STUDY OF STRUCTURAL BEHAVIOUR OF PT BEAM OF A MULTI-STORIED BUILDING UNDER SEISMIC LOAD

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Abstract— **In case of RCC (Reinforced cement concrete) beam, usually the function of concrete is to take the compressive stresses and when it comes to steel the role is to take up the tensile stress. But we are not considering the mixture of concrete placed below neutral axis because of its fragile nature in tension resistance. Even though steel is provided for resist the tensile stress some minute cracks will form in the tension zone concrete. After a lot of research, it is found out that this problem can be eliminated by stressing both the steel and concrete, but this should be carried out before the load application. Pre tensioning process and post tensioning process are two different ways by which we can complete internal prestressing. In the process of pre-tensioning, before the casting of concrete using moulds, the tendons have to be tensioned first in between rigid anchor blocks cast which can be done on floor, pre-tensioning bed and also in columns. In post-tensioning the tensioning of concrete is carried out after casting of concrete. To fit the tendons concrete blocks are casted by incorporating ducts. Once the concrete attained enough strength, a jack is connected member's end face and thus the high-tensile wires are tensioned and anchored by wedges. Some space will be remined after this process and this can be filled by grouting. This PT beam and RC beam effect used in several storey building under seismic is studied assessed using ETABS 2017 and also the effect of bracings on the PT beam structure**

Keywords:RC beam,PT beam,ETABS

I. INTRODUCTION

Earthquake resisting reinforced concrete building design is a department deals with study of earthquakes because it has started in developed countries as well as in India. The damage can be occurred due to different factors in an earthquake. On the last centuries India had undergone so many earthquake disasters in many placed in different scales. As a matter of fact the percentage of areas that are prone to heavy earthquakes are abouve 50% . Due to the uncertainty in the calculation of earthquake time and intensity it is considered as one of the most dangerous disaster and the destruction will not be over by effecting buildings it will also lead to human lose. Country's north east part and Himalayan regions are subjected to high magnitude earthquake such as 8.0 and as per the study the main reason for this is Indian plate movement towards European plate and the amount by which it is happening is 50mm per year. Earthquake can't be eliminated from earth but by taking proper building construction technique it can br controlled to an extent .

In Asian countries one of the most used structures in industrial and residential building is RCC structures. PT beams are not used in buildings with small span length. Around 20 years ago we were suffered by the shortage of expertise people in the fields of prestressing but however this situation has improved a lot in these years and we are available with a lot of people and workshops to done this. one of the main reasons why the prestressed beams are economical is that, while we are using prestressed beam the depth of the beam can be reduced and in the same case if it is an ordinary beam as the span increases, we have to increase the depth of beams because of its limitations in deflection in structural engineering construction most recent and effective structure included is PSC. Currently some of the main fields that are making use of prestressed structures are buildings, towers for communication purposes, storage which is floating in nature, subterranean structures, bridge etc. there are some main aims for structural engineers. . On the basis of availability and other common factors concrete is considered as an economical material compared to steel..

II. *OBJECTIVES*

- To develop, design and conduct analysis of structure (G+14)
- To compare the performance of RCC beam and PT beam under seismic effect
- To compare the stiffness of structure

III . METHODOLODY

Create the model

Define the material property

Define section property

Draw beams, column, slab

Assigning of loads and load combination

Check for model

Analysis the model

Final discussion of resuls and conclusion

This describes the procedure for modelling the Reinforced cement concrete beam (RCC) and Post tensioning (PT) beam.

