

e-ISSN: 2319-8753 | p-ISSN: 2320-6710

EDIA

International Journal of Innovative Research in SCIENCE | ENGINEERING | TECHNOLOGY

INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

808

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 10, Issue 6, June 2021

INTERNATIONAL STANDARD SERIAL NUMBER INDIA

Impact Factor: 7.512

9940 572 462

6381 907 438

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| e-ISSN: 2319-8753, p-ISSN: 2320-6710| <u>www.ijirset.com</u> | Impact Factor: 7.512|

|| Volume 10, Issue 6, June 2021 ||

|DOI:10.15680/IJIRSET.2021.1006235|

Seismic Analysis of Residential Structure using ETABS

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ABSTRACT : The analysis of earthquake resistant structures has evolved in the recent years with the advent of numerous techniques or methods which are used for the analysis. Earthquake load is a major parameter which is used in the design of buildings. This in turn, is calculated by analyzing the seismic load, which is in the form of dead load, live load/ imposed load and wind load acting on the structure. The objective of this study is to analyze earthquake resistant structures using ETABS. The analysis has been carried out by taking into account the architectural and structural design process. Firstly, the type of building which should be designed is decided by the seismic zone in which the construction of the building is to be carried out. In addition, the general aspects of the earthquake process have been considered to clarify the effects of earthquakes on buildings. By having a better understanding of the earthquake process and characteristic of earthquakes would enable us to make the earthquake resistant building design more efficient. Essential techniques for increasing the capacity of a building to provide protection against earthquake are discussed both with an architectural and structural approach.

KEYWORDS : seismic analysis, residential buildings, ETABS, construction projects, Structural design, Shear forces, Bending moments.

I. INTRODUCTION

There are four aspects of buildings that architects and design engineers work with to create the earthquake-resistant design of a building, namely seismic structural configuration, lateral stiffness, lateral strength and ductility, in addition to other aspects like form, aesthetics, functionality and comfort of building. Lateral stiffness, lateral strength and ductility of buildings can be ensured by strictly following most seismic design codes. But, good seismic structural configuration can be ensured by following coherent architectural features that result in good structural behaviour.

(a) Seismic Structural Configuration Seismic structural configuration entails three main aspects, namely (a) geometry, shape and size of the building, (b) location and size of structural elements, and (c) location and size of significant nonstructural elements . Influence of the geometry of a building on its earthquake performance is best understood from the basic geometries of convex and concave lenses from school-day physics class. The line joining any two points within area of the convex lens, lies completely within the lens. But, the same is not true for the concave lens; a part of the line may lie outside the area of the concave lens. Structures with convex geometries are preferred to those with concave geometries, as the former demonstrate superior earthquake performance. In the context of buildings, convex shaped buildings have direct load paths for transferring earthquake shaking induced inertia forces to their bases for any direction of ground shaking, while concave buildings necessitate bending of load paths for shaking of the ground along certain directions that result in stress concentrations at all points where the load paths bend.

II. LITERATURE REVIEW

Analysis of G+30 Highrise Buildings by Using ETABS for Various Frame Sections In Zone IV and Zone V A [1]

From the ancient time we know earthquake is a disaster causing phenomenon. Up to date days constructions are fitting increasingly narrow and extra inclined to sway and consequently detrimental within the earthquake. Researchers and engineers have worked out within the past to make the constructions as earthquake resistant. After many functional reports it has proven that use of lateral load resisting methods in the constructing configuration has drastically increased the performance of the structure in earthquake by using ETABS 9.7.4, the work has been carried out for the distinctive instances utilizing shear wall and bracings for the exceptional heights, and maximum top regarded for the reward gain knowledge is 93.5m. The modeling is completed to examine the outcome of special circumstances along with specific



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heights on seismic parameters like base shear, lateral displacements and lateral drifts. The gain knowledge has been implemented for the Zone IV and Zone V in Soil Type II (medium soils) as targeted in IS 1893-2002.

