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Research paper

Multistorey Residential Building with Base Isolation Method Using SAP

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Abstract

Residential homes are of exceptional significance after any natural calamity which encompass earthquake. The structural and non-structural additives need to stay operational and secure after earthquake. So you can mitigate the impact of earthquake at the structure the bottom isolation method is the splendid opportunity as a seismic protecting system. The primary concept of base isolation gadget is to lessen the earthquake brought on inertia forces by using growing the fundamental length of the structure. Base isolation is one of the most effective tools of engineering concerning the passive structural vibration control technologies. It is supposed to allow a building or non-building shape to continue to exist a probably devastating seismic impact thru a right preliminary design or next changes. In some instances, software of base isolation can improve each a structure's performance and its seismic sustainability notably. he behaviour of multi-storey building of ordinary and abnormal configuration beneath earth quake is complex and it varies of wind masses are assumed to behave concurrently with earth quake loads. On this paper a residential of multi-storey constructing is studied for earth quake with base isolation approach using SAP 2000.

Keywords: *Multi-storey, Residential Building, Base Isolation and SAP.*

1. Introduction

A natural disaster like an earthquake has damaged the life and property of humans mercilessly over the years. Earthquake occurs due to the disturbance that is triggered underneath the ground surface either due to release of strain energy stored or due to convergence or divergence of tectonic plates. The resulting ground movement induces large forces onto the structure for a short instance of time. Ground acceleration gives rise to inertia forces whose magnitude equals the product of mass of the structure and ground acceleration (resulting from ground motion).

Inertia forces act as lateral loads on the structures and make huge demand on the structure to withstand it, as generally it is not designed to cater for such high level of lateral loads. Early design strategies for resisting earthquake loads include strengthening the structural elements, by making use of Moment resisting frames and braces etc. But as the members become heavier due to increase in strength, it attracts larger seismic forces which turns up as a serious limitation in the above design approach. Consequently the ductile design method came into practice, in which the members are designed in such a way that they undergo deformation in the post elastic stage without collapsing. In this approach the ductile elements are made weak compared to the brittle ones. There were problems experienced with this method because of the difficulty in concreting at the beam column junctions, due to complexity of the reinforcements at the junction. Hence the recent trend is to go for Vibration control methods such as Base Isolation.

Hospital facility have to stay safe after the earthquake, for providing ordinary medical services and to keep the life of humans. Subsequently to mitigate the response of earthquake on the structure many engineers and architects looking for out the exceptional applicable method to lessen the response given to ground movement by the structures. Base isolation is one of the nice alternatives for this issue. At some point of earthquake the traditional shape without seismic isolation is subjected to vast storey drifts, which may additionally lead to harm or even crumble of the building.

While the isolated structure vibrates nearly like a rigid body with massive displacement duet the presence of isolators at the bottom of systems. A source of damping is likewise furnished to reduce the deflection of the structure. The behaviour exchange of shape without base isolator and with base isolator incorporation. Fig.1 indicates the effect of base isolation.

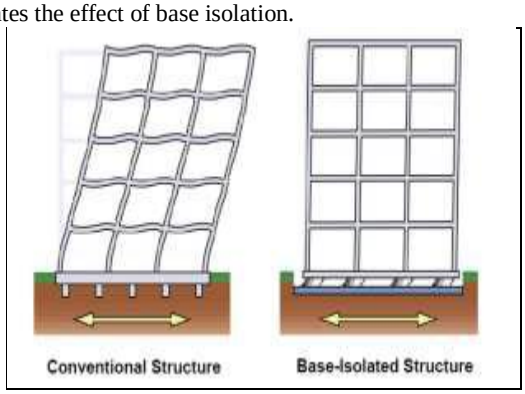

Fig.1: Effect of base isolation

Further, the damping capacities provided by way of the isolation systems help use up the energy imparted for the duration of seismic sports.

Seismic base isolation, which is now diagnosed as a mature and green technology, can be adopted to enhance the seismic overall performance of strategically essential constructing such as faculties, hospitals, business systems, multi-storey buildings and many others. With a purpose to minimize inter storey drifts, similarly to decreasing ground accelerations; the idea of base isolation is increasingly being adopted. Base isolation (BI) has additionally been called passive manage.

1.1. Objectives of the Study

Inside the present observe, the work includes the analysis of a 4 storey reinforced concrete plan geometric abnormal and one with fixed base and different with base isolated.
The objectives of the study are as follows:

- To perform modelling and evaluation of constant base and base isolated constructing by using using ETABS model software & staad pro v8i and have a look at the impact of seismic forces on those fashions.
- To design and have a look at the effectiveness of lead rubber bearing used as a base isolation system.
- To observe the behaviour of plan abnormal and vertical abnormal RC building below higher seismic region location.