IV.MODELLING OF STRUCTURE

Details of structure

Storey number: G+14

Dimension of the plan: 16m X 15m

Floor to Floor height: 3m

Materials used: M40 grade concrete and HYSD500 Steel

Size of beam: 300mm X 600mm

Size of column: 500mm X 500mm

Thickness if slab used: 150mm

Seismic sector V

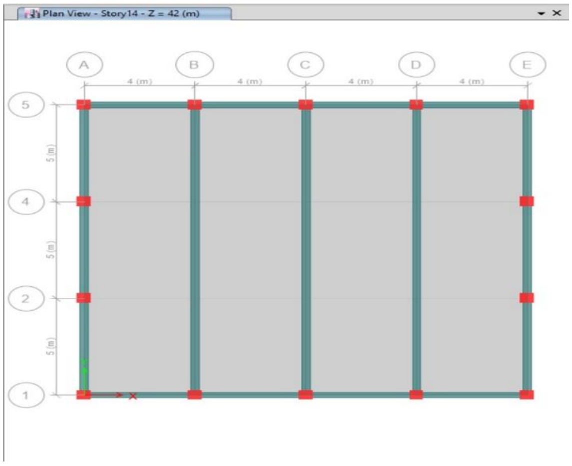

Fig 1 : plan of the building

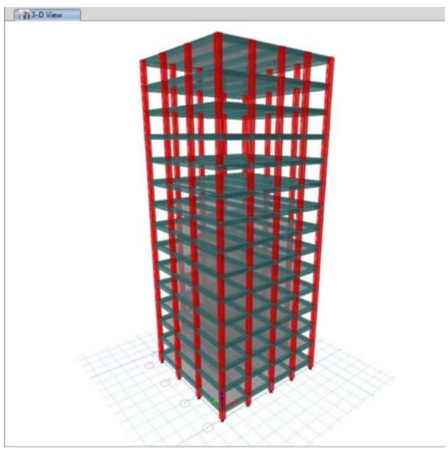

Fig 2 : Modelling of RC building

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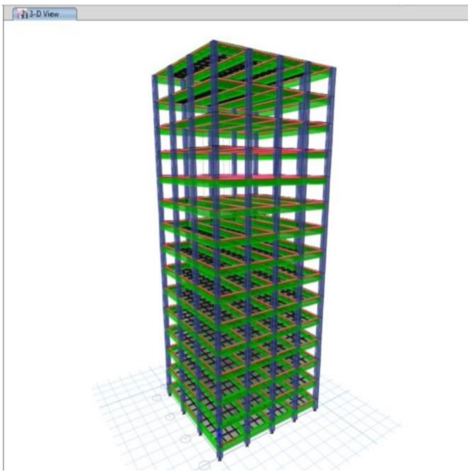

