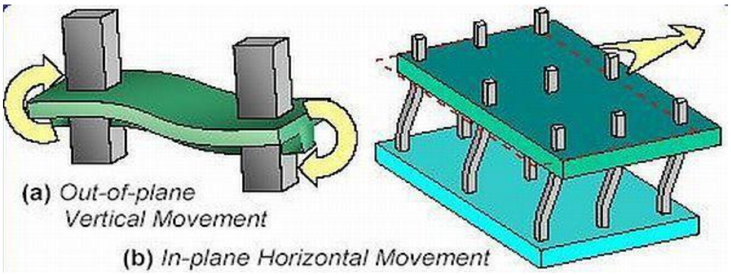

Fig. 4.2 Motion of Structure During Earthquake

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4.4.1 Role of Floor Slabs and Masonry

Floor slabs are the horizontal plate like elements, which facilitate the functional use of buildings. Usually, beams and slabs at one the storey level are cast together. In residential multi-story buildings, the thickness of slabs is only about 110-150mm. When beams bend in the vertical direction during earthquakes, these thin slabs bend along with them (fig2a). And, when beams move with columns in the horizontal direction, the slab is usually forced the beams to move together with it. In most buildings, the geometric distortion of the slab is negligible in the horizontal plane; this behavior is known as the rigid diaphragm action. After columns and floors in a RC building are cast and the concrete hardens, vertical spaces between columns and floors are usually filled-in with masonry walls to demarcate a floor into functional spaces (rooms). Normally, these masonry walls are, also called infill walls, are not connected to surrounding RC columns and beams. When columns receive horizontal forces at floor levels, they try to move in the horizontal direction, but masonry walls tend to resist this movement. Due to their heavy weight and a thickness, these walls attract rather large horizontal forces. However, since masonry is a brittle material, these walls are developing cracks once their ability to carry a horizontal load is exceeded. Thus masonry walls are enhanced by mortars of good strength, making proper masonry courses, and proper packing of gaps between RC frame and masonry infill walls.

4.4.2 Effects of Horizontal Earthquake Vibrations

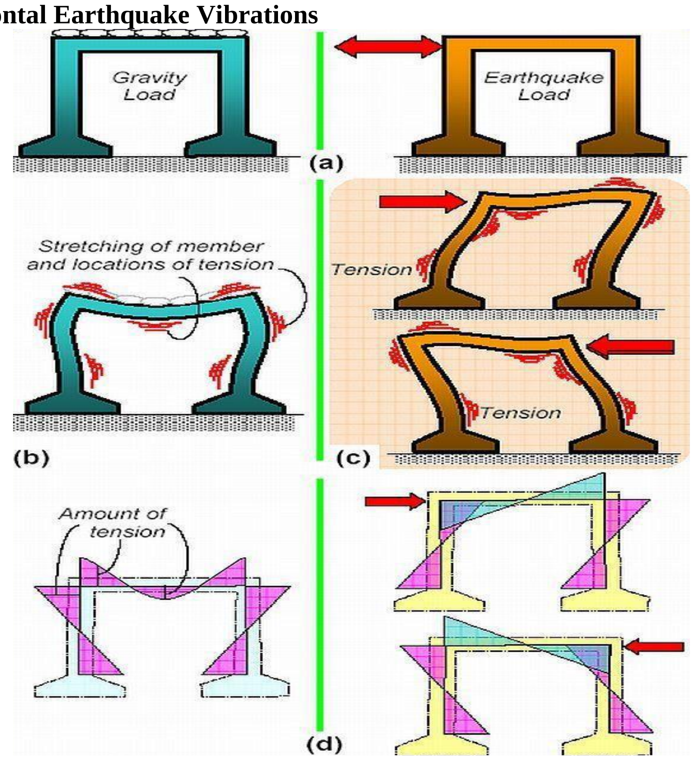

Fig. 4.3 Effect of Vibrations on structure

Under gravity loads, a tension in the beams is at the bottom surface of the beam in the central location and is at the top surface at the ends. The level is of bending the moment due to an earthquake loading depends on a severity of shaking and can exceed that due to the gravity loading. Thus, under the strong earthquake shaking, the beam ends can develop a tension on either of the top and bottom faces. Since concrete cannot carry this tension, steel bars are required on both faces of beams to resist reversals of bending a moment.

