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A Project Report on "seismic Analysis of Vertical Irregular Frames"

For the partial fulfillment of the requirement for the Degree of Bachelar of Technology in civil Engineering

Submitted By

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Abstract
Seismic analysis is important for assessing the safety of buildings in earthquake-prone regions. Irregular vertical frames are common in modern architectural designs and can significantly impact a building's seismic response. This paper presents a comprehensive review of the seismic analysis of vertical irregular frames. It also presents several case studies to illustrate the practical implications of vertical irregularities. The paper concludes by emphasizing the importance of considering vertical irregularities in seismic analysis and design. By understanding the behavior of vertical irregular frames and using appropriate analysis methodologies, engineers can ensure the safety of structures in earthquake-prone regions.

INTRODUCTION

The infrastructure of contemporary cities is mostly made up of irregular structures. The owner, architect, structural engineer, contractor, and local authorities are among the individuals involved in developing the facilities, and they all contribute to the general planning, the choice of the structural system, and its configuration. Building constructions with erroneous distributions of mass, stiffness, and strength throughout the building's height may result from this. The structural engineer's job is made more difficult when these structures are situated in an area with significant seismic activity. The seismic reaction of irregular constructions must thus be thoroughly understood by the structural engineer. Several studies have recently been conducted to assess the reaction of irregular structures to work that has already been done regarding the seismic responsiveness of buildings with asymmetrical vertical frameworks. Buildings with irregular elevations (e.g., considerable vertical setbacks in height, such as a plaza-type design in commercial structures) and irregular plans (e.g., those with re-entrant corners, such as L-shape plans on corner plots) are frequent in the impacted region.

When a multistory building is subjected to seismic loads, failure often starts where the building is weakest. Due to this flaw, the structure deteriorates and eventually collapses structurally. The main cause of this weakness is the existence of abnormalities in a building's mass, stiffness, and stiffness. Plan irregularity and vertical irregularity are the two categories into which these irregularities fall. The following categories apply to vertical abnormalities according to IS 1893:2016 (part I):

1.1 EARTHQUAKE

Tectonic plates are made of elastic but brittle rocky material. When these plates move relative to each other, they store elastic strain energy in the rocks at their interface. If the stress on the rocks exceeds their strength, they will fracture and suddenly slip, releasing the stored elastic strain energy. This sudden slip is what causes an earthquake. The energy released during an earthquake can be enormous, up to 400 times the energy released by the atomic bomb dropped on Hiroshima. The sudden slip at the fault also generates seismic waves, which travel through the Earth's body and along its surface. After the earthquake, the process of strain build-up starts all over again. Most earthquakes occur along the boundaries of tectonic plates, but some also occur within the plates themselves. The slip generated at the fault during an earthquake can be in both vertical and horizontal directions, or it can be mostly vertical or mostly horizontal.

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IRREGULARITY:

Building configuration systems have been advised by IS 1893 (part 1) 2002 [1] for improved performance of RC buildings during earthquakes. Regarding the structure's size, shape, placement of structural components, and mass, the building configuration has been classified as either regular or irregular. Building configuration systems have been described in IS 1893 2002 (part 1) for improved performance of RC structures during earthquakes. A building is described as irregular if it lacks symmetry and has discontinuities in its geometry, mass, or load-bearing parts. A structure is described as regular if its configurations are symmetrical along its axis.

Important Terminology from IS.1893(part 1): 2016
1)Storey displacement: The maximum allowable limit is specified in the IS standards for structures and refers to the overall displacement of the Storey with respect to the ground.
2)Storey drift: Storey drift is the movement of one level of a multi-story structure with respect to the level below. When a structure sways during an earthquake, inter story drift is the difference between the roof and floor displacements of any given story, normalized by the story height.
3)Storey shear: Storey shear, which is caused by pressures like seismic and wind force, is the lateral force pushing on a story. It is computed for each story, rising from the building's bottom to its top at a minimum value.