Fig 3 : Modelling of PT building

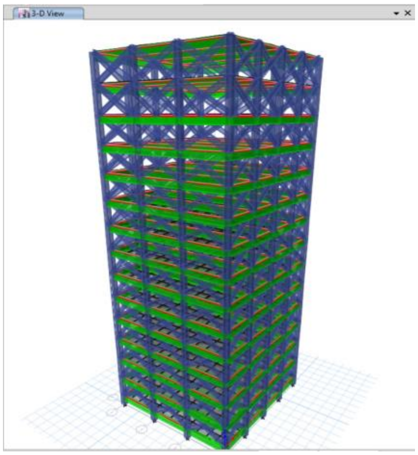

Fig 4 : Modelling of PT building with X bracings

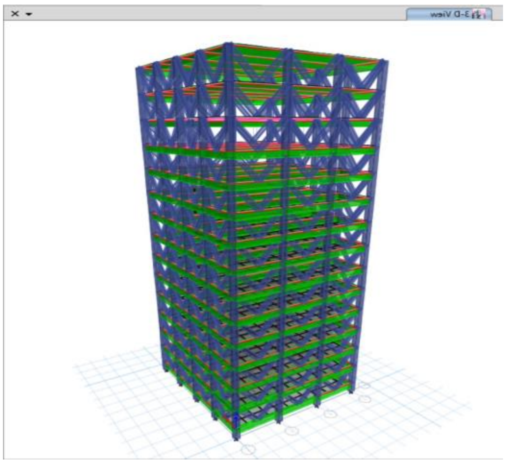

Fig 5 : Modelling of PT building with V Bracings

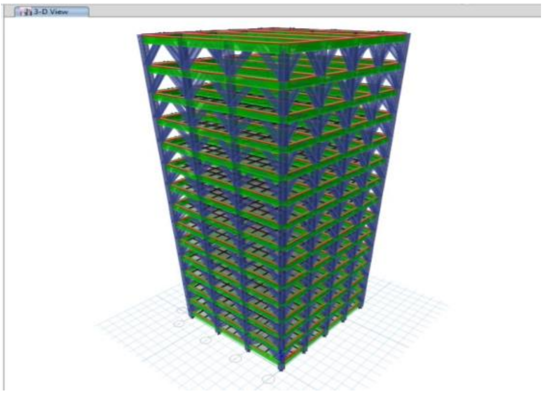

Fig 6 : Modelling of PT building with inveted V Bracings

Generating material property

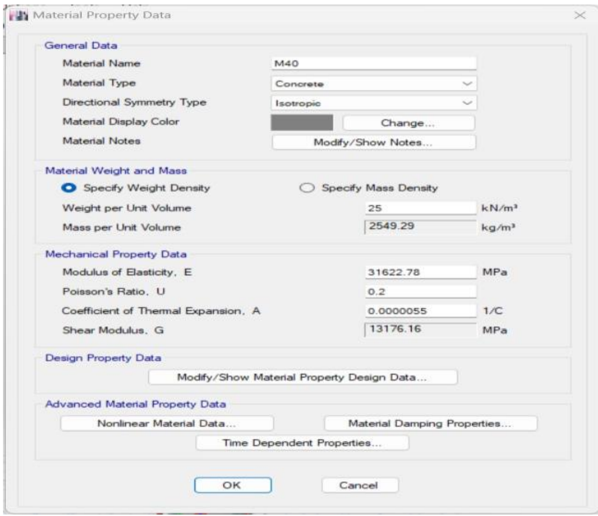

Fig 7 :material properties of concrete

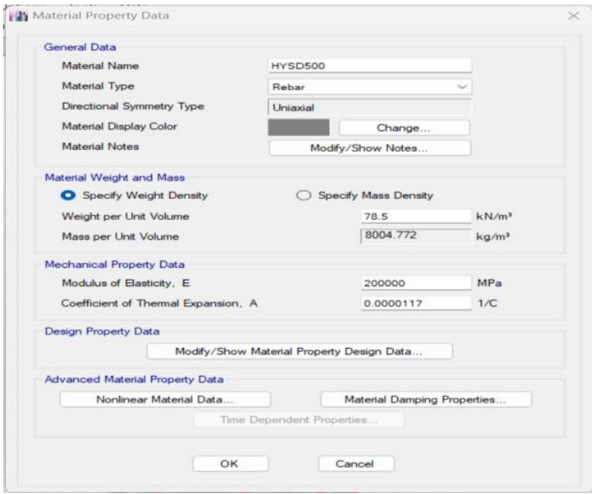

Fig 8 : material property of steel

Properties of beam,column,slab and braces

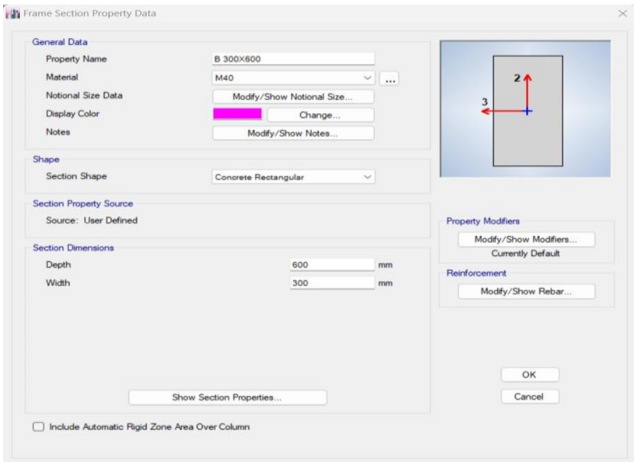

Fig 9 :properties of beam

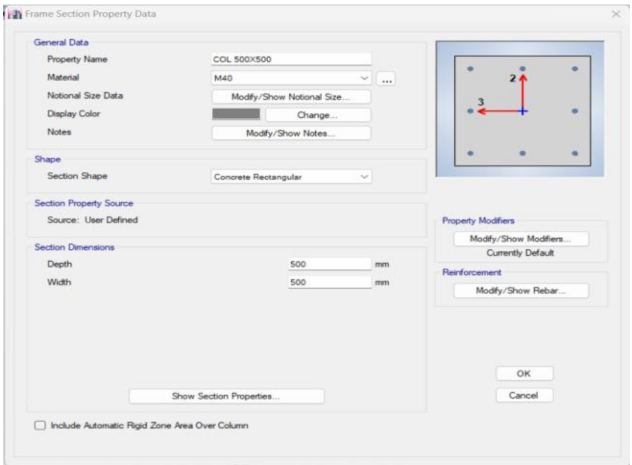

Fig 10 :properties of column

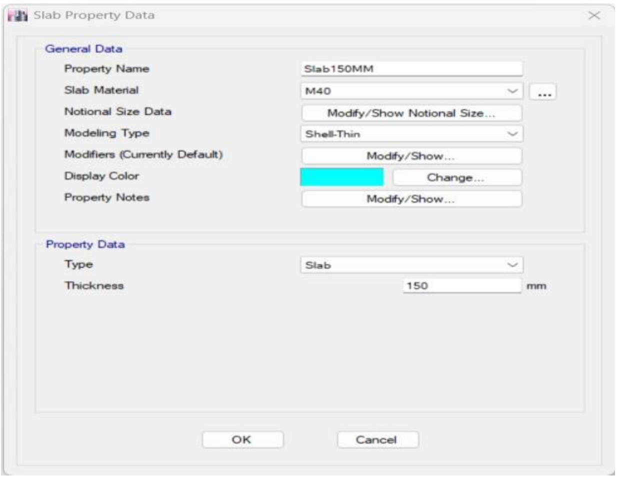

Fig 11 :properties of slab