4.5 Causes of Failure

The causes of the failure which is identified after the field survey is:-

- the soft storey failure: vertical irregularities in stiffness/strength
- floating column failure: a complex load path to transfer of forces,
- mass irregularities: an eccentric loading and P- Delta effect,
- the poor and old construction: corrosion of a reinforcement
- Pounding: hammering of adjacent buildings
- the design deficiency: lack of ductility and a ductile detailing
- construction consideration: lack of sliding and moveable joints.

These failures could be minimized by the technical awareness of an earthquake resistant design practices among an engineer, architects, planners and builders.

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4.6 Effect of Floating Column

Earthquakes perhaps the most unpredictable and devastating of all the natural disasters. They cause great destruction in terms of human casualties, and also have a tremendous economic impact on the affected area. The concern about seismic hazards has led to the awareness and a demand for the structures designed to withstand seismic forces. To make the buildings and structures safe in an earthquake prone area lies on the designers, architects, and engineers who conceptualize these structures. Many urban multistorey buildings in India today have an open first storey as an unavoidable feature. This is primarily being adopted to accommodate the parking or reception lobbies in the first storey. The total seismic base shear has experienced by a building during an earthquake is dependent on its natural period and the seismic force distribution is dependent on the distribution of stiffness and a mass along the height. The behaviour of a building during earthquakes depends critically on its overall size, a shape and geometry, in addition to how the earthquake forces are carried to the ground. The floating column which is a vertical element, its lower level resting on a beam which is a horizontal member. This horizontal member in a turn transfers the load to other columns below it. The load from the floating column act as a concentrated load on the transfer beam. The floating columns are implemented, especially above the base floor, so that added an open space is accessible for an assembly hall or a parking purpose. Floating columns are usually adopted above the ground story level. So that, the maximum space is made available in the ground floor which is essentially required in the apartments, a mall or other commercial buildings where a parking is a major problem.

4.7 Effect of Pounding

The Seismic pounding is simply known as a collision or hammering of two buildings which are adjacent to each other having different dynamic characteristics. The main reason was for the seismic pounding is a lack of the separation gap in between the adjacent buildings. Most of the time pounding between the structures is commonly observed in the old buildings that were constructed before the earthquake resistant design principles came into the picture. Even though many present codes specify a minimum seismic gap, it still fails to include the effect of all other parameters that effect the structural deformation. The simplest and effective way was for pounding the mitigation and reducing damage due to pounding is to provide enough separation gap, but it is sometimes difficult to be implemented due to the high cost of land.

4.8 Seismic Analysis Methods

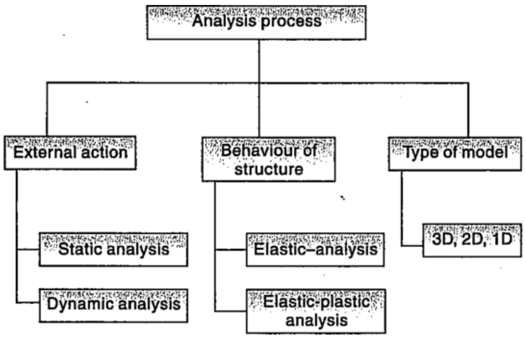

Fig. 4.4 Methods of Analysis

4.9 Irregularities in Building

4.9.1 Plan Irregularities

Torsion Irregularity- To be considered when floor diaphragms are rigid in their own plan in a relation to the vertical structural elements that resist the lateral forces. Torsional irregularity will to be considered to exist when the maximum storey drift, computed with a design eccentricity, an atone end of the structures transverse to an axis is more than 1.2 times the average of the storey drifts at the two ends of the structure.

