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COMPARATIVE STUDY ON PERFORMANCE OF MULTI STORY RCC BUILDING WITH "X" TYPE RCC BRACING

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Abstract — Special systems are required to design buildings such that they will not undergo damage even in a severe earthquake. Buildings with such better seismic performance usually cost more compare to normal buildings. However, this cost is acceptable through improved earthquake performance. One of the technologies used to defend buildings from damaging earthquake effects is "Braced Structural System". The idea behind bracing is to resist the building from the seismic forces in such a way that earthquake motions are not transmitted up through the building, or at least greatly reduced. And also balance the force acting by the wind load. The work undertaken is an attempt to recognize the behavior of "X" type RCC bracing system under lateral loading. A model of G+14 story RCC building has been considered with "X" type RCC braced system is analysed using static analysis under dynamic and wind load.

Keywords- Braced Structural System; X Bracing; Earthquake resisting structure; Braced Structure; RCC Bracing;

I. INTRODUCTION

Bracing has been used to stabilize laterally for the majority of the world's tallest building structures as well as one of the major retrofit measures. Bracing is efficient because the diagonals work in axial stress and therefore call for minimum member sizes in providing stiffness and strength against horizontal shear. A number of researchers have investigated various techniques such as infilling walls, adding walls to existing columns, encasing columns, and adding steel bracing to improve the strength and/or ductility of existing buildings. A bracing system improves the seismic performance of the frame by increasing its lateral stiffness and capacity. Through the addition of the bracing system, load could be transferred out of the frame and into the braces, bypassing the weak columns while increasing strength.

There are two types of bracing systems, Concentric Bracing System and Eccentric Bracing System. The concentric bracings increase the lateral stiffness of the frame, thus increasing the natural frequency and also usually decreasing the lateral drift. Eccentric Bracings reduce the lateral stiffness of the system and improve the energy dissipation capacity.

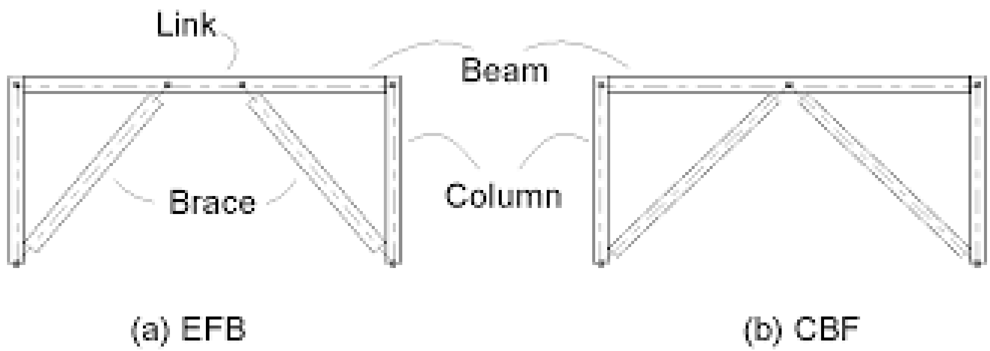


Fig 1. Eccentric and Concentric Braced Frames

II. ANALYSIS OF RCC BRACED AND BARE FRAME STRUCTURE

2.1 Geometrical Data

No. Of bay in X – dir. : 4, No. Of bay in Y – dir. : 4, Plan Dimension : 20 m x 20 m, Typical Storey Height : 3.0 m, Bottom Storey Height : 3.0 m, Height of structure : 45 m, Number of storey : G +14, Type of Building : Residential building, Type of Structure: RCC Structure.

2.2 Material Data :

Grade of Concrete: M25

Grade of Concrete: Fe 415

2.3 Loading Data

2.3.1 Dead Load : 1 kN/m^2

2.3.2 Live Load : 2 kN/m^2

2.3.3 Earthquake load in X direction and Y direction

Zone factor : IV, Soil Type : II (medium), Importance factor : 1, Response reduction factor : 5

2.3.4 Wind Load

Basic wind speed : 47 m/sec, Terrain category : II, Class : C, Risk coefficient factor : 1.0, Topography factor k3 : 1.0

2.4 Member Size Data

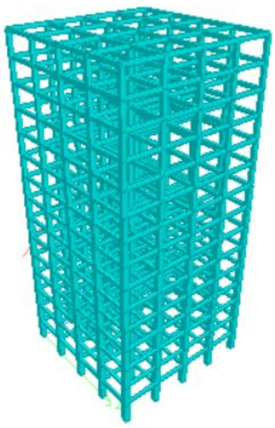
Table 1 G + 14 Story RCC Building Section Size