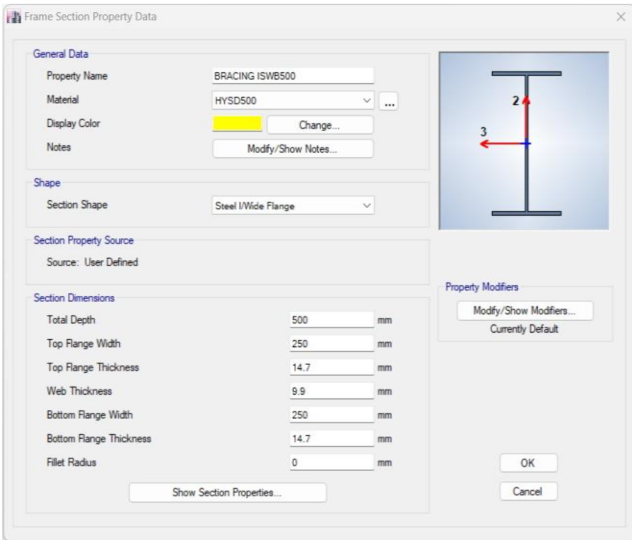

Fig 12 :properties of braces

Tendon details

The tendon of strand area of about 93mmsq is used in this study

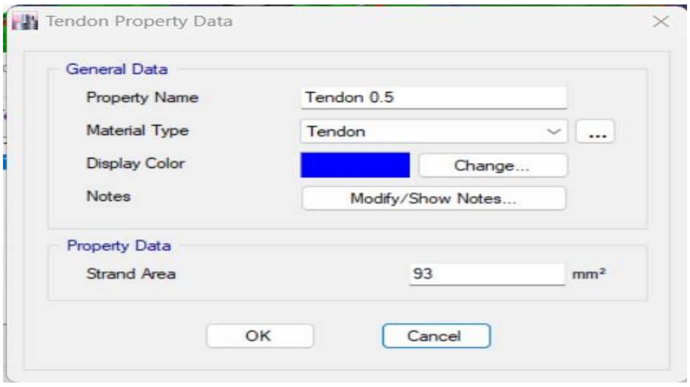

Fig 13 :tendon details

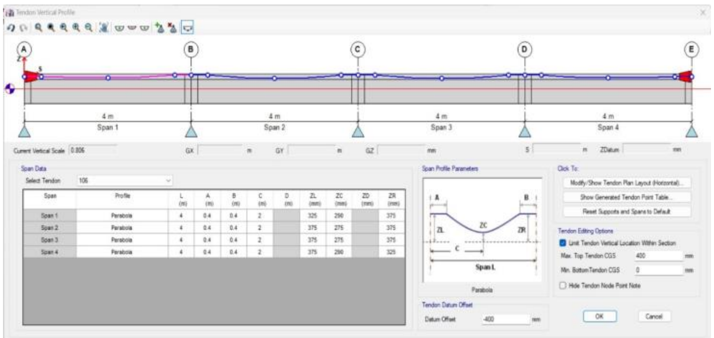

Fig 14 :tendon profile in x direction

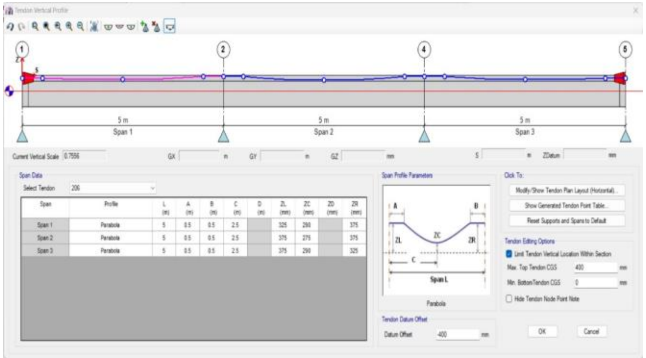

Fig 15 : tendon profile in y direction

The tendon load can be define with the help of the software. In this study the jacking stress of about 1725 Mpa is used. The jacking is done from both ends. The load pattern of the tendon is given in the figure

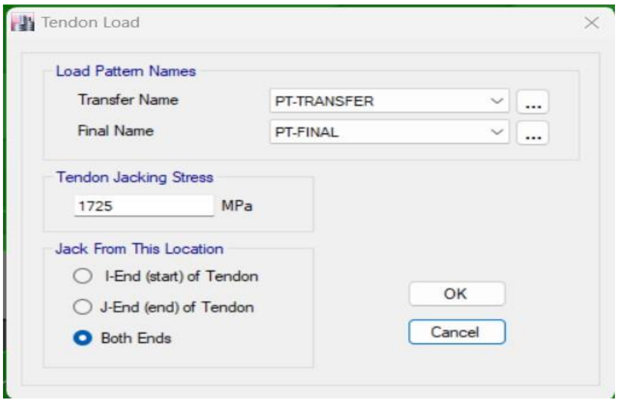

Fig 16 :tendon load

Support conditions

To dole out any sort of help either settled, stick or roller for which tap on dole out on the menu bar -> choose joint ->select type of help. We have used fixed supports here.