Re-entrant Corners-Plan configurations of a structure and its lateral force resisting the system contain re-entrant corners, where both projections of the structure beyond the re-entrant corner are greater than 15 percent of its plan dimension in the given a direction.

Diaphragm Discontinuity-Diaphragms with abrupt discontinuities or variations in stiffness, including those having cut-out or open areas greater than 50 percent of the gross enclosed the diaphragm area, or changes in effective diaphragm stiffness of more than 50 percent from one a storey to the next.

Out-of-Plane Offsets-Discontinuities in a lateral force the resistance path, such as out-of-plane offsets of vertical elements.

Non-parallel Systems-The vertical elements are resisting the lateral force are not parallel to or symmetric about the major orthogonal axes or the lateral force resisting elements.

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4.9.2 Vertical Irregularities

Stiffness Irregularity —Soft Storey- A soft storey is one in which the lateral stiffness is less than 70 percent of that in the storey above or less than 80 percent of the average lateral stiffness of the three storeys above.

Stiffness Irregularity —Extreme Soft Storey -An extreme soft storey is one in which the lateral stiffness is less than 60 percent of that in the storey above or less than 70 percent of the average stiffness of the three storeys above. For an example, buildings on STILTS will fall under this category.

Mass Irregularity-Mass irregularity shall be considered to exist where the seismic weight of any storey is more than 200 percent of that of its adjacent storeys. The irregularity will need not be considered in a case of roofs.

Vertical Geometric Irregularity-Vertical a geometric irregularity shall be considered to exist where the horizontal dimension is of the lateral force is resisting a system in any storey is more than 150 percent of that in its adjacent storey.

In-Plane Discontinuity in Vertical Elements Resisting Lateral Force-A in-plane offset of the lateral force resisting elements greater than the length of those elements.

Discontinuity in Capacity — Weak Storey-A weak storey is one in which the storey lateral strength is less than 80 percent of that in the storey above, the storey lateral strength is the total strength of all seismic force resisting elements sharing the storey shear in the considered a direction.