Dynamic analysis of buildings for earthquake resistant design [2]

This book explains concepts in behaviour of buildings during earthquakes. The book dwells on basic concepts in earthquake resistant design of buildings, first describes these at a conceptual level and then articulates further with numerical examples. It is an attempt to respond to some of the frequently asked questions by Architects and Structural Engineers regarding behaviour of Reinforced Concrete (RC) and Steel buildings under the action of lateral loads, especially during earthquakes. Since most buildings built in India are made of RC, the dominant set of examples used is of RC buildings. But, with no loss of generality, the broad concepts discussed in this document are valid for both RC and Steel buildings. Also, the discussion is limited to normal buildings without any special devices, like base isolation and other energy absorbing or dissipating devices. Also, specialized systems (like post-tensioning slab systems and nuclear power plants) are not in focus. This book employs exaggerated deformation shapes to emphasize deformations, and thereby, to develop the most needed intuition of structural behaviour of buildings during earthquakes and its consequences on earthquake-resistant design. The book contains animations related to behaviour of the various buildings models used in this work. Those readers seeing the electronic copy of this book should make special note of those pages titled Animation Set ..., to capture the hyperlinks and reach the said animations. The target audience of the book is practicing seismic structural engineers and architects, in addition to students and teachers of engineering and architecture colleges striving to understand seismic behaviour, analysis and design of buildings.

IS: 875(Part3): Wind Loads on Buildings and Structures -Proposed Draft & Commentary [3]

This document has been developed under the project on Building Codes sponsored by Gujarat State Disaster Management Authority, Gandhinagar at Indian Institute of Technology Kanpur. The views and opinions expressed are those of the authors and not necessarily of the GSDMA, the World Bank, IIT Kanpur, or the Bureau of Indian Standards.

Seismic Analysis & Design of Multistory Building Using Etabs [4]

E-tabs are mostly used to analyze concrete& steel structure, low& high rise buildings, skyscrapers& portal frames structure. In this project we had studied structural behavior of multi-story building (G+7) on E-tabs.

Observations on the Behavior of Reinforced Concrete Buildings During Earthquakes [5]

The purpose of the presented work is the behavior assessment of reinforced concrete frame structures with irregularities in elevation. Three six-storey frame structures with different degrees of irregularity in elevation were selected and their responses were compared with the ones of a corresponding regular structure. In this study, the effects of the variation of the axial force in the columns and of different contributions of slab width to the beams' flexural strength were investigated. In addition, a structure similar in configuration with one of the previously selected was defined and designed using current Portuguese codes to perform a comparison between different design approaches. Structural performance was assessed by comparing local ductility levels, displacements, inter-storey drifts and damage indices of the irregular frames and the regular one.



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[DOI:10.15680/IJIRSET.2021.1006235]

III. RESEARCH METHOD

This work we propose analysis of a P+4 RC framed structure (50m X 17m) located in Aurangabad (Zone II) for residential purpose using ETABS.

Length x Width	50m x 17m
No. of storey	P+4
Beam	230 mm x 600 mm
Column	230 mm x 600 mm
Slab Thickness	130 mm
Support Conditions	Fixed
Thickness of External Wall	150 mm
Grade of Concrete and Steel	M20 & Fe 415

Objectives of Work

- To understand the basic principles of structures by using Indian Standard Codes.
- To understand the parameters of design for beams, columns, slabs and other structural components.
- To prepare the 3D model of the structure by using the ETABS software for detailed analysis and design.
- To perform analysis and design of earthquake resistant structure

Following factors were taken into consideration for analysis of P+4 structure.

- Zone Factor (Z)-0.1
- Importance Factor (I)-1
- Response Reduction FactorI-5
- Damping Factor-1



After the application of the earthquake resistant design, the buildings are expected to resist the earthquake action by undergoing deflection or sway.

IV. MATERIAL AND METHODS

After the ETABS has completed analysing the whole structure, we can now proceed to the design part of the structure. ETABS can design a structure for various types of materials like Steel, Concrete, Aluminium & Timber. We will choose RCC or Reinforced Cement Concrete for designing our structure. After Completion of the analysis, we can view



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the design of a structural member such as beam or column by right clicking the member. ETABS carries out the design according to the design code that we have selected while analysing the member. We had selected it as IS 456:2000. Once all the parameter and data are entered into ETABS, we run the analysis again so as to get the design values. After the completion of the analysis we get the design values for the various members in the form of a written data. to get the entire schedule of a member we have to just right click the member and we will get the schedule for that particular member.