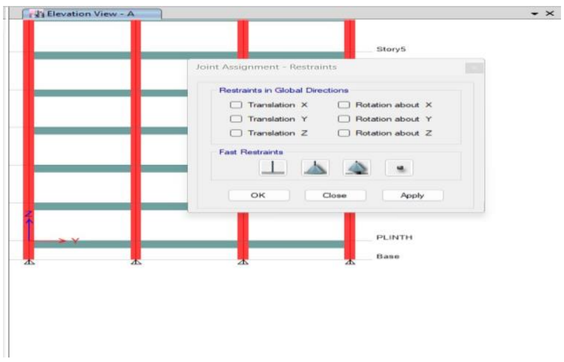

Fig 17 :assign support conditions

Table 1 :: load combinations

	Load combinations		
1	LL	9	1.5 (DL + EQY)
2	LL+DL	10	1.5 (DL – EQX)
3	1.5(LL+DL)	11	1.5 (DL – EQY)
4	1.2 (DL +LL + EQX)	12	0.9DL + 1.5EQX
5	1.2 (DL + LL + EQY)	13	0.9DL + 1.5EQY
6	1.2 (DL +LL – EQX)	14	0.9DL – 1.5EQX
7	1.2 (DL + LL – EQY)	15	0.9DL – 1.5EQY
8	1.5(DL +EQX)		

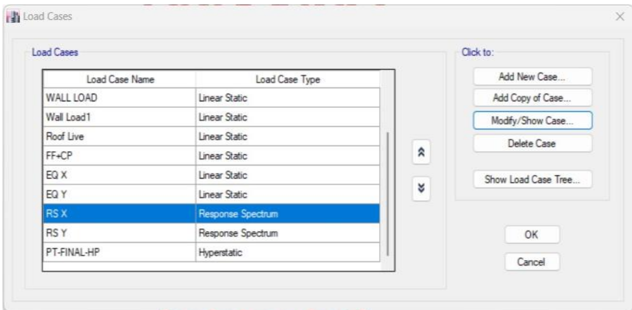

Fig 18 :load cases

Defining response spectrum

The response spectrum varies as the variations in different earthquakes, but for the ease of study IS 1893:2002 specifies a response spectrum which can be considered for all purpose nature and it is dedutced from considering for some huge earthquakes .