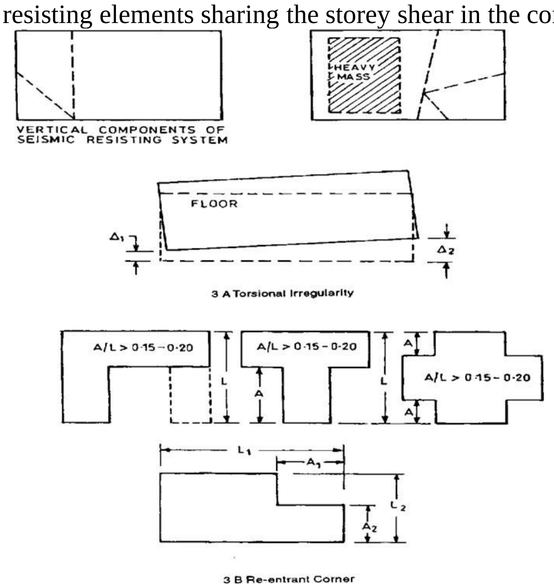

Fig. 4.5 Plan Irregularities

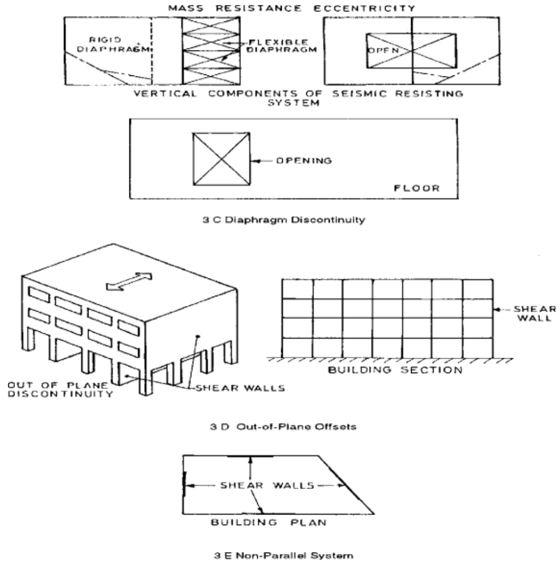

Fig. 4.5.1 Plan Irregularities

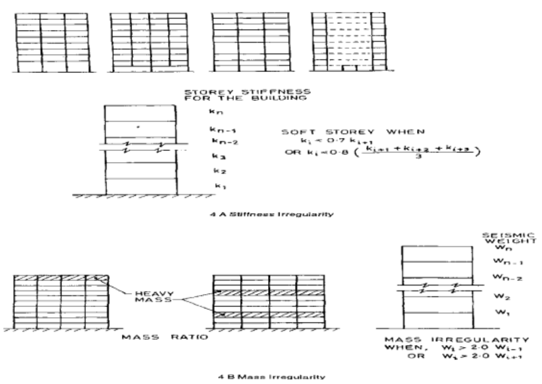

Fig.4.6 Vertical Irregularities

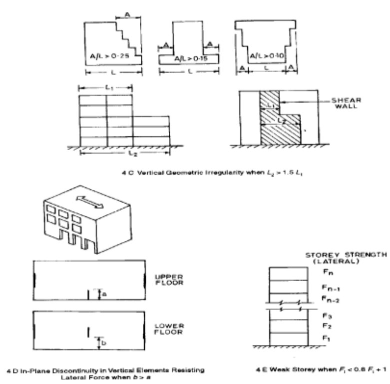

Fig. 4.6.1 Vertical Irregularities

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5. CASE CONSIDERATION

5.1 Material Constants

Table 5.1 Material Constants

Material	Concrete	Steel
Grade	M 25	Fe 415
Mass Density	2549.3	7849
Unit Weight	25	76.97
Modulus of Elasticity	25,000,000	20,000,000
Poisson's Ratio	0.15	0.3

5.2 Building Parameters

Table 5.2 Building Parameters

Parameter	Value
Live load	1.5 kN/m2
Density of concrete	25 kN/m3
Thickness of slab	130 mm
Depth of beam	300 mm
Width of beam	230 mm
Dimension of column	300 x 450 mm
Thickness of outside wall	230 mm
Thickness of inner side wall	150 mm
Height of floor	3.05 m
Earthquake zone	IV
Damping ratio	0.05 %
Type of soil	II
Type of structure	Special moment resisting frame
Response reduction factor	**5**
Importance factor	**1.5**
Roof treatment	1 kN/m2
Floor finishing	1 kN/m2
Number of Storey's	06 (G+5)

5.3 Verification Numerical

Consider a G+5 RCC Building as shown in figure with an UDL of 9 Kn/m,
Case I :- Regular Building Frame