2. Methodology

Fig.2 shows the methodology of this study.

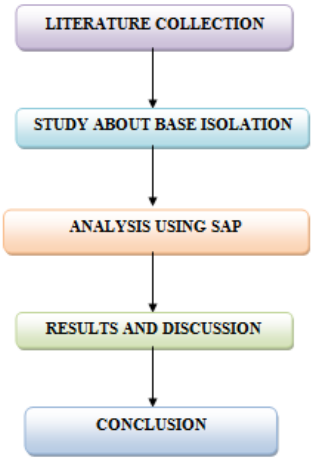

Fig.2: Methodology

3. Base Isolation

Base isolation system includes isolation system without or with isolation additives, where:

- Isolation additives are the connections among isolation systems and their parts having no decoupling effect of their personal.

In seismic isolation, the fundamental motive is to reduce significantly the floor motion forces and electricity transmission. Putting in keeping apart layers with a big horizontal flexibility is ideal manner to gain that intention. Base isolation is assessed below two categories. They're elastomeric bearings and sliding kind bearings.

3.1. Application of Base Isolation

- Although the era remains developing it has already been utilized in interminable wide variety of systems.
- It turned into firstly carried out in New-Zealand in 1974 and become first enforced in India in 2001 after Gujarat earthquake.
- In angels town corridor (top 138m) in los angels is the tallest base isolated building inside the world.
- It has observed numerous applications in modern times which include retrofitting it in residential homes, buildings of ancient importance, monuments, bridges, and many others.

3.2. Seismic Base Isolation Technique for Building Earthquake Resistance

It's far simplest to look the principle at work through referring without delay to the most extensively used of these superior strategies, called base isolation.
If the flexible pads are nicely chosen, the forces prompted by using ground shaking may be some times smaller than that skilled by using the constructing constructed immediately on floor, namely a set base constructing. The bendy pads are called base-isolators, whereas the structures included by means of those devices are known as base-isolators buildings. The principle function of the bottom isolation era is that it introduces flexibility within the structure.
As a end result, a robust medium-upward push masonry or reinforced concrete building becomes extraordinarily flexible. The isolators are frequently designed, to take in power and as a consequence add damping to the system. Generally low to medium rise buildings homes rested on difficult soil underneath high-rise buildings or homes rested on tender soil are n't appropriate for base isolation.
On top and backside, the bearing is geared up with metal plates which might be used to connect the bearing to the building and foundation. We are saying that the constructing is deforming.

4. Software

4.1. Sap

Sap2000 is great-reason civil-engineering software program program first-rate for the analysis and design of engineering operating on transportation, commercial enterprise, public works, sports activities, and different centers. Sap2000 is object primarily based, which means that the fashions are created the usage of individuals that constitute the physical truth. a beam with a couple of participants framing into it's far created as a single item, actually as it exists in the actual global, and the meshing had to make sure that connectivity exists with the alternative participants is dealt with internally byte software.

5. Analysis Report

5.1. Model Geometry

This total segment gives model geometry facts, together with objects such as all joint coordinates, all joint restraints, and all element connectivity. Fig.3 indicates the finite element version.

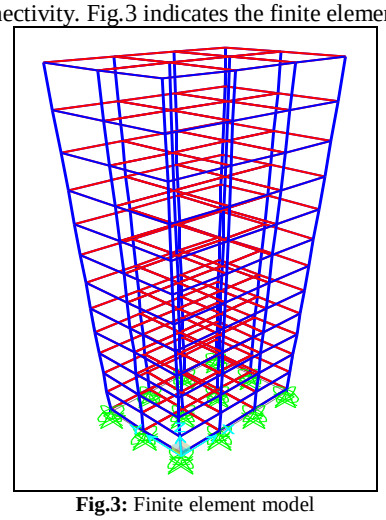

Fig.3: Finite element model

5.2. Material Properties

This phase gives material belongings information for substances used inside the version. Table 1 indicates the fabric properties – primary mechanical homes.

Table 1: Material properties - basic mechanical properties

Material	Unit Weight	Unit Mass	E1	G12	U12	A1
	N/mm3	N-s2/mm4	N/mm2	N/mm2		1/C
4000Psi	2.3563E-05	2.4028E-09	24855.58	10356.49	0.2	9.9000E-06
A615Gr60	7.6973E-05	7.8490E-09	199947.98			1.1700E-05
A992Fy50	7.6973E-05	7.8490E-09	199947.98	76903.07	0.3	1.1700E-05
Default Material	2.3563E-05	2.4028E-09	24821.13	10342.14	0.2	9.9000E-06
M30	0.0000E+00	0.0000E+00	27386.13	11410.89	0.2	5.5000E-06

Table 2 shows the material proerties – steel data.