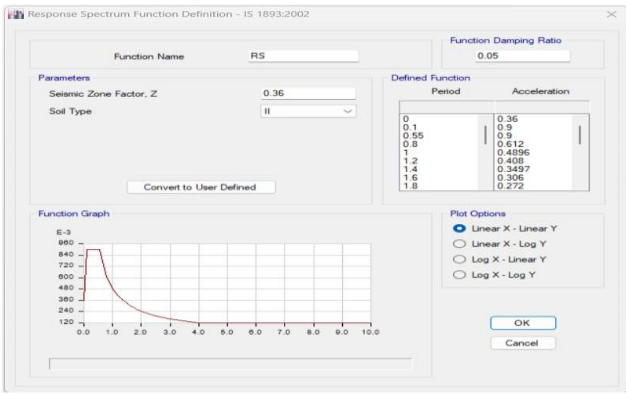

Fig 19 : response spectrum function

V. RESULT AND DISCUSSIONS

In this study the PT and RC beam is modeled and analysis is done by the ETAB software version 17. The structures are analyzed for response spectrum method. The comparison of the structures are done in the result. Following figures explain the maximum displacement of stories, Drift of stories and storey stiffness of PT beam and RC Structure.

A. STOREY DISPLACEMENT

The table shows the displacement in millimeters of the RC beam structure

Storey	Displacement of RC beam structure		
	Height (m)	*In x direction*	*In y direction*
Base	-1.5	0	0
Plinth	0	1.337795	1.487328
1	3	4.605928	4.442368
2	6	6.637458	7.3314
3	9	9.913958	10.117105
4	12	11.647104	12.765945
5	15	13.978523	15.263394
6	18	16.176295	17.600877
7	21	18.231488	19.773151
8	24	20.135026	21.774331
9	27	21.875145	23.594667
10	30	23.435688	25.218349
11	33	24.795504	26.622849
12	36	25.929596	27.780287
13	39	26.811969	28.663016
14	42	27.448449	29.273486

Table 2 : displacement of RC beam

From the table 2 its clear that the storey displacement of the RCC beam is directly propotional to storey height

The maximum storey displacement is on the 14thstorey which is about 29.273486mm and the base has the minimum storey displacement that is zero

The table shows the displacement in millimeters of the RC beam structure

Table 3 : displacement of PT beam

Storey	Displacement of PT beam structure		
	Height (m)	*In x direction*	*In y direction*
Base	-1.5	0	0
Plinth	0	1.136999	1.166398
1	3	3.356479	3.468163
2	6	5.61036	5.779558
3	9	7.86245	8.071045
4	12	10.08071	10.314047
5	15	12.239035	12.485023
6	18	14.315505	14.564106
7	21	16.290746	16.533508
8	24	18.146439	18.377168
9	27	19.864203	20.077315
10	30	21.424906	21.614333
11	33	22.808502	22.968241
12	36	23.994723	24.118292
13	39	24.965782	25.046208
14	42	25.738801	25.747219

The maximum storey displacement is on the 14thstorey which is about 25.747219mm and the base has the minimum storey displacement that is zero

From the result above we can conclude that the PT beam has the lower displacement than the RCC beam about 12.04 %

B. STOREY DRIFT

Storey drift is the displacement occurred laterally in a floor with respect to the floor lying below .

