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Analysis and Design of Telecommunication Tower using Different Truss System by ETab Software

Pratighya Parmar[1], Nitesh Kushwaha[2]

[1]M. Tech. Scholar, [2]Professor,
[1,2]Department of Civil Engineering, Millennium Institute of Technology & Science, Bhopal, Madhya Pradesh, India

ABSTRACT

In the present work an attempt has been made to study the behavior of buildings with roof top tower in the event of an Earth Quake using ETAB and hence optimum tower design will bring in substantial savings. The selection of an optimum outline together with right type of bracing system contributes to a large extent in developing an economical design of tower. The height of tower is fixed by the user and the structural designer has the task of designing the general configuration and member and joint details. Study on suitability of different type of truss system for telecom towers subjected to different seismic loads. In this research work our motive is to justify the variation in strength of 3 cases of towers for same loading and different seismic conditions to carry out the best of them.

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INTRODUCTION

Telecommunication towers has became an essential item especially in wireless telecommunication sector with the development of wireless telecommunication technologies such as CDMA (Code Division Multiple Access), GSM (Global System for Mobile),WAP (wireless Web Access), etc.

OBJECTIVES

Study on suitability of different type of truss system for telecom towers subjected to different seismic loads.

METHODOLOGY

Separate models are created on ETAB Software to check the suitability of different type of truss system for telecom towers subjected to different seismic loads.

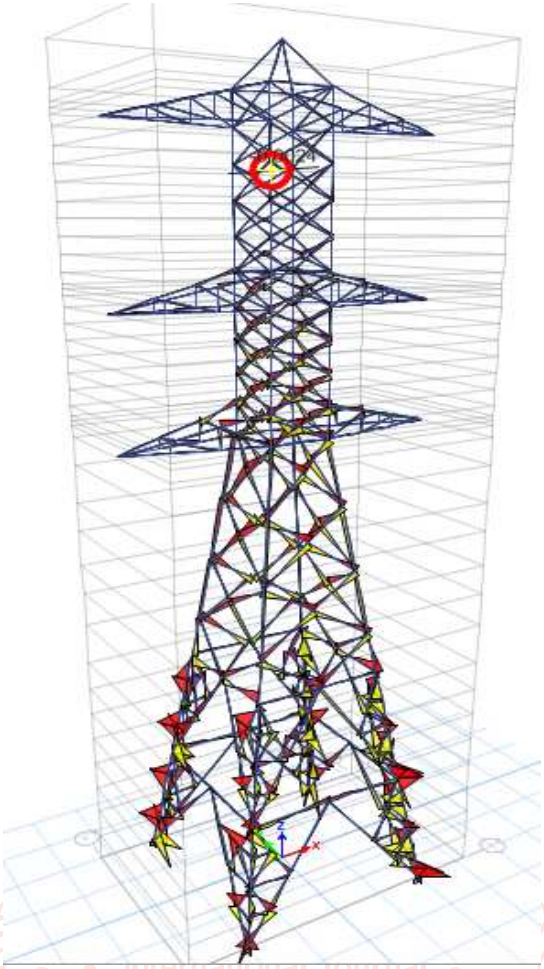

Fig. Analysis of Portal System Truss Tower (ETABS – 48.5m)

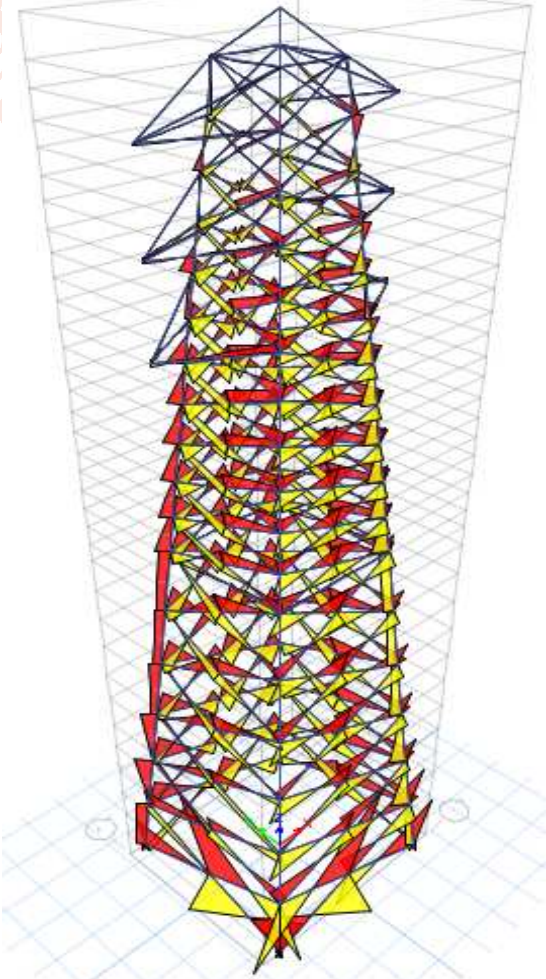

Fig. Analysis of Warren System Truss Tower (ETABS – 48.5m)