METHODOLOGY

The powerful yet user-friendly ETABS system, particularly tailored analysis and design software for building systems.The graphical interface of ETABS Version 8 is strong and user-friendly, and it also has unparalleled modeling, analytical, and design processes.
Utilizing a shared database to integrate. Despite being swift and simple for simple structures. ETABS is able to take care of the biggest and most complicated construction models, including a variety of non-linear behavior, making it the structural engineers' preferred tool in the construction sector.
Analysis and results Assumptions: Model A1 Model A2 Model A3 Model A4 Column Dimensions 0.23x0.45 Beam Dimensions 0.23x0.45 Wall Dimensions 0.23x3x4 Density of concrete 25kg/m3 Height of one floor 3m Height of building 12m Width of building 12m No. of Bays 4 Length of each Bay 4m Seismic Zone Factor 1 Response reduction factor 3 Soil Type Medium or Stiff soil.

ANALYSIS AND RESULTS

Column Dimensions	0.23x0.45
Beam Dimensions	0.23x0.45
Wall Dimensions	0.23x3x4
Density of concrete	25kg/m^3
Height of one floor	3m
Height of building	12m
`Width of building	16m
No. of Bays	4
Length of each Bay	4m
Seismic Zone Factor	1
Response reduction factor	3
Soil Type	Medium or Stiff soil

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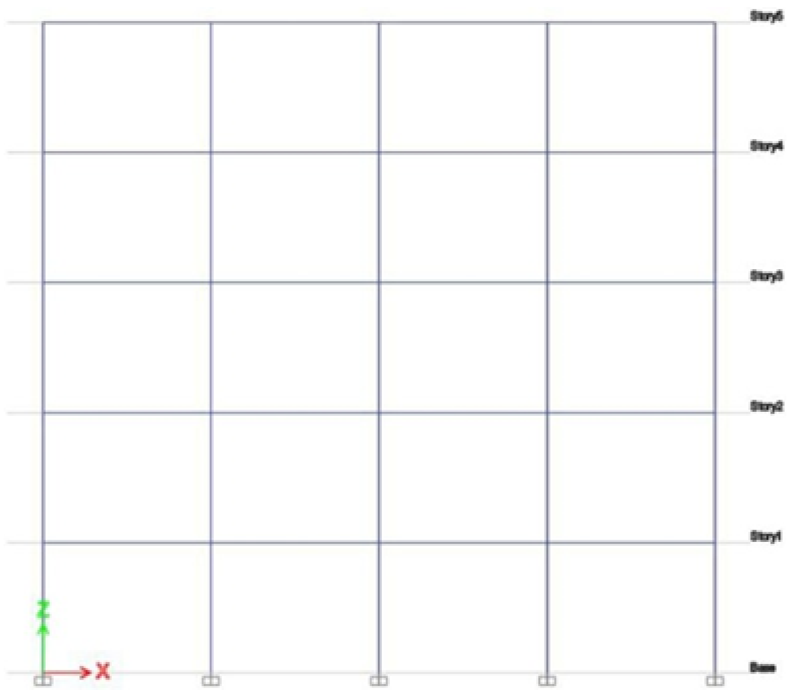
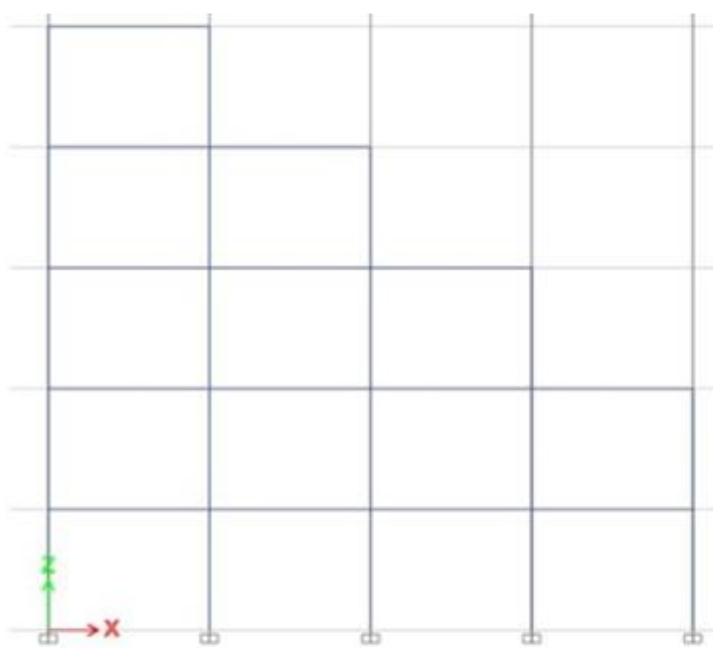