Storey drift ratio= storey Drift/storey height

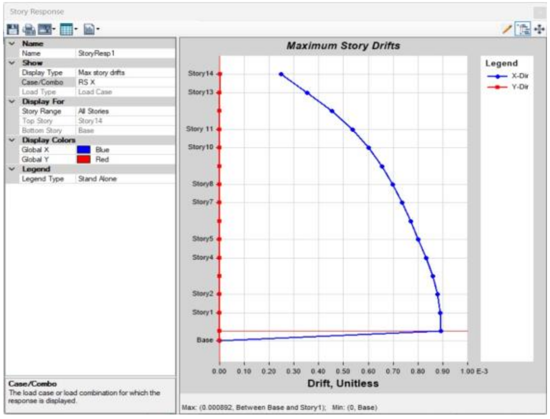

Fig 20 :: Drift of RC beam in x direction

The storey drift of the RC beam structure is shown in the figure. The maximum drift in x and y direction is 0.000892 and 0.00992. The maximum drift is acting between the base and first storey. The maximum drift is 0.000992 and the minimum is zero at the base

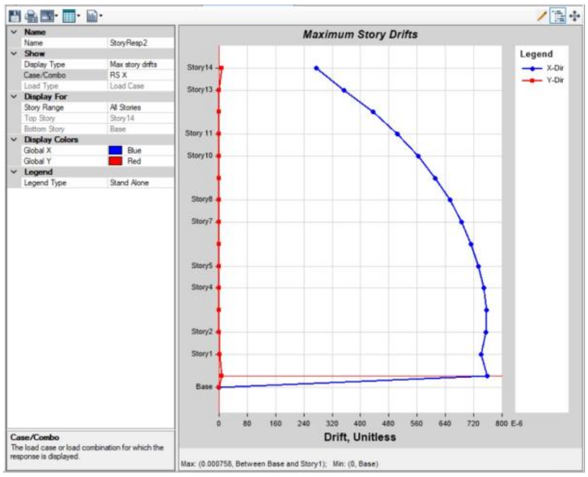

Fig 21 :: : Drift of PT beam in x direction

The storey drift of the PT beam structure is shown in the figure. The maximum drift in x and y direction is 0.000758 and 0.000778. The maximum drift is acting between the base and first storey. The maximum drift is 0.000778 and the minimum is zero at the base. From the result above we can conclude that the PT beam has the lower drift than the RCC beam about 21.57 %

C. STOREY STIFFNESS

The value of force required to displace building to a certain amount is called stiffness. the greater the stiffness, the greater it can resist the deformations by earthquake because stiffness limits the building deformation demand. stiffness depends upon forces and deformations

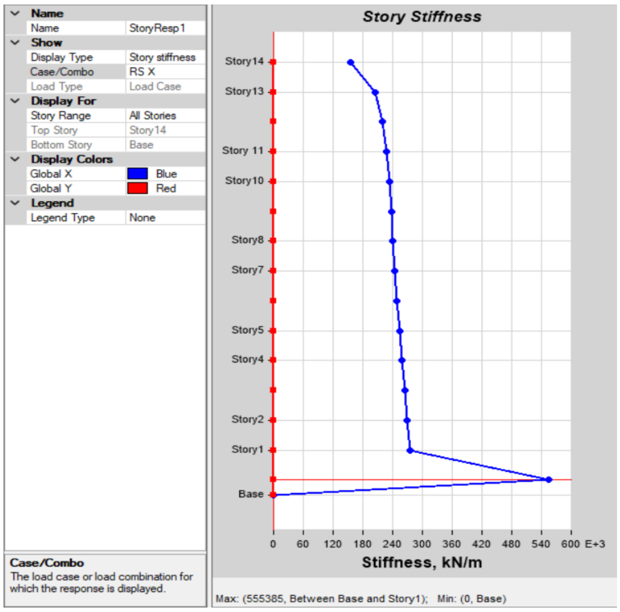

Fig 22 :: Stiffness of RC beam in x direction

The storey stiffness of the RC beam structure is given in the figure. The stiffness is maximum between base and storey 1. The maximum stiffness is about 555385 KN/m which is in x direction and in y direction it is about 460116 KN/m