8 5 264-3003 Loads 40, 23	ab 09-db 76-45	ROOF
Loads 40: 23	Assignmen	et Data
Loads 40; 23	Assignmen	Geometry
40; 23		
5.75.56 4.4	d i: Joant 40 d : Joant 40 d :J. Joant 23 (m)	 Geometric Jainta En En Length

Figure 1 : Beam Information

Display Options				3D Interaction Surface	Current Interaction Curve
Show Design Code Data Show Feer Model Data Show Feer Model Data Dickide Material Strength Reduction Dickide Material Strength Reduction				P	E+3 1.50 - 1.25 - 1.00 - 0.75 -
rve Data				ALL	ĝ 0.50 -
Point	P kN	M2 kN-m	M3 kN-m		0.25 -
1	1402.1352	0	0		0.00 -
2	1360.29	0	51.3492	-M3	-0.25 -
3	1210.6666	0	81.7544	MZ	-0.50 -
4	1044.8382	0	107.2636	-M2	-0.75 -
5	861.0429	0	128.5323	M3	-50 0 50 100 150 200 250
6	648.9843	0	146.703	'-P	M (kN-m)
7	451.0808	0	145.8298		
8	255.0816	0	132.6397	Plan 315 de	0 Superimore Dashed Elser Curve
9	69.3631	0	108.5873		Contraction of the second
10	-146.1825	0	64.3483	Bevation 35	Note: Compression is positive in this form.
11	-398.4	0	0	•	
				20 101 000 000	Done

Figure 2: Column Interaction Surface



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|| Volume 10, Issue 6, June 2021 ||



|DOI:10.15680/IJIRSET.2021.1006235|

Figure 3: Story Response Plot

Story	4F B75		Section Name B230X600	B230×600	
Beam					
COMBO	STATION	TOP	BOTTOM	SHEAR	
ID	LOC	STEEL	STEEL	STEEL	
UDCon4	1.8750	0	261	254.94	
UDCon4	2.0500	0	261	254.94	
UDCon4	2.2250	0	261	254.94	
UDCon4	2.4000	0	261	254.94	
UDCon5	0.3000	261	0	254.94	
UDCon5	0.4750	261	0	254.94	
UDCon5	0.6500	261	0	254.94	
UDCon5	0.8250	261	0	254.94	
UDCon5	1.0000	261	261	254.94	
UDCon5	1.1750	261	261	254.94	
UDCon5	1.3500	261	261	254.94	
UDCon5	1.5250	261	261	254.94	
UDCon5	1.7000	0	261	254.94	
UDCon5	1.8750	0	261	254.94	
UDCon5	2.0500	0	261	254.94	
			_	_	
		Overwrite	es Details	Diagrams	

Figure 4: Beam Design Information



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Story	ST.C		Section Name	C230X600	
Column	C12		MAJOR SHEAR		
COMBO	STATION LONGITUDINAL			MINOR SHEAR	
ID	LOC	REINFORCEMENT	REINFORCEMENT	REINFORCEMENT	
UDConl	0.0000	1104	254.94	665.06	
UDConl	1.2000	1104	254.94	665.06	
UDConl	2.4000	1104	254.94	665.06	
UDCon2	0.0000	1104	254.94	665.06	
UDCon2	1.2000	1104	254.94	665.06	
UDCon2	2.4000	1104	254.94	665.06	
UDCon3	0.0000	1104	254.94	665.06	
UDCon3	1.2000	1104	254.94	665.06	
UDCon3	2.4000	1104	254.94	665.06	
UDCon4	0.0000	1104	254.94	665.06	
UDCon4	1.2000	1104	254.94	665.06	
UDCon4	2.4000	1104	254.94	665.06	
UDCon5	0.0000	1104	254.94	665.06	
UDCon5	1.2000	1104	254.94	665.06	
UDCon5	2.4000	1104	254.94	665.06	,
		Overwrit	Interaction	Details	

[DOI:10.15680/IJIRSET.2021.1006235]