Model A1



Model A2

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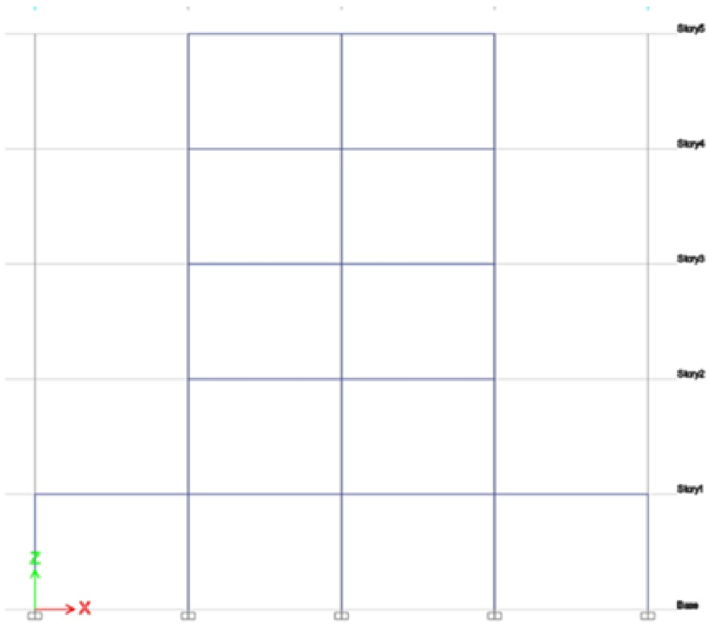

Model A3

A. Description for Loading:
The loading on the buildings is considered as per following calculations Height=12m
Base=16m

Slab (self weight)-
(8×25×0.15)/4=7.5kN/m
Column (self weight)-
3×0.25×0.45×25=7.76kN
Beam (self weight)-
(0.23×0.45×25)/4=2.58kN
Wall (self weight)-
3×0.23×20=13.8kN/m
Live load
3×8/4=6kN/m
Live Load Reduction 25% of total load
Live load =1.5Kn

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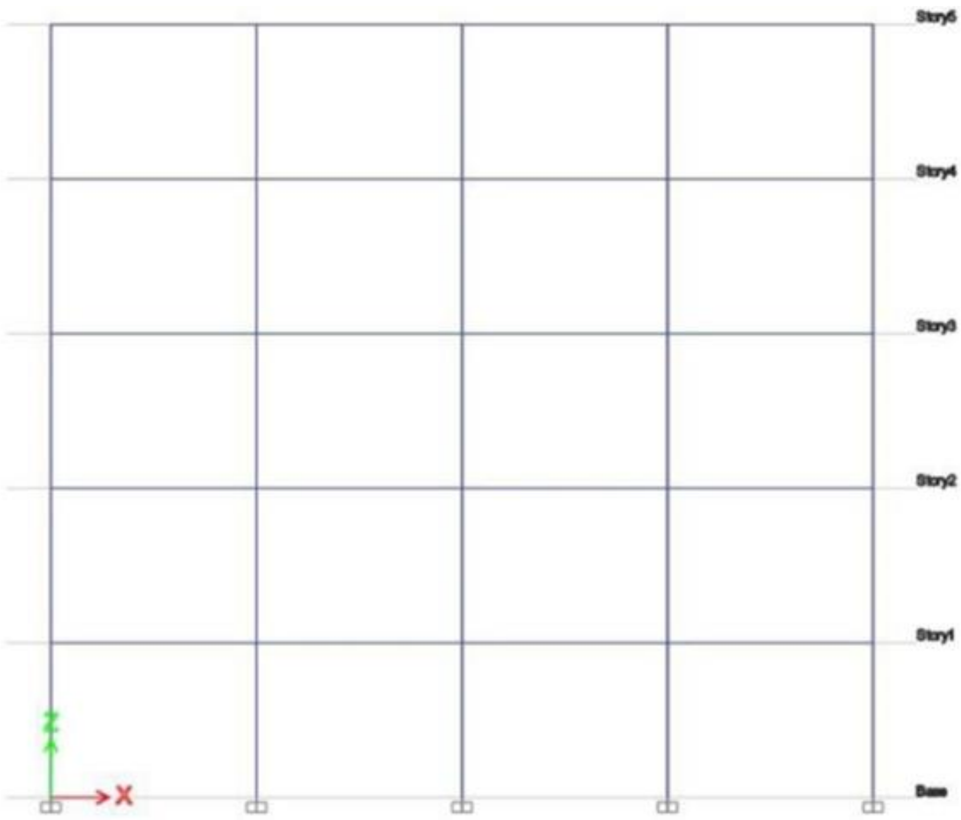

