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Research paper

Dynamic Analysis of Structure Subjected to Bi-Directional and Uni-Directional Earthquake Forces Using ETABS

T.Subramani[1*], S.Sujatha[2]

[1*] *Managing Director, Priyanka Associates (Civil Engineers and Valuers), Salem, TamilNadu, India.*
[2] *Assistant Executive Engineer, PWD, Namakkal., TamilNadu, India.*
[*]*Corresponding author E-mail: tsmcivil2007@gmail.com*

Abstract

When the buildings are are subjected to gravitational and seismic hundreds the larger height acceleration thing is performing in a single course (uni-directional) and with the two additives appearing inside the lateral and within the transverse directions (bi-directional). It's miles determined that there aren't any incredible variations among them but the interplay among the bending moments and the axial force inside the yield surfaces is considered. The differences among the responses acquired from the uni- and the bi-directional dynamic loads are evaluated via the usage of etab software and the variations of the buildings subjected to uni and bi-directional horizontal masses mixed with gravitational hundreds are smaller than the variations of responses of these subjected to seismic uni and bi-directional hundreds. in this work we proposed to discover difference and it interference due seismic loading has find out it.

Keywords: *Dynamic analysis, Bi-Directional, Uni-Directional, Earthquake and ETABS..*

1. Introduction

To study the response of a reinforced concrete frame building under bi-directional ground motion, the above modeled structure is lightly modified. A doubly symmetric building is obtained either shifting the central frame in Y direction on the axis of symmetry and by changing the reinforcement in some sections of the beams. In this way the effects of the action of the secondary horizontal component on the seismic behavior are isolated from the effects of plan asymmetry.

A not unusual practice in structural building layout is to use the seismic response originated by using ground motion acting one by one within the orthogonal directions of the building. in this evaluation a sizable contribution to the building torsion stiffness because of the traverse frames seems. An extra contribution to the lateral building stiffness arises when the three-dimensional stiffness of the elements is taken into consideration. but, the truth that the earthquake has indeed an arbitrary path, represented through a bi-directional floor motion, should reduce the contribution of the traverse frames to the building torsion and lateral stiffness.

To study the response of a reinforced concrete frame building under bi-directional ground motion, the above modelled structure is lightly modified. A doubly symmetric building is obtained either shifting the central frame in Y direction on the axis of symmetry and by changing the reinforcement in some sections of the beams. In this way the effects of the action of the secondary horizontal component on the seismic behaviour are isolated from the effects of plan asymmetry.

2. Methodology

Fig.1 shows the methodology of this study.

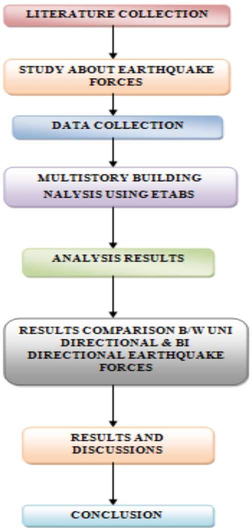

Fig.1: Methodology

3. Earthquake Force

In maximum instances this resistance can be achieved by following easy, cheaper concepts of good building creation exercise. Adherence to these simple guidelines will no longer save you all harm in moderate or huge earthquakes, however lifestyles

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threatening collapses ought to be prevented, and harm confined to repairable proportions.
This furnished a good review of structural movement, mechanism of harm and modes of failure of buildings. from these research, positive trendy standards have emerged:

- Systems ought to now not be brittle or collapse all at once. Rather, they have to be tough, able to deflect or deform a massive quantity.
- Resisting factors, which include bracing or shear walls, have to be supplied lightly throughout the constructing, in both instructions face-to-face, as well as top to backside.
- All factors, together with partitions and the roof, have to be tied collectively with the intention to act as an included unit for the duration of earthquake shaking, shifting forces across connections and stopping separation.