G + 14 Story RCC Building			
Storey	Column Size (mm)	Beam Size (mm)	Bracing Size (mm)
Story 1 to Story 3	600 X 600	300 X 450	230 X 230
Story 4 to Story 6	550 X 550	300 X 450	230 X 230
Story 7 to Story 9	500 X 500	300 X 450	230 X 230
Story 10 to Story 12	450 X 450	300 X 300	230 X 230
Story 13 to Story 15	350 X 350	300 X 300	230 X 230

2.5 Model Details :

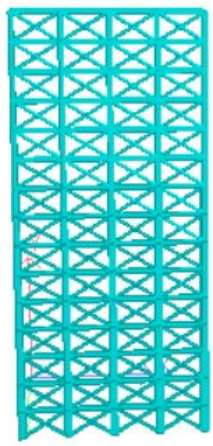
1. Bare Model

Elevation View

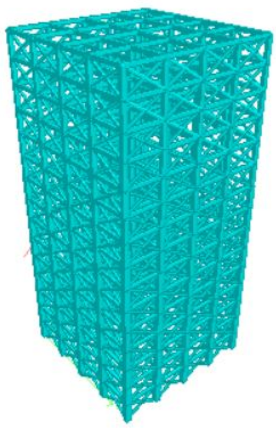


3D View

2. RCC Braced Model I



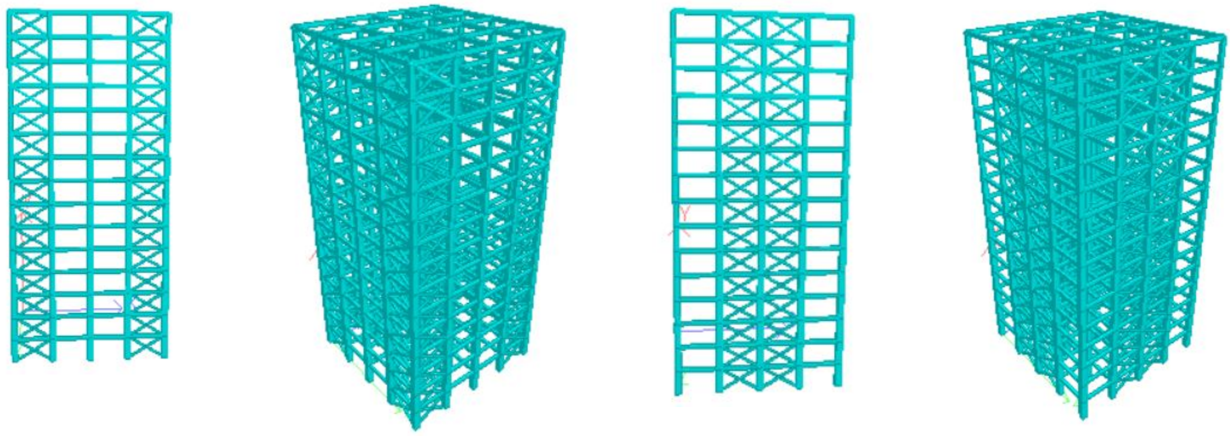
Elevation View



3D View

3. RCC Braced Model II

4. RCC Braced Model III



Elevation View 3D View Elevation View 3D View

Fig. 2 Models

III. Analysis And Results

The static analysis is carried out considering wind loads and earthquake loads on structures. Wind analysis of structure is performed as per IS: 875(III) -1987 using STAAD Pro. V8i.

Comparative analysis of conventional RCC structural system and RCC braced RCC structural system is compared in terms of base shear storey displacement, and storey drift are presented for all buildings.

Here, the structure is symmetric so here we present the graphs for only one direction.