Fig 19:Regular frame

Total load on Beam=25.38kN/m

- Analysis

Ta=0.09H
√d = 0.009 12 √16 = 0.27………..(IS1893 Part 1:2016, Clause7.6.2)
Sa/g =2.50 ………………...…..(IS1893 Part 1:2016, Clause6.4.5)
Ah= $ZISa$ $2Rg$ Z Zone III, Z= 0.16 R=3 I=1 Ah= 0.16×2.50 2×3 Ah=0.067
W= Seismic weight of building
Weight of one floor=25.38×16=406.08kN 27
Weight of column=0.23×0.45×25×3=7.76kN
Weight of one floor=25.38×16=413.84kN
Total weight of building=2069.2kN
Base Shear (VB) VB=Ah×W = 0067×2069.2 VB=138.63Kn

Floor level	Wi	Hi	$Wihi^2$
Ground Floor	413.84	3	3724.56
1st	413.84	6	14898.24
2nd	413.84	9	33521.04
3rd	413.84	12	59592.96
4th	413.84	15	93114

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∑ Wihi2=204850.8
Q_{GF}=2.95kn

Q_1=11.83kn

Q_2=26.63kn
Q_3=47.35kn
Q_4=73.98 kN

BASE SHEAR CALCULATION

Table 1:Model A1

height, h=	12
width, d=	16
Ta=	0.027
S_a/g=	2.5
Seismic Weight=	2069.2
V_B=	138.6364

Floor	wi	hi	wi*hi2	Qi=	VB(wi*hi2)/Ewihi2
Ground	413.84	3	3724.56	Ground	2.520662
1	413.84	6	14898.24	1	10.08265
2	413.84	9	33521.04	2	22.68596
3	413.84	12	59592.96	3	40.33059
4	413.84	15	93114	4	63.01655
		Total=	204850.8		

Table 2:Model A2

height, h=	12
width, d=	16
Ta=	0.027
S_a/g=	2.5
Seismic Weight=	1460.08
V_B=	97.82536

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Floor	wi	hi	wi*hi2	Qi=	VB(wi*hi2)/Ewihi2	
Ground	413.84	3	3724.56	Ground	3.685433704	
1	413.84	6	14898.24	1	14.74173481	
2	312.32	9	25297.92	2	25.03216675	
3	210.8	12	30355.2	3	30.03632031	
4	109.28	15	24588	4	24.32970442	
		Total=	98863.92			