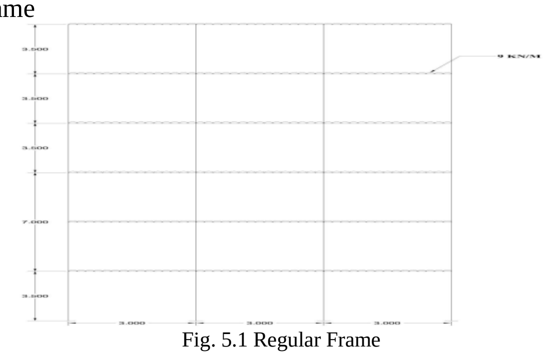

Fig. 5.1 Regular Frame

Case II :- Irregular Building Frame

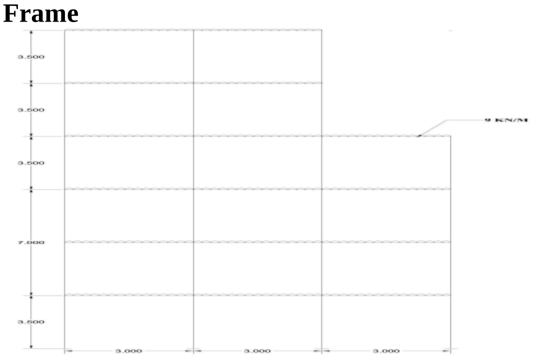

Fig. 5.2 Irregular Frame

5.4.1 Detail Calculations

Case I :-

a) Load Calulations = (6 x 9 x 9) = 486 Kn

b) Ah Calculation

Ta = (0.09 x 21) / (9)0.50 = 0.63

Sa/g = 1.36/ T = 1.63/0.63 = 2.15 ------------------------------------ For Type II Soil

Z = 0.24 --- Zone IV

R = 3 -- OMRF

I = 1.50 --Public Building

Ah = (Z/2) x (I/R) x (Sa/g) = (0.24/2) x (1.5/3) x 2.15 = 0.129

Vb = Ah x W = 0.129 x 486 = 62.69 Kn

Table 5.3 Storey Shear for Case I

Storey	Wi	Hi	(WiHi^2)	iHi^2)/ ∑ (WiHi^2)	Qi
06	81	21	35721	0.40	25.07
05	81	17.5	24806.25	0.27	16.92
04	81	14	15876	0.18	11.28
03	81	10.5	8930.25	0.10	6.27
02	81	7	3969	0.04	2.51
01	81	3.5	992.25	0.01	0.63

∑ 90294.75 **∑ 62.69**

Case II :-

a) Load Calulations = (2 x 9 x 6) **+** (4 x 9 x 9) = 432 Kn

b) Ah Calculation

Ta = (0.09 x 21) / (9)$^{0.50}$ = 0.63

Sa/g = 1.36/ T = 1.63/0.63 = 2.15 --- For Type II Soil Z = 0.24 --- Zone IV

R = 3 -- OMRF

I = 1.50 --- Public Building

Ah = (Z/2) x (I/R) x (Sa/g) = (0.24/2) x (1.5/3) x 2.15=0.129 Vb = Ah x W = 0.129 x 432 = 55.72 Kn

Table 5.4 Storey Shear for Case II

Storey	Wi	Hi	(WiHi^2)	iHi^2)/ ∑ (WiHi^2)	Qi
06	54	21	23814	0.34	18.94
05	54	17.5	16537.5	0.24	13.37
04	81	14	15876	0.22	12.25
03	81	10.5	8930.25	0.13	07.25
02	81	7	3969	0.06	03.34
01	81	3.5	992.25	0.01	00.55

∑ 70119 **∑ 55.72**

Table 5.5 Comparison of Storey Shear for Case I and Case II

Storey	Case I Storey Shear	Case II Storey Shear
06	25.07	18.94
05	16.92	13.37
04	11.28	12.25
03	06.27	07.25
02	02.51	03.34
01	00.63	00.55

∑ 62.69 **∑ 55.72**

6. RESULTS

6.1Drift Value Comparisons

6.1.1Drift Value (Interior Edge)

Table 6.1 Drift value comparison for all cases at exterior edge

Node No.	Location	Drift Value (mm)			
		Case-I	Case-II	Case-III	Case-IV
327	Sixth Floor Top (22.50)	----	----	----	----
321	Fifth Floor Top (19.00)	13.883	15.007	----	13.742
315	Fourth Floor Top (15.50)	24.156	26.159	----	23.389
309	Third Floor Top (12.00)	30.99	26.769	16.334	28.838
303	Second Floor Top (8.50)	34.739	29.838	24.124	----
297	First floor top (5.00)	36.114	31.472	27.575	85.556
291	Ground Level (1.50)	34.582	30.582	27.51	31.588