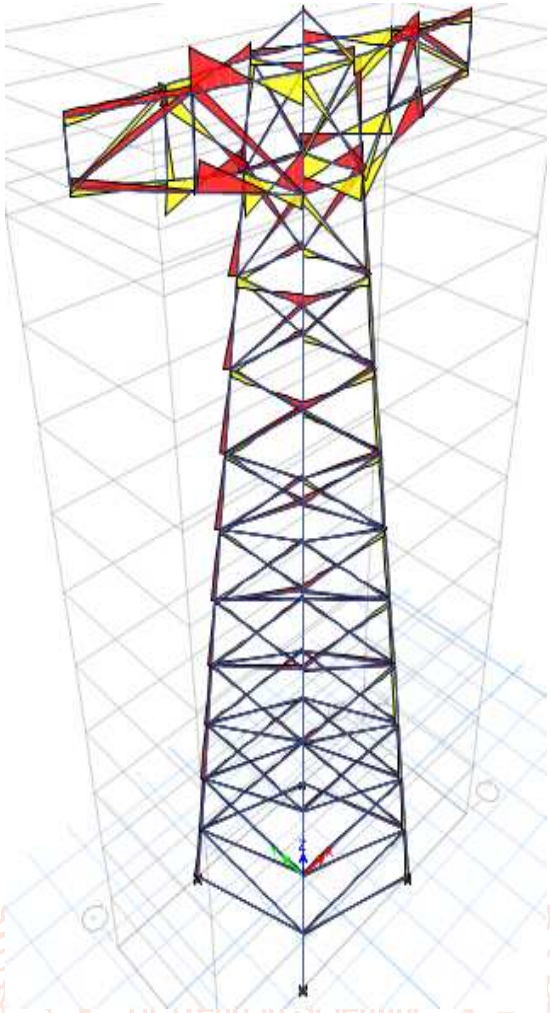

Fig. Analysis of Single Web System Truss Tower (ETABS – 48.5m)

RESULTS

Max Displacement Result

Results for Tower Height 48.5 m for Seismic Zone II

Table: Portal System Truss Tower Displacement

Portal System Truss Tower Displacement							
	Horizontal	Vertical	Horizontal	Resultant	Rotational		
	X mm	Y mm	Z mm	mm	rX rad	rY rad	rZ rad
Max X	136.844	-5.052	0	136.937	0	0	-0.004
Max Y	116.348	33.454	0	121.062	0	0	-0.005
Max Z	0	-3.864	490.909	490.925	0.018	0	0
Max rX	0.105	-4.478	421.466	421.49	0.019	-0.001	0
Max rY	5.223	-10.252	-10.51	15.583	0.003	0.005	-0.001
Max rZ	-0.033	-18.137	19.185	26.401	0.009	-0.001	0.007
Max Rst	0	-3.864	490.909	490.925	0.018	0	0

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Warren System Truss Tower Displacement							
	Horizontal	Vertical	Horizontal	Resultant	Rotational		
	X mm	Y mm	Z mm	mm	rX rad	rY rad	rZ rad
Max X	114.16	-5.073	-0.157	114.273	0	0	-0.003
Max Y	0	25.988	179.01	180.886	0.01	0	0
Max Z	0	-5.074	396.93	396.963	0.012	0	0
Max rX	0	-27.123	308.359	309.549	0.013	0	0
Max rY	-1.183	-2.854	-2.015	3.688	0.001	0.002	-0.001
Max rZ	-101.405	14.511	-0.184	102.439	0	0	0.008
Max Rst	0	-5.074	396.93	396.963	0.012	0	0

Table: Single Web System Truss Tower Displacement

Single Web System Truss Tower Displacement							
	Horizontal	Vertical	Horizontal	Resultant	Rotational		
	X mm	Y mm	Z mm	mm	rX rad	rY rad	rZ rad
Max X	106.771	-0.672	457.763	470.051	-0.065	0.03	0.014
Max Y	79.521	25.804	-7.529	83.942	0	-0.001	-0.006
Max Z	-58.307	-19.255	661.31	664.154	-0.085	-0.049	-0.021
Max rX	-11.456	-25.006	257.593	259.058	0.025	-0.027	-0.007
Max rY	-2.099	-8.019	358.587	358.683	-0.024	0.073	0.003
Max rZ	53.458	4.461	659.247	661.426	-0.086	-0.05	0.022
Max Rst	-58.307	-19.255	661.31	664.154	-0.085	-0.049	-0.021

Results for Tower Height 48.5 m for Seismic Zone III

Table: Single Web System Truss Tower Displacement

Displacement Portal System Truss Tower							
	Horizontal	Vertical	Horizontal	Resultant	Rotational		
	X mm	Y mm	Z mm	mm	rX rad	rY rad	rZ rad
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Max rX	0.105	-4.478	421.466	421.49	0.019	-0.001	0
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Max Z	0	-5.074	396.93	396.963	0.012	0	0
Max rX	0	-27.123	308.359	309.549	0.013	0	0
Max rY	-1.183	-2.854	-2.015	3.688	0.001	0.002	-0.001
Max rZ	-101.405	14.511	-0.184	102.439	0	0	0.008
Max Rst	0	-5.074	396.93	396.963	0.012	0	0