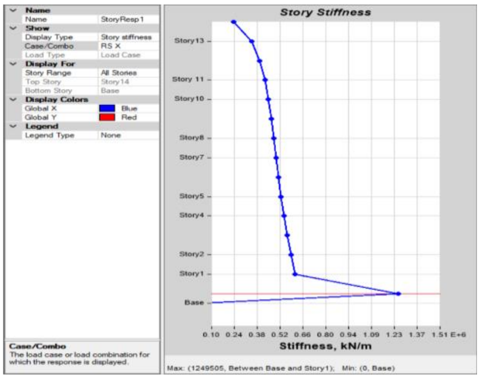

Fig 23 :: Stiffness of PT beam in x direction

The storey stiffness of the PT beam structure is given in the figure. The stiffness is maximum between base and storey 1. The maximum stiffness is about 1249505 KN/m which is in x direction and in y direction it is about 1205524 KN/m

EFFECT OF BRACINGS ON DISPLACEMENT

Effect of X bracings on PT beam

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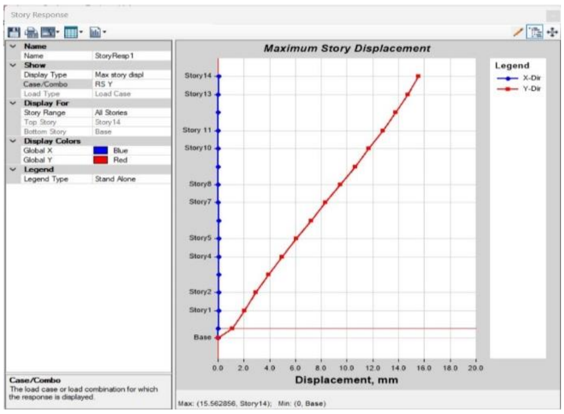

Fig 24 :displacement in Y direction

Maximum displacement is 15.562856mm which is in y direction and is lower than the PT beam structure without bracings

Effect of V bracings on PT beam

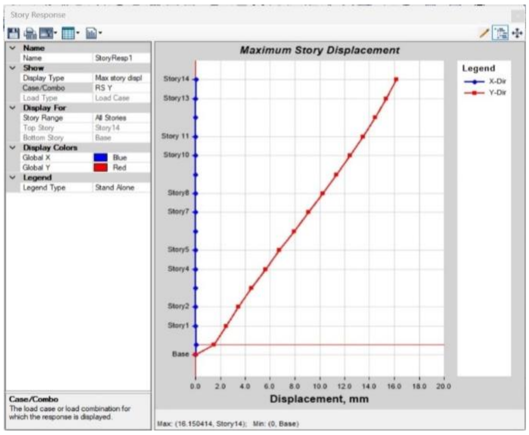

Fig 25 : displacement in Y directon

maximum displacement is 16.150414mm which is in y direction and is lower than the PT beam structure without bracings

Effect of inverted V bracings on PT beam

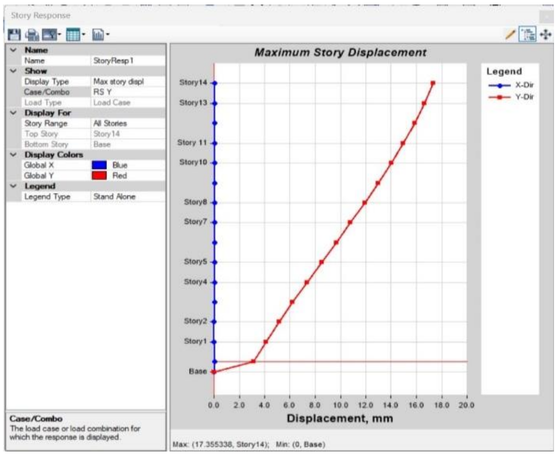

Fig 26 : displacement in Y directon

maximum displacement is 17.355338mm which is in y direction and is lower than the PT beam structure without bracings

From the above study it is clear that the PT beam structure with X bracings have least displacement when compared to V and inverted V bracings

VI. CONCLUSION

The following points are concluded from the study paper,

❖ The modelling of the RC and PT beam is completed and is study under the seismic loading

❖ The PT beam has the lower displacement than the RCC beam about 12.04 %

❖ The PT beam has the lower drift than the RCC beam about 21.57 %

❖ The PT beam structure has the higher storey stiffness than the RCC beam structure

❖ Three types of bracings are added to the PT beam structure and the effect on storey displacement is observed

❖ PT beam structure with X bracings have least displacement when compared to V and inverted V bracings

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