Table 2 Base Shear

Base Shear (kN)				
Model of Structure	Bare Frame	RCC Braced Model I	RCC Braced Model II	RCC Braced Model III
in X Dir.	1720.66	1846.76	1783.71	1783.71
in Y Dir.	1720.66	1846.76	1783.71	1783.71

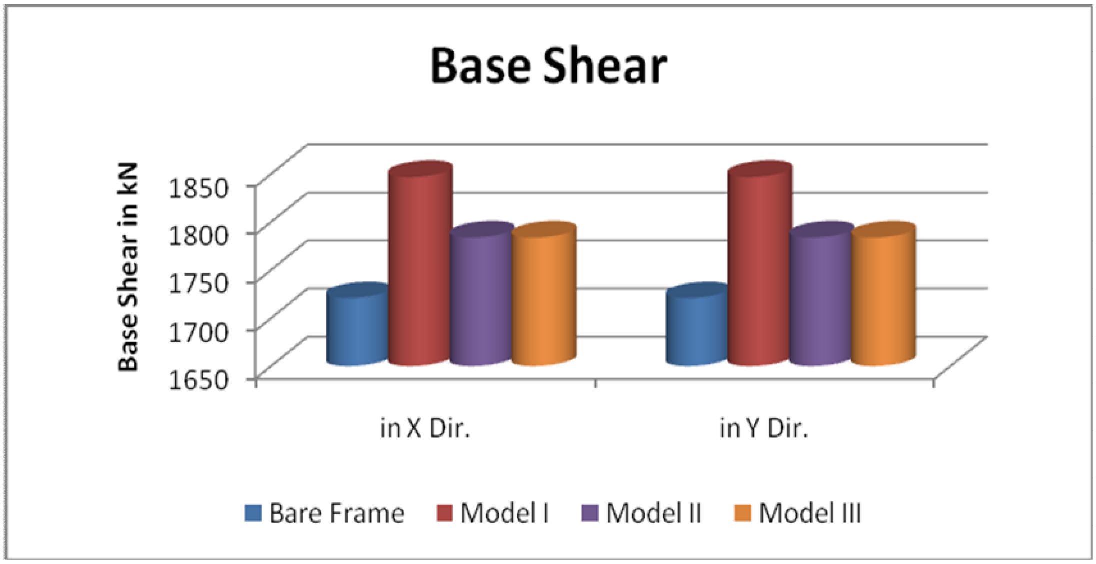


Fig. 3 Base Shear

Table 3 Story Displacement

Story	Height (m)	Story Displacement (mm)							
		Bare Model		RCC Braced Model I		RCC Braced Model II		RCC Braced Model III	
		X Dir.	Y Dir.	X Dir.	Y Dir.	X Dir.	Y Dir.	X Dir.	Y Dir.
Story 15	45	142.496	142.496	20.592	20.592	69.511	69.511	52.192	52.192
Story 14	42	138.309	138.309	19.645	19.645	64.906	64.906	49.058	49.058
Story 13	39	131.239	131.239	18.519	18.519	59.877	59.877	45.531	45.531
Story 12	36	121.583	121.583	17.237	17.237	54.482	54.482	41.677	41.677
Story 11	33	112.996	112.996	15.857	15.857	49.138	49.138	37.828	37.828
Story 10	30	103.186	103.186	14.372	14.372	43.622	43.622	33.776	33.776
Story 9	27	92.291	92.291	12.814	12.814	37.934	37.934	29.618	29.618
Story 8	24	81.473	81.473	11.241	11.241	32.410	32.410	25.535	25.535
Story 7	21	70.074	70.074	9.639	9.639	26.978	26.978	21.463	21.463
Story 6	18	58.226	58.226	8.043	8.043	21.720	21.720	17.491	17.491
Story 5	15	46.747	46.747	6.479	6.479	16.833	16.833	13.759	13.759
Story 4	12	35.118	35.118	4.978	4.978	12.266	12.266	10.224	10.224
Story 3	9	23.708	23.708	3.532	3.532	7.266	7.266	6.964	6.964
Story 2	6	13.264	13.264	2.179	2.179	4.638	4.638	4.076	4.076
Story 1	3	4.502	4.502	0.707	0.707	1.688	1.688	1.544	1.544
Base	0	0	0	0	0	0	0	0	0