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Max rZ	53.458	4.461	659.247	661.426	-0.086	-0.05	0.022
Max Rst	-58.307	-19.255	661.31	664.154	-0.085	-0.049	-0.021

Max Forces & Moments Result

Results for Tower Height 48.5 m for Seismic Zone II

Portal System Truss Tower Force							
	Node	FxkN	FykN	FzkN	MxkNm	My kNm	MzkNm
Max Fx	21	496.601	-1.117	0.031	0.001	-0.107	-1.283
Max Fy	32	444.022	2.669	-0.726	-0.003	0.926	2.632
Max Fz	35	-7.833	-0.07	5.594	0.004	-2.132	-0.324
Max Mx	28	13.026	1.065	-3.982	0.005	3.289	0.867
Max My	32	11.433	1.066	3.933	-0.003	4.306	-1.184
Max Mz	32	444.022	2.669	-0.726	-0.003	0.926	2.632

Table:

Warren System Truss Tower Force							
	Node	FxkN	FykN	FzkN	MxkNm	My kNm	MzkNm
Max Fx	4	586.467	-0.249	-0.007	0.001	-0.03	-0.31
Max Fy	9	-1.882	0.71	-0.145	-0.001	0.139	0.698
Max Fz	26	160.209	-0.137	1.11	0.001	-1.277	-0.2
Max Mx	26	40.377	0.51	0.001	0.002	0.058	0.379
Max My	27	160.659	-0.182	1.11	0.001	1.214	0.158
Max Mz	9	-1.882	0.71	-0.145	-0.001	0.139	0.698

Table:

Single Web System Truss Tower Force							
	Node	FxkN	FykN	FzkN	MxkNm	My kNm	MzkNm
Max Fx	2	461.689	0.508	0.237	-0.002	0.477	-0.641
Max Fy	52	-89.447	1.199	-0.316	0	0.336	2.056
Max Fz	34	-146.77	0.549	11.323	-0.054	-28.285	0.554
Max Mx	18	148.981	0.23	-11.29	0.059	28.095	-0.442
Max My	61	-147.03	-0.442	11.323	-0.054	29.427	0.281
Max Mz	60	-2.378	1.187	1.635	0.024	-6.242	3.99

Table:

Results for Tower Height 48.5 m for Seismic Zone III

Forces Portal System Truss Tower						
	FxkN	FykN	FzkN	MxkNm	My kNm	MzkNm
Max Fx	496.6	-1.117	0.031	0.001	-0.107	-1.283
Max Fy	444.02	2.669	-0.726	-0.003	0.926	2.632
Max Fz	-7.833	-0.07	5.594	0.004	-2.132	-0.324
Max Mx	13.026	1.065	-3.982	0.005	3.289	0.867
Max My	11.433	1.066	3.933	-0.003	4.306	-1.184
Max Mz	444.02	2.669	-0.726	-0.003	0.926	2.632

Table:

Forces Warren System Truss Tower						
	FxkN	FykN	FzkN	MxkNm	My kNm	MzkNm
Max Fx	586.47	-0.249	-0.007	0.001	-0.03	-0.31
Max Fy	-1.882	0.71	-0.145	-0.001	0.139	0.698
Max Fz	160.21	-0.137	1.11	0.001	-1.277	-0.2
Max Mx	40.377	0.51	0.001	0.002	0.058	0.379
Max My	160.66	-0.182	1.11	0.001	1.214	0.158
Max Mz	-1.882	0.71	-0.145	-0.001	0.139	0.698

Table:

Forces Single Web System Truss Tower						
	FxkN	FykN	FzkN	MxkNm	My kNm	MzkNm
Max Fx	461.69	0.508	0.237	-0.002	0.477	-0.641
Max Fy	-89.45	1.199	-0.316	0	0.336	2.056
Max Fz	-146.8	0.549	11.323	-0.054	-28.285	0.554
Max Mx	148.98	0.23	-11.287	0.059	28.095	-0.442
Max My	-147	-0.442	11.323	-0.054	29.427	0.281
Max Mz	-2.378	1.187	1.635	0.024	-6.242	3.99

Table:

Max Displacement Result

Model	P	VX	VY	T	MX	MY

ETABS Results for Tower Height 48.3 m for Seismic Zone II

Model	Direction	Maximum	Average	Ratio
		mm	mm	
Portal System Truss Tower	Y	293.655	291.551	1.007
Warren System Truss Tower	Y	302.34	301.29	1.00
Single Web System Truss Tower	Y	311.03	311.03	1

Table:

ETABS Results for Tower Height 48.5 m for Seismic Zone III

Model	Direction	Maximum	Average	Ratio
		mm	mm	
Portal System Truss Tower	Y	293.655	291.551	1.007
Warren System Truss Tower	Y	302.34	301.29	1.00
Single Web System Truss Tower	Y	311.03	311.03	1