Table 2: Material properties - steel data

Material	Fy	Fu	Final Slope
	N/mm2	N/mm2	
A992Fy50	344.74	448.16	-0.1

Table 3 shows the material properties – concrete data.

Table 3: Material properties - concrete data

Material	Fc	eFc	Final Slope
	N/mm2	N/mm2	
4000Psi	27.58	27.58	-0.1
M30	30.	30.	-0.1

Table 4 shows the material properties – rebar data.

Table 4: Material properties - rebar data

Material	Fy	Fu	Final Slope
	N/mm2	N/mm2	
A615Gr60	413.69	620.53	-0.1

5.3. Section Properties

Table 5 shows the frame section properties

Table 5: Frame section properties general, part 1 of 4

Section Name	Material	Shape	t3	t2	tf	tw	t2b	tfb
			mm	mm	mm	mm	mm	mm
BEAM	M30	Rectangular	400.	300.				
COLUMN	M30	Rectangular	600.	400.				
W44X335	Default Material	I/Wide Flange	1117.6	403.86	44.958	26.162	403.86	44.958

Table 6 shows the frame section properties

Table 6: Frame section properties - general, part 2 of 4

Section Name	Area	Tors Const	I33	I22	I23	AS2	AS3
	mm2	mm4	mm4	mm4	mm4	mm2	mm2
BEAM	120000.	1943850586.	1600000000.	900000000.	0.	100000.	100000.
COLUMN	240000.	7512493827.	7200000000.	3200000000.	0.	200000.	200000.
W44X335	63548.26	31092486.22	1.294E+10	499477711.	0.	29238.65	30261.23

Table 7 shows the Frame section properties - concrete column

Table 7: Frame section properties - concrete column, part 1 of 2

Section Name	Rebar MatL	Rebar MatC	Reinf Config	Lat Reinf	Cover	NumBars3Dir	NumBars2Dir
					mm		
BEAM	A615Gr60	A615Gr60	Rectangular	Ties	40.	3	3
COLUMN	A615Gr60	A615Gr60	Rectangular	Ties	40.	3	3

Table 8 shows the Frame section properties - concrete column,

Table 8: Frame section properties - concrete column, part 2 of 2

Section Name	Bar Size L	Bar Size C	Spacing C	NumCBars2	NumCBars3
			mm		
BEAM	#9	#4	150.	3	3
COLUMN	#9	#4	150.	3	3

5.4. Structure Results

Fig.4 shows the deformed shape.

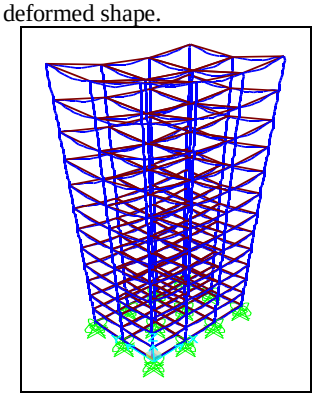

Fig.4: Deformed shape

5.5. Base Reactions

Table 9 shows the base reactions.

Table 9: Base reactions

Output Case	Global FX	Global FY	Global FZ	Global MX	Global MY	Global MZ
	N	N	N	N-mm	N-mm	N-mm
DEAD	1.819E-12	7.276E-11	7072000.	2.829E+10	-4.243E+10	4.917E-07
~LLRF	0.	0.	0.	0.	0.	0.
Live	0.	0.	0.	0.	0.	0.
SEI	0.	0.	0.	0.	0.	0.
WIND	0.	0.	0.	0.	0.	0.

5.6. Frame Results

Table 10 shows the Element Forces - Frames, Part 1 of 2

Table 10: Element Forces - Frames, Part 1 of 2

Frame	Station	Output Case	P	V2	V3
	mm		N	N	N
18	200.	DEAD	-1471.29	-14105.24	-2.26
18	650.	DEAD	-1471.29	-10505.24	-2.26
18	1100.	DEAD	-1471.29	-6905.24	-2.26
18	1550.	DEAD	-1471.29	-3305.24	-2.26
18	2000.	DEAD	-1471.29	294.76	-2.26
18	2450.	DEAD	-1471.29	3894.76	-2.26
18	2900.	DEAD	-1471.29	7494.76	-2.26
18	3350.	DEAD	-1471.29	11094.76	-2.26
18	3800.	DEAD	-1471.29	14694.76	-2.26

Fig.5 shows the stress diagram.