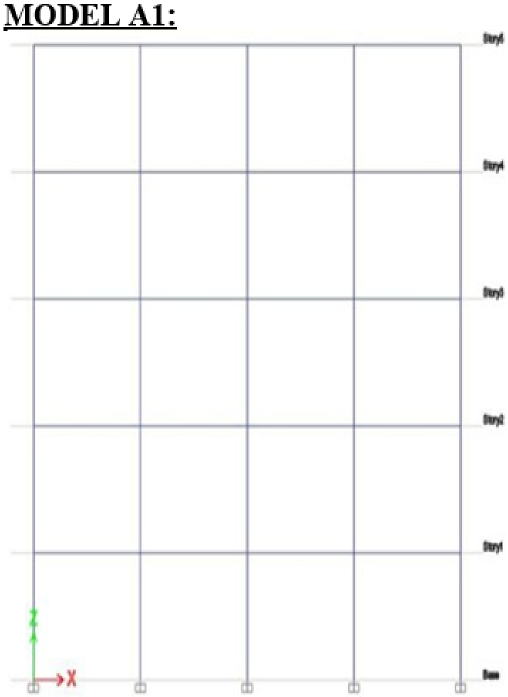
Table 5:Model A5

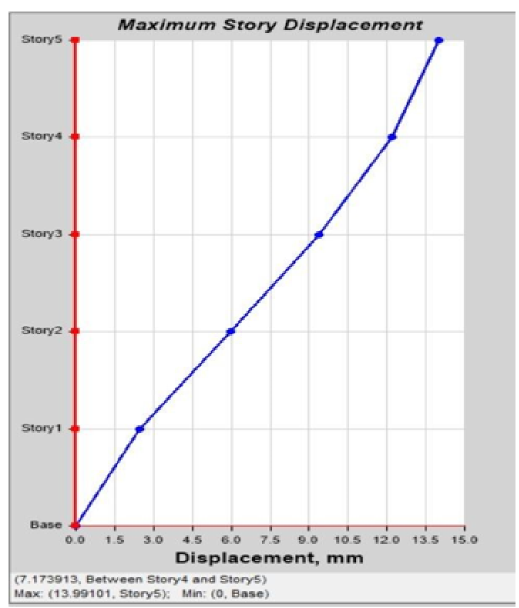
height, h=	12
width, d=	16
$T_{a=}$	0.027
$S_a/g=$	2.5
Seismic Weight=	1460.08
$V_B=$	97.82536

Floor	wi	hi	wi*hi2	Q_i=	V_B(wi*hi2)/Ewihi2
Ground	210.8	3	1897.2	Ground	1.035290858
1	210.8	6	7588.8	1	4.14116343
2	210.8	9	17074.8	2	9.317617718
3	413.84	12	59592.96	3	32.51952702
4	413.84	15	93114	4	50.81176097
		Total	179267.8		

CHAPTER 6: RESULTS AND DISCUSSIONS

MODEL A1:





Displacement=13.99mm

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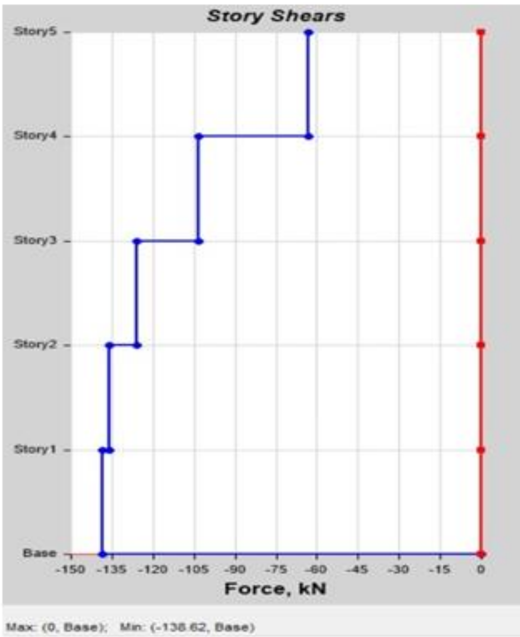
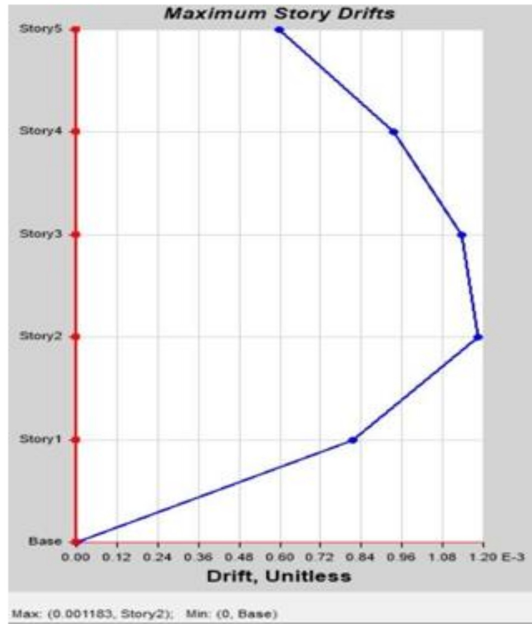
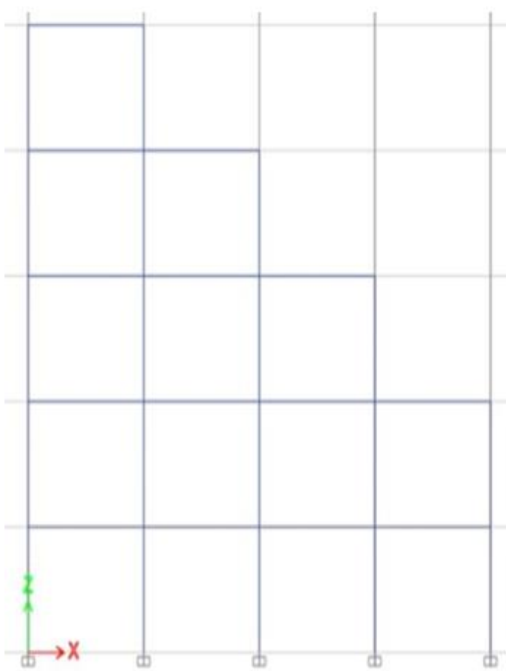