6.1.2 Drift Value (Exterior Edge)

Table 6.2 Drift value comparison for all Interior edge

Node No.	Location	Drift Value (mm)			
		Case-I	Case-II	Case-III	Case-IV
372	Sixth Floor Top (22.50)	----	----	----	----
366	Fifth Floor Top (19.00)	13.217	15.133	14.456	13.577
360	Fourth Floor Top (15.50)	22.853	26.489	25.187	10.695
354	Third Floor Top (12.00)	29.61	34.54	32.991	43.528
348	Second Floor Top (8.50)	33.714	39.415	37.459	35.072
342	First floor top (5.00)	35.771	41.853	39.562	37.265
336	Ground Level (1.50)	29.055	33.953	3.999	30.244

6.2 Beam End Forces

6.2.1 Case I (Exterior Edge)

Table 6.3 Beam end Forces Comparisons for case I (Exterior edge)

Beam No.	Fx	Fy	Fz	Mx	My	Mz
308	63.634	31.913	25.709	0.200	46.910	-57.207
297	263.151	41.984	46.498	0.394	83.299	-83.863
286	356.712	49.363	60.070	0.412	106.418	-89.210
275	741.161	52.391	68.503	0.326	120.664	-93.129
264	1320.859	50.452	74.544	0.207	127.655	91.311
327	647.732	19.110	23.331	0.904	-52.943	-39.969
253	624.765	37.217	58.507	1.079	105.931	-66.561
329	647.734	19.138	23.380	0.904	63.882	-55.681

6.2.2 Case I (Interior Edge)

Table 6.4 Beam end Forces Comparisons for case I (Interior edge)

Beam No.	Fx	Fy	Fz	Mx	My	Mz
187	104.631	30.728	31.115	0.064	54.846	55.347
176	426.784	48.287	58.169	0.106	102.313	75.899
165	763.445	52.192	76.050	0.122	133.335	-101.629
154	1103.433	63.694	86.283	0.134	151.007	112.463
143	1178.785	66.085	91.494	0.198	160.484	115.819
132	1519.649	57.118	88.499	0.302	154.961	100.391
197	1888.811	53.647	98.098	0.109	78.391	55.082

6.2.3 Case II (Exterior Edge)

Table 6.5 Beam end Forces Comparisons for case II (Exterior edge)

Beam No.	Fx	Fy	Fz	Mx	My	Mz
308	65.56	29.31	29.19	0.24	53.36	-54.94
297	193.70	48.23	50.73	0.37	90.94	-67.32
286	511.33	30.96	39.24	1.58	101.18	-51.85
275	693.32	47.90	77.44	2.09	136.21	-66.69
264	1038.72	46.43	76.49	2.64	148.36	-66.085
327	627.732	18.17	20.32	0.65	-54.65	-40.62
253	625.42	35.19	55.56	1.52	107.46	-65.46
329	637.65	17.23	24.36	0.95	62.31	-48.56

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6.2.4 Case II (Interior Edge)

Table 6.6 Beam end Forces Comparisons for case II (Interior edge)

Beam No.	Fx	Fy	Fz	Mx	My	Mz
187	102.46	31.26	32.25	0.045	55.58	56.37
176	385.46	50.27	59.63	0.125	110.43	77.46
165	800.46	49.56	75.40	0.128	135.46	104.56
154	1098.46	65.34	85.46	0.245	155.46	110.48
143	1465.30	67.46	93.75	0.201	160.78	120.48
132	1856.47	56.42	86.48	0.345	157.26	120.79
197	2109.56	56.48	95.46	0.145	80.23	57.46

6.2.5 Case III (Exterior Edge)

Table 6.7 Beam end Forces Comparisons for case III (Exterior edge)

Beam No.	Fx	Fy	Fz	Mx	My	Mz
308	58.19	31.378	27.890	27.890	50.950	-55.940
297	256.640	45.820	51.072	0.562	91.508	-83.950
286	489.391	35.271	66.754	1.274	118.222	-64.453
275	743.488	44.364	75.888	2.117	132.590	-79.824
264	100.738	43.750	79.973	2.599	140.714	-79.290
327	653.218	16.035	25.691	0.988	-58.174	-35.090
253	629.887	30.934	64.395	0.787	116.666	-54.692
329	653.218	16.076	25.721	0.988	170.325	-45.228