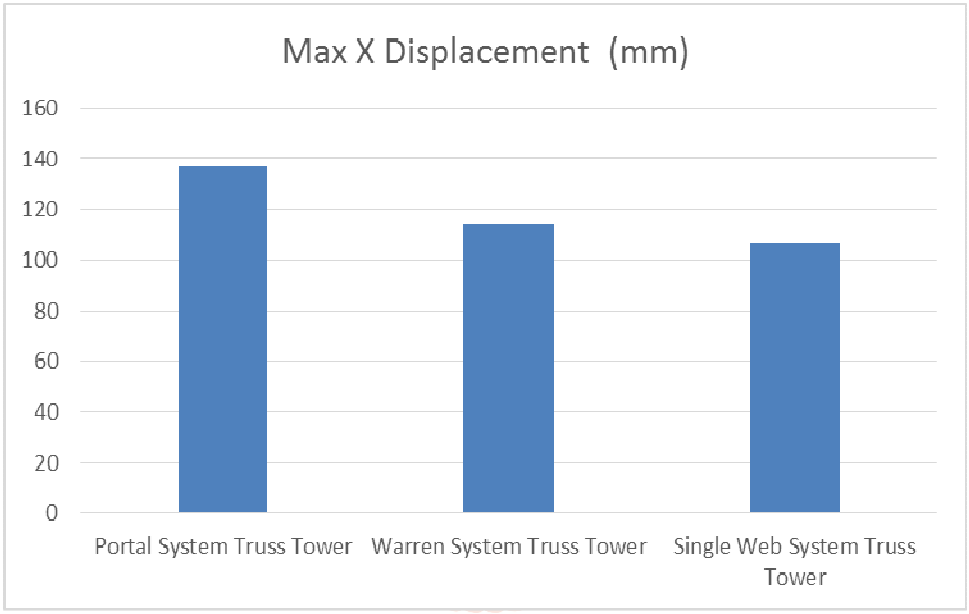
Table:

Max Forces & Moments Result
Results for Tower Height 48.5 m for Seismic Zone III

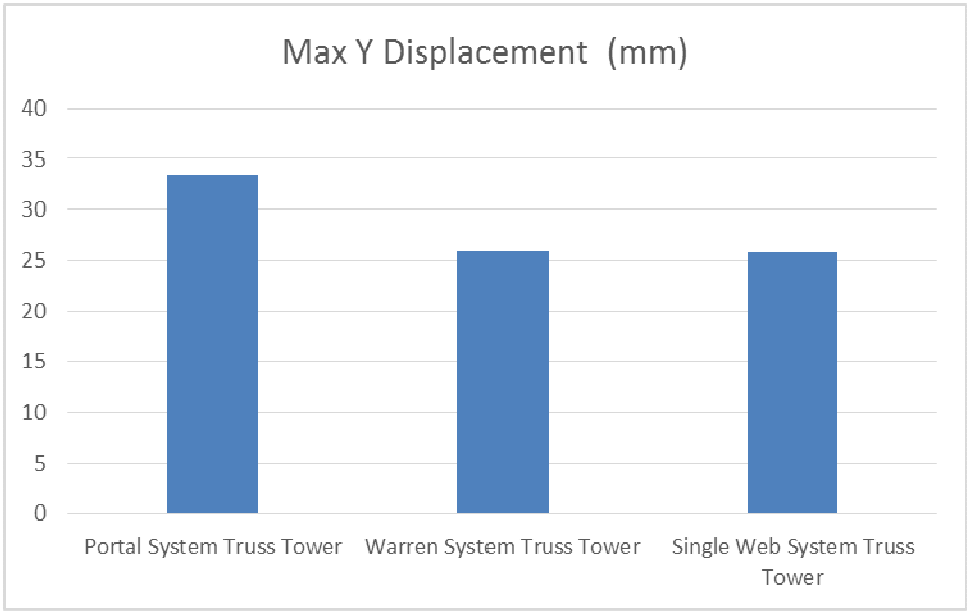
Model	P	VX	VY	T	MX	MY
	kN	kN	kN	kNm	kNm	kNm
Portal System Truss Tower	20.0432	-0.0017	149.9	0.014	-177.327	-0.0009
Warren System Truss Tower	370.307	411.583	13.88	0.668	-892.6879	1485.04
Single Web System Truss Tower	0.7785	-5.5879	-1.955	6.857	2.5237	9.9293

Table:

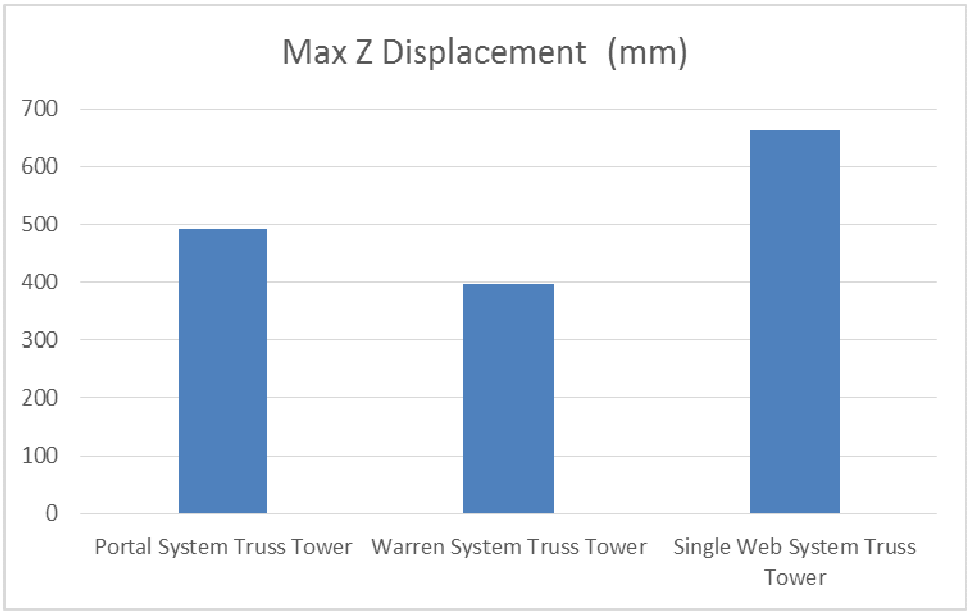
Max Displacement Graphs
Graphs for Tower Height 48.5 m for Seismic Zone II