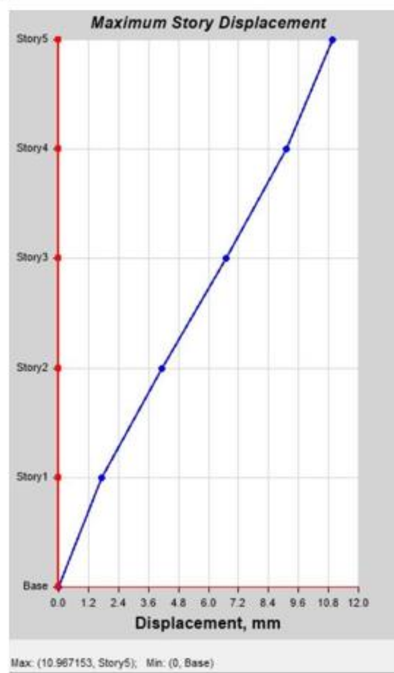
Base Shear=138KN



Story drift=0.0011 at story 2

MODEL A2





Displacement=10.96mm

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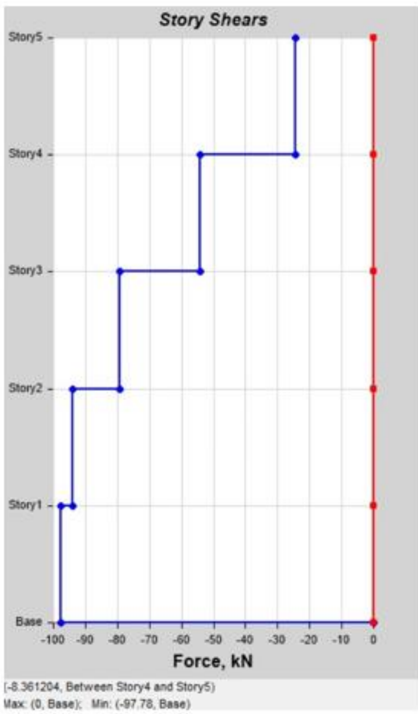
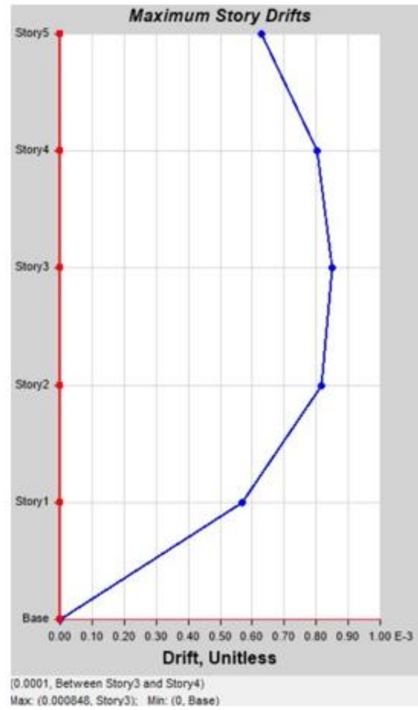
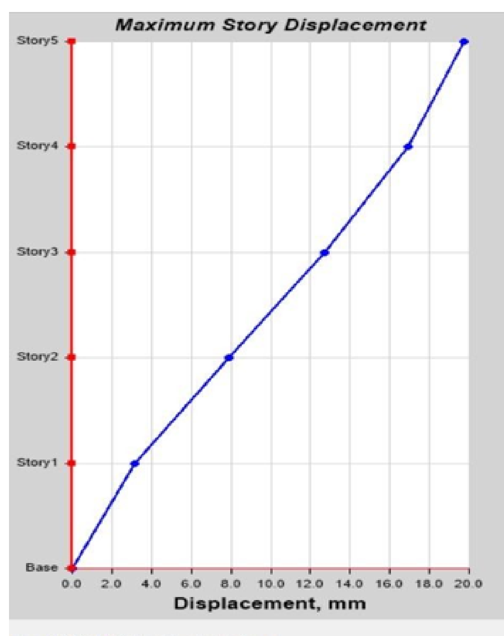