6.2.6 Case III (Interior Edge)

Table 6.8 Beam end Forces Comparisons for case III (Interior edge)

Beam No.	Fx	Fy	Fz	Mx	My	Mz
187	----	----	----	----	----	----
176	----	----	----	----	----	----
165	369.466	50.655	42.979	3.170	76.205	95.799
154	719.249	51.451	62.166	2.927	109.104	91.312
143	1071.562	49.660	71.603	2.699	125.222	96.145
132	1428.494	46.937	70.652	2.260	124.047	83.808
197	1517.718	42.788	78.199	0.729	62.541	43.489

6.2.7 Case IV (Exterior Edge)

Table 6.9 Beam end Forces Comparisons for case IV (Interior edge)

Beam No.	Fx	Fy	Fz	Mx	My	Mz
308	63.400	30.153	26.047	0.184	47.550	-59.027
297	264.418	-46.471	47.410	0.410	80.336	-86.431
286	496.917	50.786	61.772	0.555	106.722	-91.959
275	748.520	54.312	70.844	0.800	124.815	-96.694
264	1009.515	52.161	75.242	0.713	132.455	-93.685
327	656.410	19.241	24.262	0.893	-54.174	-40.016
253	632.625	37.640	60.849	1.012	109.569	-67.616
329	656.410	16.351	24.310	0.886	66.456	-56.289

6.2.8 Case IV (Interior Edge)

Table 6.10 Beam end Forces Comparisons for case IV (Interior edge)

Beam No.	Fx	Fy	Fz	Mx	My	Mz
187	113.559	37.169	30.365	0.053	46.984	66.771
176	39.451	53.529	57.639	0.089	101.396	96.374
165	17.893	67.090	77.616	0.281	135.188	142.381
154	----	----	----	----	----	----
143	----	----	----	----	----	----
132	474.322	61.302	85.291	0.578	152.796	13.705
197	610.258	50.452	88.752	0.173	70.963	-50.924

6.3 Support Reaction Values

6.3.1 Exterior Edge Node No. 385

Table 6.11 Support reaction Comparisons for all cases (Exterior edge)

Beam No.	Fx	Fy	Fz	Mx	My	Mz
Case I	43.734	1349.061	-79.120	-115.566	1.407	-96.924
Case II	38.596	1407.331	91.557	135.110	1.480	-82.950
Case III	38.596	136.0895	-87.366	-127.412	0.964	-77.231
Case IV	44.167	1368.318	-82.381	-120.291	1.400	-97.261

6.3.2 Interior Edge Node No. 332

Table 6.12 Support reaction Comparisons for all cases (Interior edge)

Beam No.	Fx	Fy	Fz	Mx	My	Mz
Case I	-53.647	1888.811	98.089	78.391	-0.109	55.082
Case II	-45.952	1734.961	86.526	69.106	-0.818	46.473
Case III	-42.788	1517.719	78.490	62.541	0.729	43.489
Case IV	50.452	529.550	88.752	70.590	-0.175	-50.924

07.CONCLUSION

The study undertaken is related to the impact of vertical irregularities on the RC structure when subjected to seismic forces.For this four models where created and analyize for seismic forces using stadpro software .The RC structure is G+5 is located in zone 4 and for each of this four cases the vertical irregularity where introduced .Out of all the four cases it has been observed that with the change in irregularity location the behavior of structure changes rapidly.

For the case no 4 the condition looks very severe as it can be observed that high irregularity causes increase in reaction values as well as change in drift location in beam and forces .However it can bbe made out that the building behavior is unpredictable with the change in location of irregularity and the unstability shourly occurs with increase in vertical irregularity of higher level.

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