Graph: Max. Displacement in X Direction

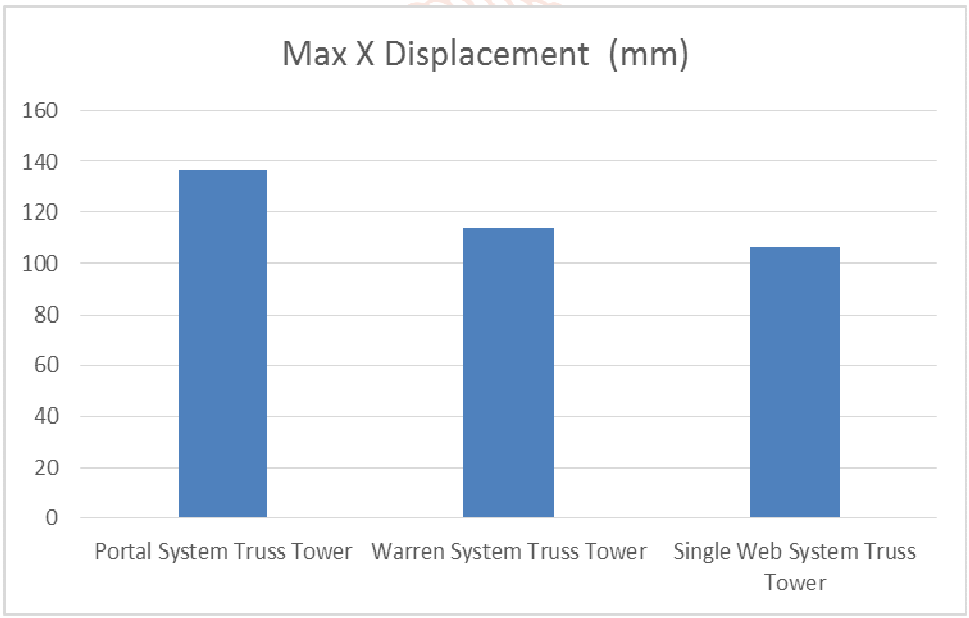


Graph: Max. Displacement in Y Direction

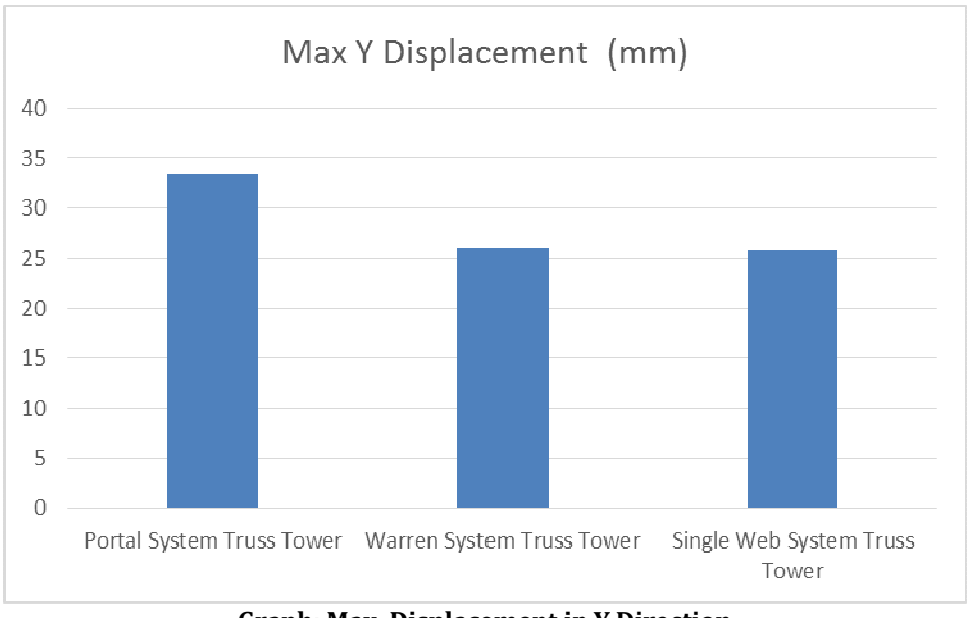


Graph: Max. Displacement in Z Direction

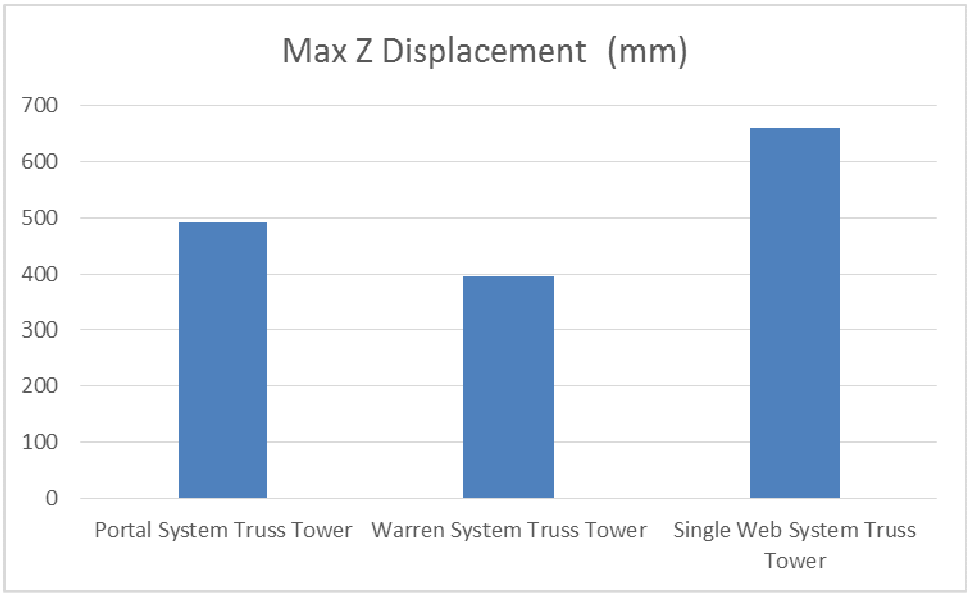
Graphs for Tower Height 48.5 m for Seismic Zone III