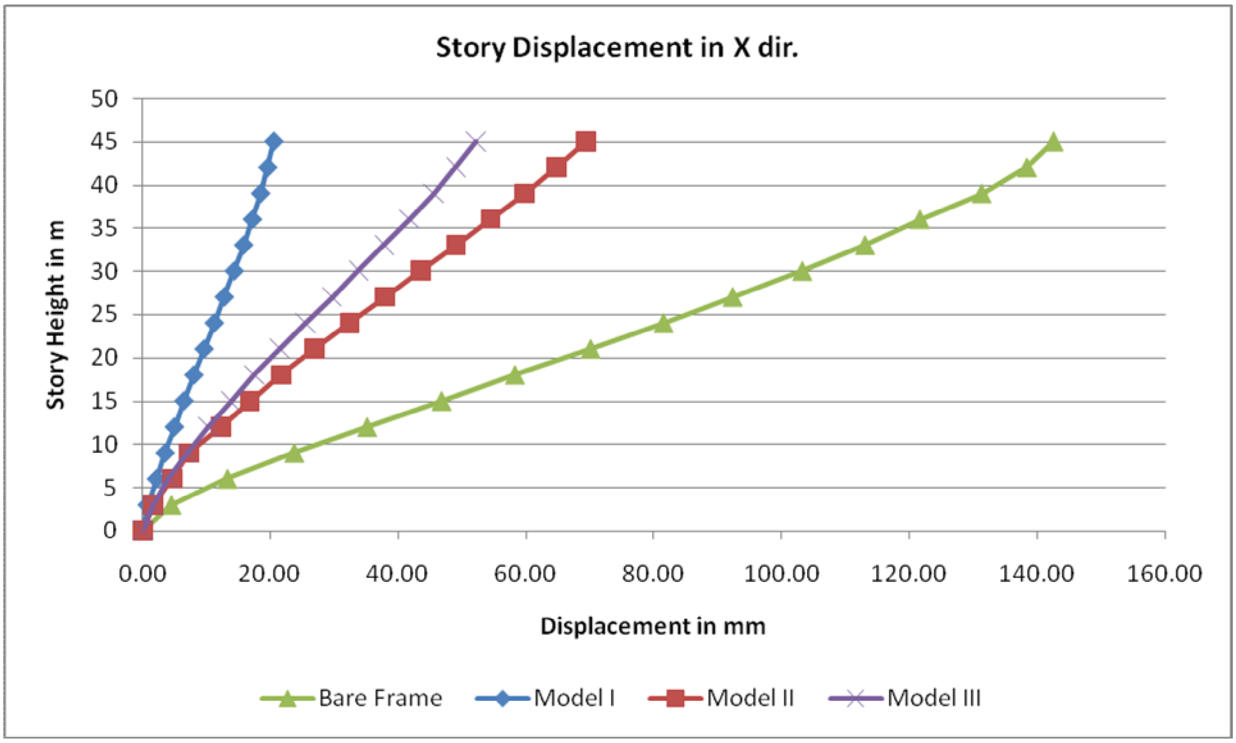


Fig. 4 Story Displacement

Table 4 Story Drift

Story	Height (m)	Story Drift (mm)							
		Bare Model		RCC Braced Model I		RCC Braced Model II		RCC Braced Model III	
		X Dir.	Y Dir.	X Dir.	Y Dir.	X Dir.	Y Dir.	X Dir.	Y Dir.
Story 15	45	4.185	4.185	0.416	0.416	2.224	2.224	1.460	1.460
Story 14	42	7.069	7.069	0.505	0.505	2.430	2.430	1.700	1.700
Story 13	39	8.214	8.214	0.592	0.592	2.633	2.633	1.853	1.853
Story 12	36	8.587	8.587	0.649	0.649	2.671	2.671	1.870	1.870
Story 11	33	9.810	9.810	0.709	0.709	2.743	2.743	1.996	1.996

Story 10	30	10.896	10.896	0.752	0.752	2.815	2.815	2.061	2.061
Story 9	27	10.818	10.818	0.773	0.773	2.762	2.762	2.051	2.051
Story 8	24	11.400	11.400	0.791	0.791	2.745	2.745	2.046	2.046
Story 7	21	11.847	11.847	0.850	0.850	2.678	2.678	2.013	2.013
Story 6	18	11.479	11.479	0.859	0.859	2.501	2.501	1.899	1.899
Story 5	15	11.582	11.582	0.807	0.807	2.358	2.358	1.817	1.817
Story 4	12	11.446	11.446	0.746	0.746	2.159	2.159	1.694	1.694
Story 3	9	10.455	10.455	0.690	0.690	1.870	1.870	1.509	1.509
Story 2	6	8.869	8.869	0.651	0.651	1.602	1.602	1.346	1.346
Story 1	3	4.509	4.509	0.564	0.564	1.107	1.107	0.974	0.974
Base	0	0	0	0	0	0	0	0	0