Base shear=97.78Kn



Story drift=0.00084 at story 3

MODEL A5



Displacement=19.77mm

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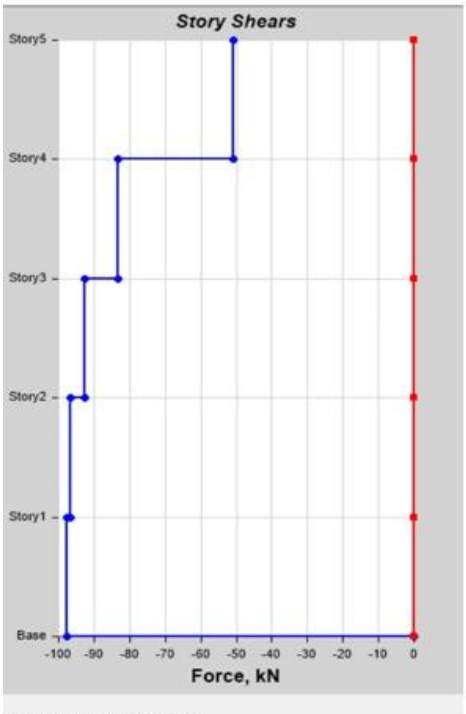
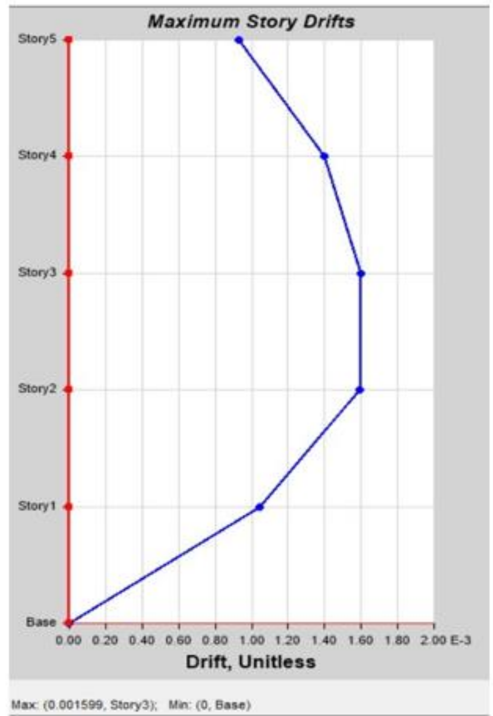


Base shear=97.82KN



Story drift=0.0015 at story 3

RESULT:

Sr no	Model name	Base Shear	Displacement	Story Drift	Story Drift Position
1	Model A1	138 KN	13.99 mm	0.0011	2nd Story
2	Model A2	97.78KN	10.96 mm	0.00084	3rd Story
3	Model A3	57.01 KN	16.01 mm	0.0014	3rd Story
4	Model A4	84.22 KN	13.84 mm	0.0012	3rd Story
5	Model A5	97.82 KN	19.77 mm	0.0015	3rd Story
6	Model A6	111.4 KN	21.7 mm	0.0018	2nd Story
7	Model A7	125.03 KN	23.76mm	0.0019	2nd Story

DESCRIPTION:

- Regular frame i:e model a1 shows displacement of 13.99mm.
- Stepped frame i:e model a2 shows displacements of 10.96mm.
- Model a3 shows displacement of 16.01mm
- Model a4 shows displacement of 13.84

- Model a5 shows displacement of 19.77mm
- Model a6 shows displacement of 21.7mm.
- Model a7 is showing the worst displacements of 23.76 mm

CONCLUSION:

- In all irregular configurations, model A2 shows displacement of 10.96 mm and base shear 97.78 KN. This frame shows good performance.
- In all irregular configurations, model A7 shows displacement of 23.76 mm, and base shear 125.03 KN. This frame shows poor performance.
- Stepped frame shows less displacement as compare to regular frame.
- In all irregular Models, model A2 is showing good performance whereas model A7 having poor performance

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