Graph: Max. Displacement in X Direction

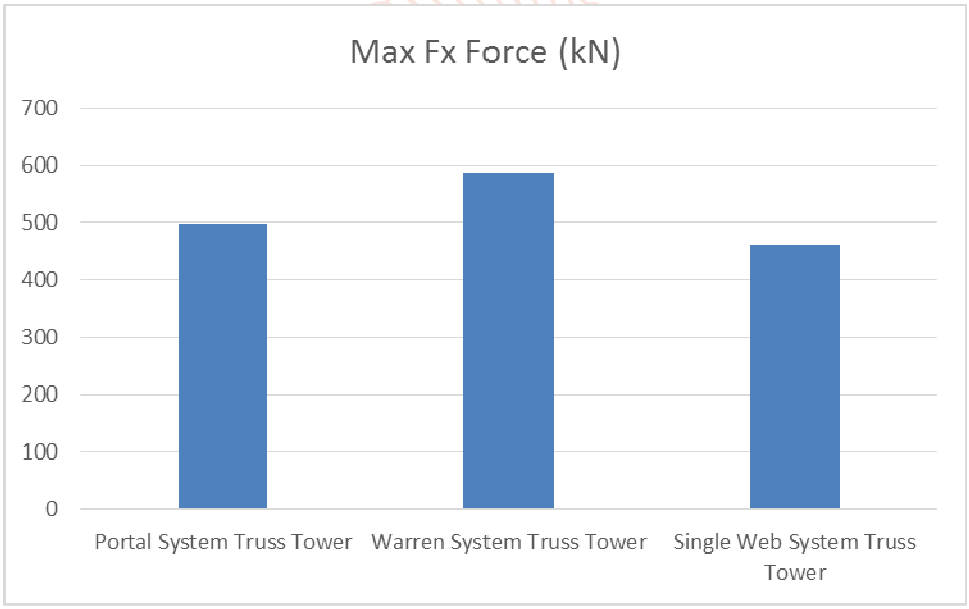


Graph: Max. Displacement in Y Direction

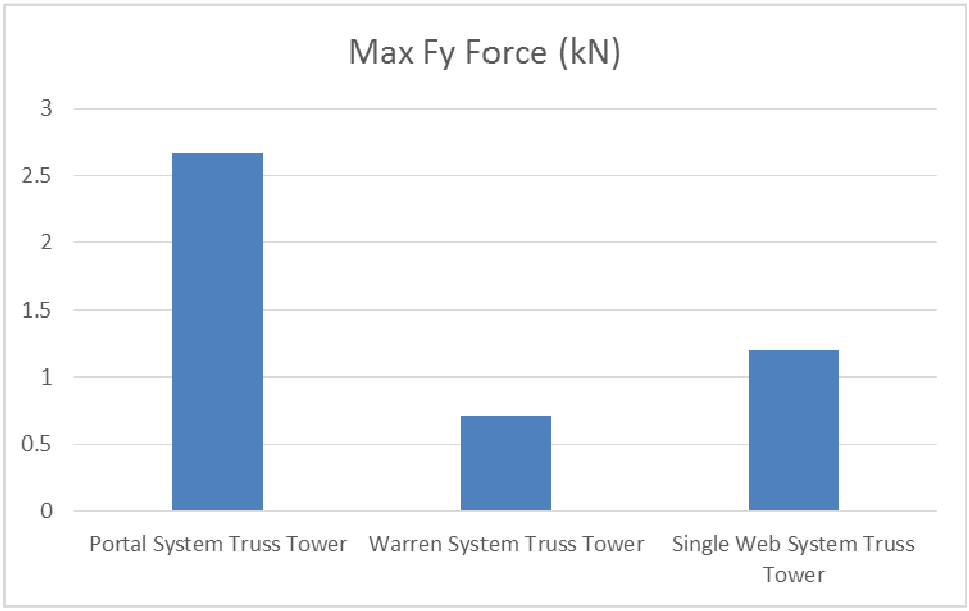


Graph: Max. Displacement in Z Direction

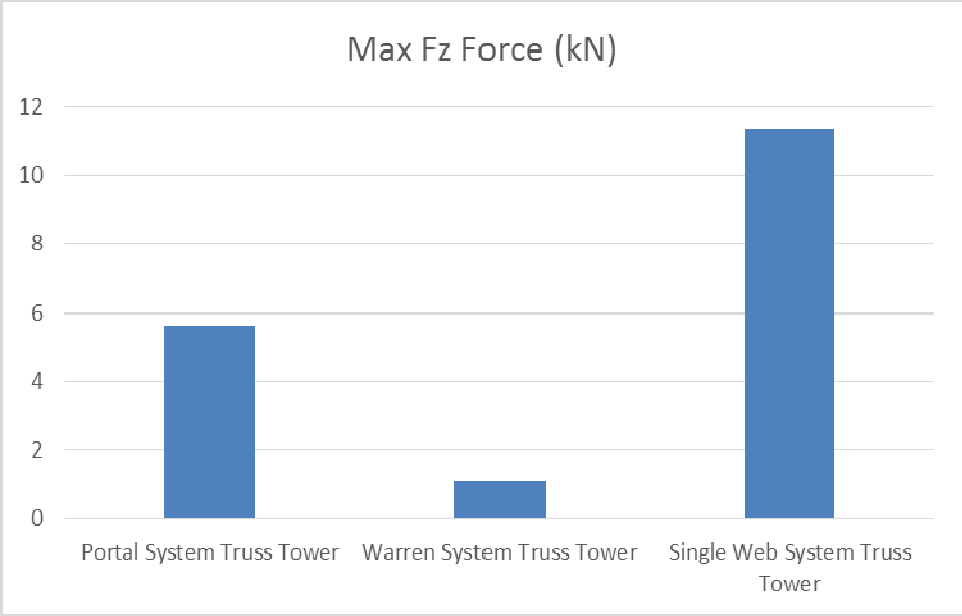
Max Force & Bending Moment Graphs
Graphs for Tower Height 48.5 m for Seismic Zone II