4. Bidirectional Modelling of Building Structures

All engineering structures are composed of intrinsic mass and elastic traits. The dynamic modelling has comparable characteristics with the static evaluation. But, the dynamic evaluation is a whole lot complicated than static analysis. For instance, the mass modelling technique for the dynamic version requires an elastic version and a mass model minutely delicate by using discrete masses.
Recent earthquakes show that the bidirectional effect is the principle damage supply of the structural damage. The seismic evaluation must do not forget the bidirectional excitation. the ordinary technique of building structure layout regards the seismic reaction bobbing up from the ground motion that acts separately within the two orthogonal guidelines.
The impact of the magnitude of the axial forces appearing inside the corner columns in case of bidirectional ground motion subjected to structures is different from that in case of unidirectional ground motion. Reference additionally cautioned that, for a shape exposed to 2 simultaneous horizontal earthquake additives, the transverse element behaviour can be nonlinear and so the contribution to the actual torsional stiffness is smaller. The have a look at concluded that the addition of the transverse factors in the version significantly hampers the reaction of the border factors while the structure is subjected to the bidirectional seismic waves.
The evaluation of actual buildings shows that it is asymmetric in nature to a few diploma with a formal symmetric plan. The asymmetric nature of building will set off lateral in addition to torsional vibrations simultaneously and is termed as torsion coupling (TC) considering the case of natural translational excitations. Soil-structure interaction outcomes are taken into consideration and can be substantial in case of the building structures built on gentle medium. The consequences of critically regulate the dynamic traits of a structure inclusive of natural frequencies, damping ratios, and mode shapes. The information of behaviour and impact of the excitation forces performs a extensive position within the system of the constructing structures dynamic model. the movement of the portion of the earth crust is named as earthquake which is shock and vibration followed with the sudden release of stresses. Generally the epicenters for earthquake exist much less than 25 miles under the earth's floor and are observed through collection of vibrations. These forces bring about series of shape vibrations. the forces acting on the x-axis and y-axis can be illustrated via the following dynamic equations

5. E-TABS Results

Fig.2 shows the Etabs modelling.

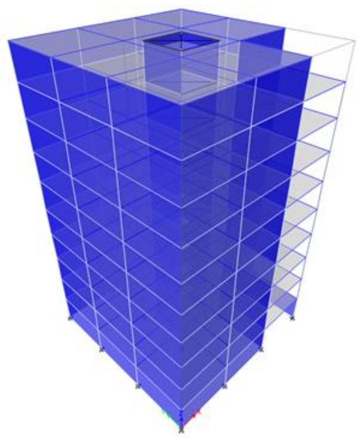

Fig.2: Modelling

5.1. Structure Data

This location gives version geometry statistics, together with items inclusive of tale tiers, factor coordinates, and element connectivity.

5.1.1. Storey Data

Table 1 shows the storey data.

Table 1: Storey Data

Name	Height mm	Elevation mm	Master Story	Similar To	Splice Story
Story10	3000	30000	Yes	None	No
Story9	3000	27000	No	Story10	No
Story8	3000	24000	No	Story10	No
Story7	3000	21000	Yes	None	No
Story6	3000	18000	No	Story7	No
Story5	3000	15000	No	Story7	No
Story4	3000	12000	No	Story7	No
Story3	3000	9000	No	Story7	No
Story2	3000	6000	No	Story7	No
Story1	3000	3000	No	Story7	No
Base	0	0	No	None	No

5.2. Loads

This area provides loading information as applied to the model.

5.2.1. Load Patterns

Table 2 shows the load patterns.

Table 2: Load patterns

Name	Type	Self Weight Multiplier	Auto Load
Dead	Dead	1	
Live	Reducible Live	0	
WIND X	Wind	0	Indian IS875:1987
WIND Y	Wind	0	Indian IS875:1987
EQX 1	Seismic	0	IS1893 2002
EQX 2	Seismic	0	IS1893 2002
EQX A	Seismic	0	IS1893 2002
EQX B	Seismic	0	IS1893 2002

5.2.2. Load Cases

Table 3 shows the load cases – summary.

Table 3: Load cases – summary

Name	Type
Dead	Linear Static
Live	Linear Static
WIND X	Linear Static
WIND Y	Linear Static
EQX 1	Linear Static
EQX 2	Linear Static
EQX A	Linear Static
EQX B	Linear Static

5.3. Analysis Results

This area provides analysis results.

5.3.1. Structure Results

Table 4 shows the base reactions.

Table 4: Base reactions

Load Case/Combo	FY kN	FZ kN	MY kN-m	MZ kN-m
Dead	0	52739.5919	-465616	0
Live	0	761	-6795	0
WIND X	919.5381	0	-49069.6128	36413.7106
WIND Y	-3425.9337	0	0	-29871.8123
EQX 1	0	0	-31593.6251	14008.3116
EQX 2	0	0	-31593.6251	11540.7367
EQX A	-1370.8749	0	0	-13129.9629
EQX B	-1370.8749	0	0	-10662.3881
DCon1	0	79109.3879	-698424	0
DCon2	0	80250.8879	-708617	0
DCon3	1103.4458	64200.7103	-625777	43696.4527
DCon4	-1103.4458	64200.7103	-508010	-43696.4527
DCon5	-4111.1204	64200.7103	-566893	-35846.1748
DCon6	4111.1204	64200.7103	-566893	35846.1748
DCon7	1379.3072	79109.3879	-772029	54620.5659

5.4. Storey Response Plots for Uni-Directional Earth Force

5.4.1. Storey Displacement

Table 5 shows the storey displacement.