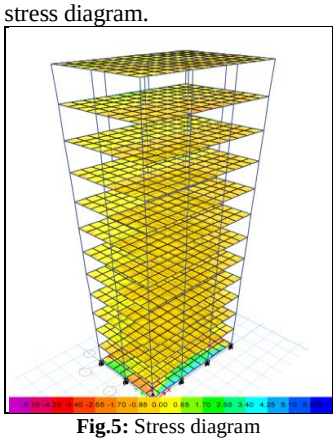

Fig.5: Stress diagram

Fig.6 shows the bending moment diagram.

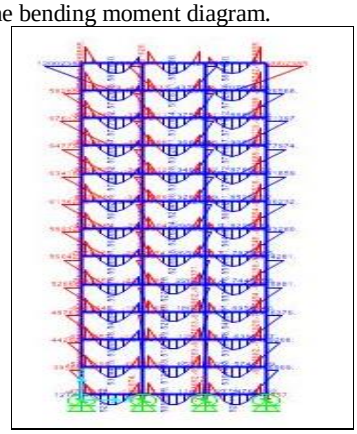

Fig.6: Bending moment diagram

Fig.7 shows the shear force diagram.

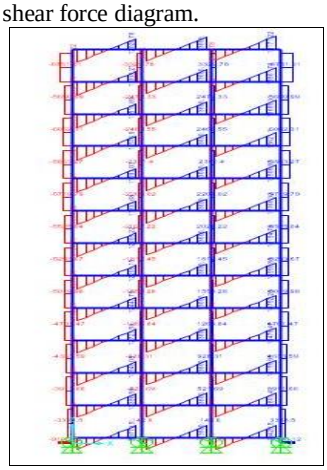

Fig.7: Shear force diagram

5.7. Material Take-Off

Table 11 shows the material list 2 - by section property.

Table 11: Material list 2 - by section property

Section	Object Type	Num Pieces	Total Length	Total Weight
			mm	N
COLUMN	Frame	156	438480.	0.
BEAM	Frame	221	884000.	0.
M30 200.000	Area			0.

5.8. Design Preferences

5.8.1. Steel Design

Table 12 shows the steel design – AISC 360-10, Part 1 of 4.

Table 12: Steel Design - AISC 360-10, Part 1 of 4

TH Design	Frame Type	Pat LLF	S Ratio Limit	MaxIter	SDC	Seis Code	Seis Load	Imp Factor
Envelopes	SMF	0.75	0.95	1	D	Yes	Yes	1.

Table 13 shows the steel design – AISC 360-10, Part 2 of 4.

Table 13: Steel Design - AISC 360-10, Part 2 of 4

System Rho	System Sds	System R	System Cd	Omega0	Provision	A Method	SO Method	SR Method
1.	0.5	8.	5.5	3.	LRFD	Direct Analysis	General 2nd Order	Tau-b Fixed

Table 14 shows the steel design – AISC 360-10, Part 3 of 4.

Table 14: Steel Design - AISC 360-10, Part 3 of 4

NL Co eff	Phi B	Phi C	Phi TY	Phi TF	Phi V	Phi V Rolled I	Phi VT	Plug Weld
0.002	0.9	0.9	0.9	0.75	0.9	1.	0.9	Yes

Table 15 shows the steel design – AISC 360-10, Part 4 of 4.

Table 15: Steel Design - AISC 360-10, Part 4 of 4

HSS Welding	HSS Reduce T	Check Defl	DL Rat	SDL And LLR at	LLR at	Total Rat	Net Rat
ERW	No	No	120.	120.	360.	240.	240.

5.9. Concrete Design

Table 16 shows the concrete design – ACI 318-14, Part 1 of 2.

Table 16: Concrete Design - ACI 318-14, Part 1 of 2

TH Design	Num Curves	Num Points	Min Eccen	Pat LLF	UF Limit	Rho	Sds
Envelopes	24	11	Yes	0.75	0.95	1.	0.5

Table 17 shows the concrete design – ACI 318-14, Part 2 of 2.

Table 17: Concrete Design - ACI 318-14, Part 2 of 2

Phi T	PhiC Tied	PhiC Spiral	Phi V	Phi V Seismic	Phi V Joint
0.9	0.65	0.75	0.75	0.6	0.85

6. Conclusion

Dynamic Response Spectrum Analysis is used and finished for 4 - storey building. The total structure is analyzed with fixed base and with base isolator. Comparative study of all different parameters like shear force diagram, displacement, spectral acceleration, bending moment diagram, frequency, base shear is carried out with isolator using software SAP. It can be concluded that total performance of isolated building is better compared to the non-isolated building.

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