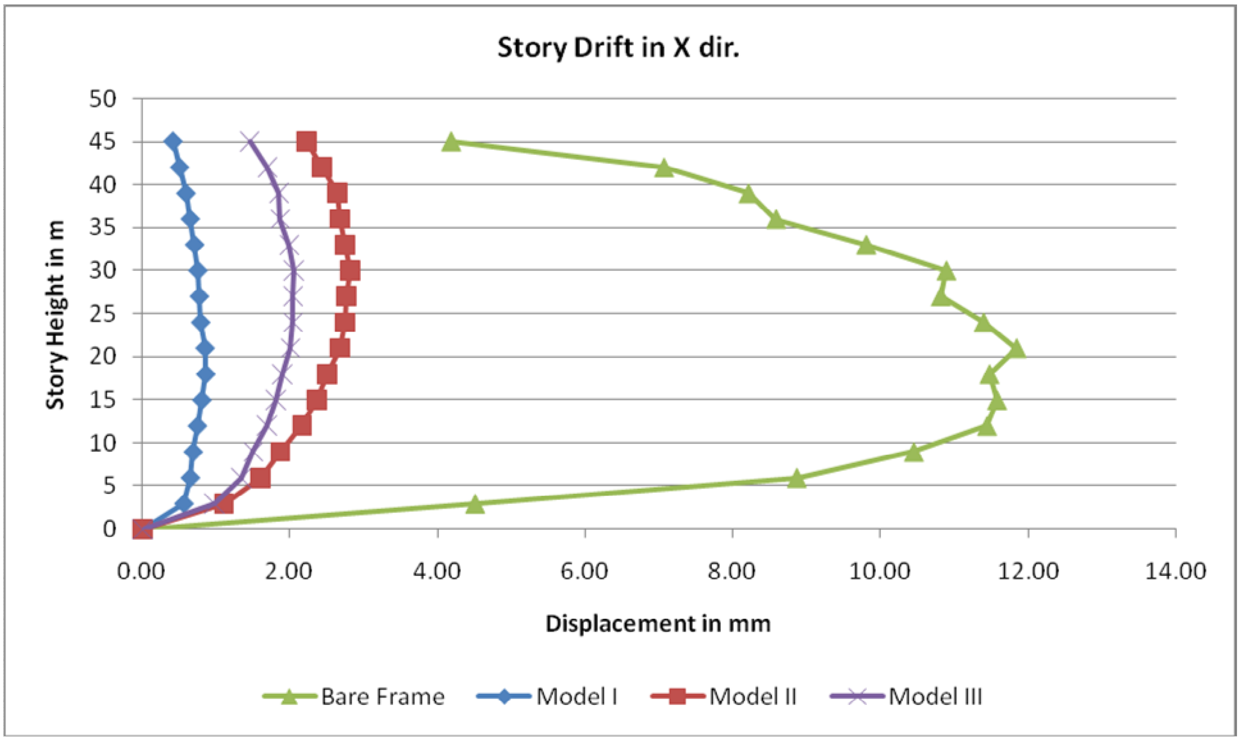


Fig. 5 Story Drift

When the distribution of internal forces in the structure was studied, it revealed reduction in the critical force values thereby demanding a further revision in the section to reduce the cost. A second iteration was carried out for 15 stories in zone V structure. The reduction in the column section was proposed.

A beam cross section was found adequate when used as a doubly reinforced section to carry the maximum bending moment at the beam column junction. The required reinforcement was calculated and the cost of steel was considered along with that of the concrete to get the final material cost.

Considering above forces, the adequacy of the section for a frame with diagonal braces for a single frame was checked for other types of braces. Saving in the material so observed has been given in Table number 5.

***Table 5* Quantity Comparison**

Quantity Comparison		
Model	**Concrete (cum)**	**Steel (kN)**
Bare Frame	682.4	925.41
Model I	813.6	801.42
Model II	738.5	839.41
Model III	738.5	834.07

IV. CONCLUSION

After the analysis and study of results we can conclude that the bracing are very effective technical solution to resist the lateral forces and reduce the forces from the column. Hence, base shear increase and story drift and story displacement reduce.

By using different patterns the results is different. As we make frame more no. of braced frame in structure than the reduction of lateral forces on column will increase. And the story drift and displacement also decrease.

By using periphery of structure fully braced than the reduction in Story Displacement is much higher than partialy braced in periphery of structure and the reduction of displacement of braced frame model I to bare frame is around 70%-80%, for braced frame model II to bare frame model 45%-50% and for braced frame model III to bare frame model 60%-65%

And comparing the used material for all the models and the compare the material for bare frame to RCC braced frame we got best result in model III. Hence the most economic is model III

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