Table 5: Storey displacement

Story	Elevation	Location	X-Dir	Y-Dir
	m		mm	mm
Story10	30	Top	0.820121324	0.110492567
Story9	27	Top	0.756969346	0.102179872
Story8	24	Top	0.675900274	0.091296434
Story7	21	Top	0.584136565	0.078555284
Story6	18	Top	0.493404942	0.065752854
Story5	15	Top	0.399415627	0.051893046
Story4	12	Top	0.304863981	0.037757774
Story3	9	Top	0.211526765	0.028303353
Story2	6	Top	0.12773647	0.016162336
Story1	3	Top	0.05478256	0.006180153

Fig.3 shows the Storey displacement for uni-directional Earth force

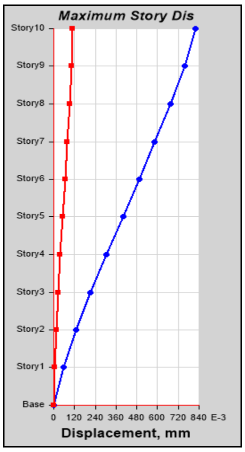

Fig.3: Storey displacement for uni directional Earth force

5.4.2. Storey Drift

Table 6 shows the storey drift results.

Table 6: Storey drift results

Story	Elevation	Location	X-Dir	Y-Dir
	m			
Story10	30	Top	2.10507E-05	2.7709E-06
Story9	27	Top	2.7023E-05	3.62781E-06
Story8	24	Top	3.05879E-05	4.24705E-06
Story7	21	Top	3.02439E-05	4.26748E-06
Story6	18	Top	3.13298E-05	4.61994E-06
Story5	15	Top	3.15172E-05	4.71176E-06
Story4	12	Top	3.11124E-05	3.15147E-06
Story3	9	Top	2.79301E-05	4.04701E-06
Story2	6	Top	2.4318E-05	3.32739E-06
Story1	3	Top	1.82609E-05	2.06005E-06

Fig.4 shows the story drift for uni directional earth force

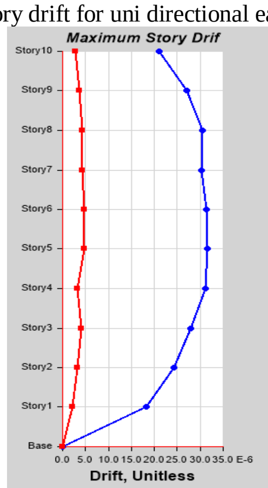

Fig.4: Story drift for uni directional earth force

5.4.3. Storey Overturning Moments

Table 7 shows the story overturning moments

Table 7: Storey overturning moments

Story	Elevation	Location	X-Dir	Y-Dir
	m		kN-m	kN-m
Story10	30	Top	-3.33786E-12	2.6077E-11
Story9	27	Top	1.48246E-09	-830.8050817
Story8	24	Top	2.96199E-09	-2592.146029
Story7	21	Top	3.2371E-09	-5081.47296
Story6	18	Top	3.44634E-09	-8135.461718
Story5	15	Top	3.53503E-09	-11609.66553
Story4	12	Top	3.20417E-09	-15375.68536
Story3	9	Top	2.27833E-09	-19326.08457
Story2	6	Top	1.48917E-09	-23380.19716
Story1	3	Top	7.26342E-10	-27481.00032
Base	0	Top	-3.03984E-10	-31593.62506