Figure 5: Column Design Information

Story	Column	Unique Name	Output Case	Case Type	Step Type	Step Number	Station m	P kN	V2 kN	V3 kN
ST.C	C4	23	Dead	LinStatic			0	-47.9685	15.7353	0.5654
ST.C	C4	23	Dead	LinStatic			1.2	-43.8297	15.7353	0.5654
ST.C	C4	23	Dead	LinStatic			2.4	-39.6909	15.7353	0.5654
ST.C	C4	23	Live	LinStatic			0	-13.3223	5.0363	0.3337
ST.C	C4	23	Live	LinStatic			1.2	-13.3223	5.0363	0.3337
ST.C	C4	23	Live	LinStatic			2.4	-13.3223	5.0363	0.3337
ST.C	C4	23	Masonary	LinStatic			0	-13.396	4.6676	0.3842
ST.C	C4	23	Masonary	LinStatic			1.2	-13.396	4.6676	0.3842
ST.C	C4	23	Masonary	LinStatic			2.4	-13.396	4.6676	0.3842
ST.C	C4	23	FF	LinStatic			0	-5.5409	2.6423	0.0729
ST.C	C4	23	FF	LinStatic			1.2	-5.5409	2.6423	0.0729
ST.C	C4	23	FF	LinStatic			2.4	-5.5409	2.6423	0.0729
ST.C	C4	23	EqX	LinStatic	Step By Step	1	0	3.2072	0.2898	-3.5147
ST.C	C4	23	EqX	LinStatic	Step By Step	1	1.2	3.2072	0.2898	-3.5147
ST.C	C4	23	EqX	LinStatic	Step By Step	1	2.4	3.2072	0.2898	-3.5147
ST.C	C4	23	EqX	LinStatic	Step By Step	2	0	3.1044	0.6658	-3.5814
ST.C	C4	23	EqX	LinStatic	Step By Step	2	1.2	3.1044	0.6658	-3.5814
ST.C	C4	23	EqX	LinStatic	Step By Step	2	2.4	3.1044	0.6658	-3.5814
ST.C	C4	23	EqX	LinStatic	Step By Step	3	0	3.31	-0.0861	-3.4481
ST.C	C4	23	EqX	LinStatic	Step By Step	3	1.2	3.31	-0.0861	-3.4481
ST.C	C4	23	EqX	LinStatic	Step By Step	3	2.4	3.31	-0.0861	-3.4481
ST.C	C4	23	EqY	LinStatic	Step By Step	1	0	-4.6861	8.3271	0.5364
ST.C	C4	23	EqY	LinStatic	Step By Step	1	1.2	-4.6861	8.3271	0.5364
ST.C	C4	23	EqY	LinStatic	Step By Step	1	2.4	-4.6861	8.3271	0.5364
ST.C	C4	23	EqY	LinStatic	Step By Step	2	0	-4.3162	6.996	0.7709
ST.C	C4	23	EqY	LinStatic	Step By Step	2	1.2	-4.3162	6.996	0.7709
ST.C	C4	23	EqY	LinStatic	Step By Step	2	2.4	-4.3162	6.996	0.7709
ST.C	C4	23	EqY	LinStatic	Step By Step	3	0	-5.0559	9.6583	0.3019
ST.C	C4	23	EqY	LinStatic	Step By Step	3	1.2	-5.0559	9.6583	0.3019
ST.C	C4	23	EqY	LinStatic	Step By Step	3	2.4	-5.0559	9.6583	0.3019
ST.C	C4	23	UDCon1	Combination			0	-100.3581	34.5677	1.5336
ST.C	C4	23	UDCon1	Combination			1.2	-94.15	34.5677	1.5336

Table 1 : Element forces – column

Limitation

The buildings are designed to sway during the earthquake action in order to minimize the effect of the earthquake. Due to this:

• The effect of the earthquake is raw, i.e. the movement of the building is felt by the residents in the buildings.



| e-ISSN: 2319-8753, p-ISSN: 2320-6710| <u>www.ijirset.com</u> | Impact Factor: 7.512|

|| Volume 10, Issue 6, June 2021 ||

DOI:10.15680/IJIRSET.2021.1006235

• The furniture in the building and the utilities running in the building should be secured before they face the effect of the earthquake.

V. CONCLUSION

This research weanalyze earthquake resistant structures using ETABS. The analysis has been carried out by taking into account the architectural and structural design process. Firstly, the type of building which should be designed is decided by the seismic zone in which the construction of the building is to be carried out. In addition, the general aspects of the earthquake process have been considered to clarify the effects of earthquakes on buildings. By having a better understanding of the earthquake process and characteristic of earthquakes would enable us to make the earthquake resistant building design more efficient. Essential techniques for increasing the capacity of a building to provide protection against earthquake are discussed both with an architectural and structural approach.

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