Fig.5 shows the Storey overturning moments for uni directional Earth force

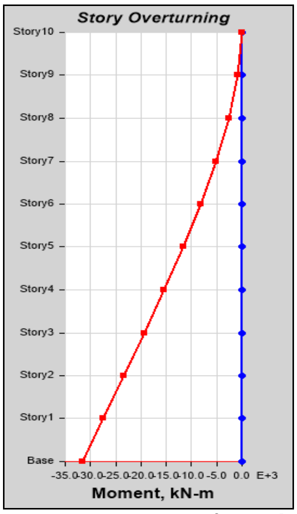

Fig.5: Storey overturning moments for uni directional **earth** force

Fig.6 shows the Stress diagram for uni directional Earth force

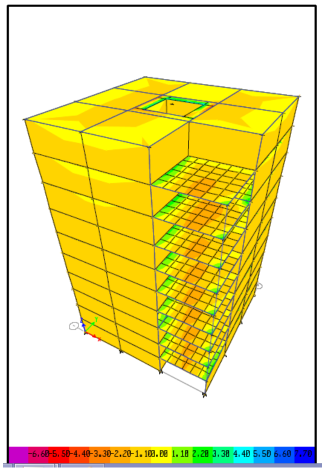

Fig.6: Stress diagram for uni directional Earth force

Fig.7 shows the stress diagram for Bi- directional Earth force

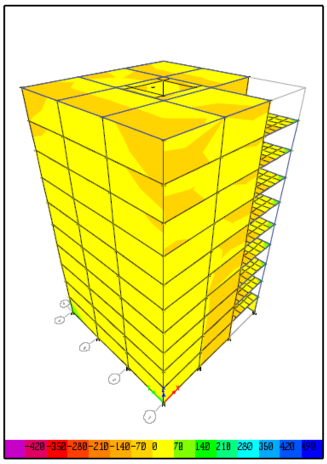

Fig.7: Stress diagram for Bi- directional Earth force

5.5. Storey Response Plots for Bi - Directional Earth Force

5.5.1. Storey Displacement

Table 8 shows the Storey displacement for Bi - directional earth force

Table 8: Storey displacement for Bi - directional earth force

Story	Elevation	Location	X-Dir	Y-Dir
	m		mm	mm
Story10	30	Top	0.792946374	0.091435367
Story9	27	Top	0.730635977	0.08356778
Story8	24	Top	0.651610343	0.073765189
Story7	21	Top	0.562520271	0.062569188
Story6	18	Top	0.474373697	0.051584622
Story5	15	Top	0.383305642	0.039836022
Story4	12	Top	0.291943194	0.028009578
Story3	9	Top	0.202076027	0.020722704
Story2	6	Top	0.121644968	0.01107919
Story1	3	Top	0.052007568	0.003663275

Fig.8 shows the Storey displacement for Bi- directional Earth force

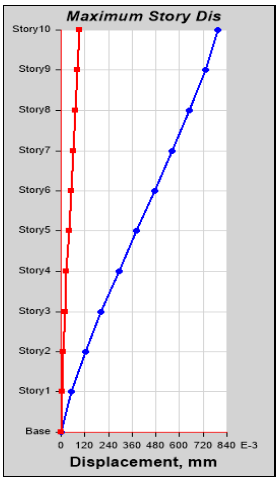

Fig.8: Storey displacement for Bi- directional Earth force

5.5.2. Storey Drift

Table 9 shows the storey drift results.

Table 9: Storey drift results

Story	Elevation	Location	X-Dir	Y-Dir
	m			
Story10	30	Top	2.07701E-05	2.62253E-06
Story9	27	Top	2.63419E-05	3.26753E-06
Story8	24	Top	2.96967E-05	3.732E-06
Story7	21	Top	2.93822E-05	3.66152E-06
Story6	18	Top	3.0356E-05	3.9162E-06
Story5	15	Top	3.04541E-05	3.94215E-06
Story4	12	Top	2.99557E-05	2.42896E-06
Story3	9	Top	2.68104E-05	3.2145E-06
Story2	6	Top	2.32125E-05	2.47197E-06
Story1	3	Top	1.73359E-05	1.22109E-06

Fig.9 shows the Storey drift for Bi –directional Earth force.

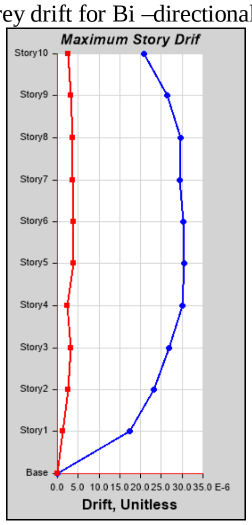

Fig.9: Story Drift For Bi -Directional Earth force

5.5.3. Storey Overturning Moments

Table 10 shows the storey overturning moments

Table 10: Storey overturning moments

Story	Elevation	Location	X-Dir	Y-Dir
	m		kN-m	kN-m
Story10	30	Top	-2.87592E-11	4.29153E-11
Story9	27	Top	1.4613E-09	-830.8050817
Story8	24	Top	2.9334E-09	-2592.146029
Story7	21	Top	3.24152E-09	-5081.47296
Story6	18	Top	3.39055E-09	-8135.461718
Story5	15	Top	3.50189E-09	-11609.66553
Story4	12	Top	3.12822E-09	-15375.68536
Story3	9	Top	2.1894E-09	-19326.08457
Story2	6	Top	1.38819E-09	-23380.19716
Story1	3	Top	6.09219E-10	-27481.00032
Base	0	Top	-4.3416E-10	-31593.62506

ig.10 shows the Storey overturning moments for Bi-directional Earth force

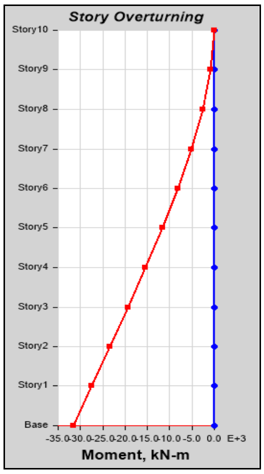

Fig.10: Storey overturning moments for Bi-directional Earth force

5.6. Concrete Design

5.6.1. Beam Design

Fig.11 shows the beam design.

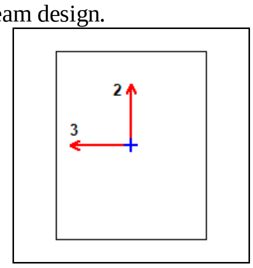

Fig.11: Beam design

Table 11 shows the beam element detail type.

Table 11: Beam element detail type

Level	Element	Section ID	Combo ID	Station Loc	Length (mm)	LLRF
Story1	B2	BEAM	DCon38	5700	6000	1

5.6.2. Column Design

ETABS 2015 Concrete Frame Design
IS 456:2000 Column Section Design

Fig.12 shows the column design.

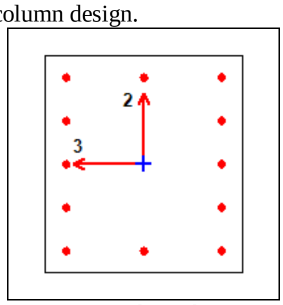

Fig.12: Column design

Table 12 shows the column element details type

Table 12: Column element details type

Level	Element	Section ID	Combo ID	Station Loc	Length (mm)	LLRF
Story1	C1	COLUMN	DCon38	2500	3000	0.6

5.7. Comparison Table

Table 13 shows the comparison table for uni-directional Vs bi-directional.

Table 13: Comparison table Uni-directional Vs Bi-directional

Factor	Uni-directional		Bi-directional	
	X-dir	Y-dir	X-dir	Y-dir
Story displacement	0.820	0.110	0.792	0.091
Story drift	2.105E-05	2.77 E-06	2.077 E-05	2.622 E-06
Over turning Moments	-3.33 E-12	2.607 E-11	-2.87 E-11	4.29 E-11

Fig.13 shows the graph for comparison uni-directional Vs bi-directional x- direction

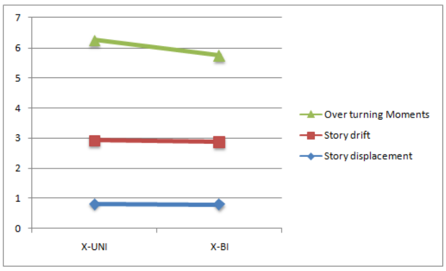

Fig.13: Graph for comparison uni-directional vs bi-directional x- direction

Fig.14 shows the graph of Comparison Uni-directional Vs Bi-directional Y- Direction

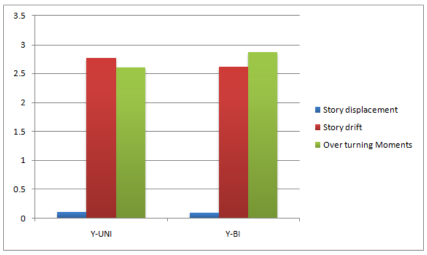

Fig.14: Graph for comparison uni-directional vs bi-directional y- direction

7. Conclusion

In this work the responses of buildings with elastic and with non-linear behaviour, subjected to dynamic loading will be studied. It can be concluded that the evaluation of the element design strengths based on a uni-directional analysis of the whole structure is generally adequate. Best in structures with very different transverse stiffness appreciate to the lateral stiffness a bi-directional evaluation could be important. The most seismic axial forces in columns are underestimated by means of a unidirectional earthquake. Based on E-Tabs Results comparison between Unidirectional vs Bi-directional earthquake forces Story displacement, drift values will be maximum at unidirectional (0.820- X-dir , 2.77 - Y-dir).

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