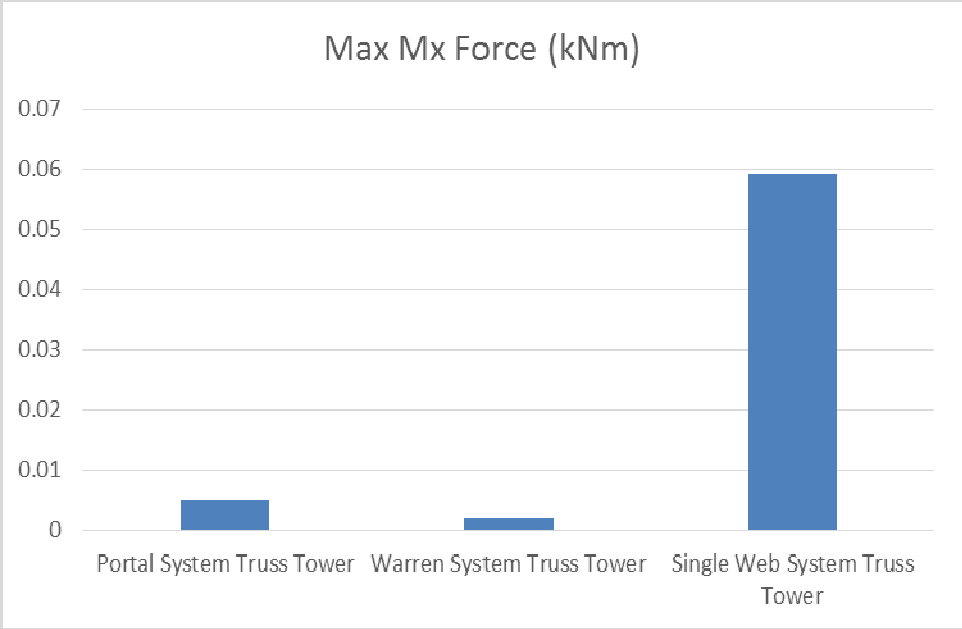
Graph: Max. Force in X Direction



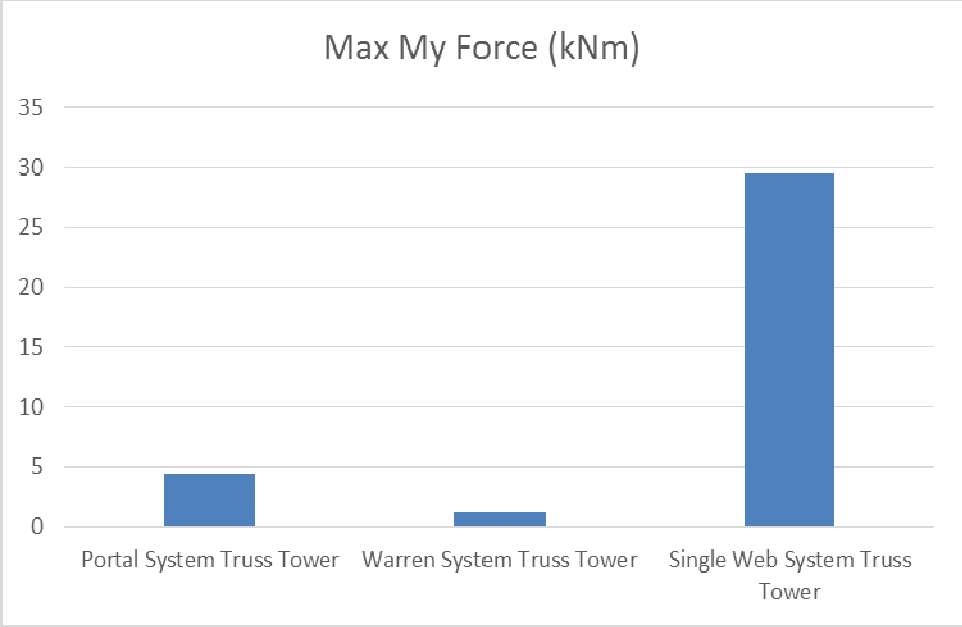
Graph: Max. Force in Y Direction



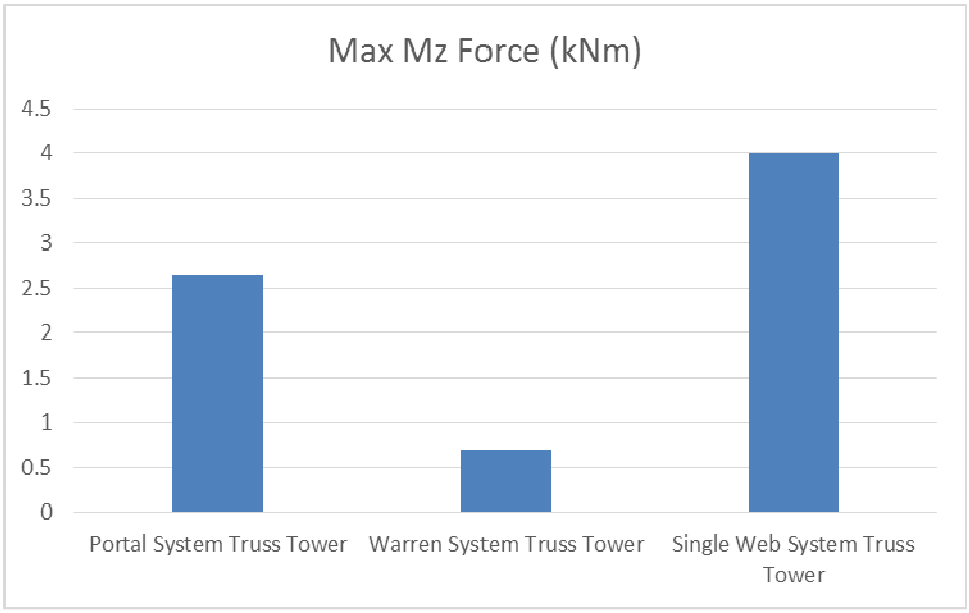
Graph: Max. Force in Z Direction



Graph: Max. Bending Moment in X Direction

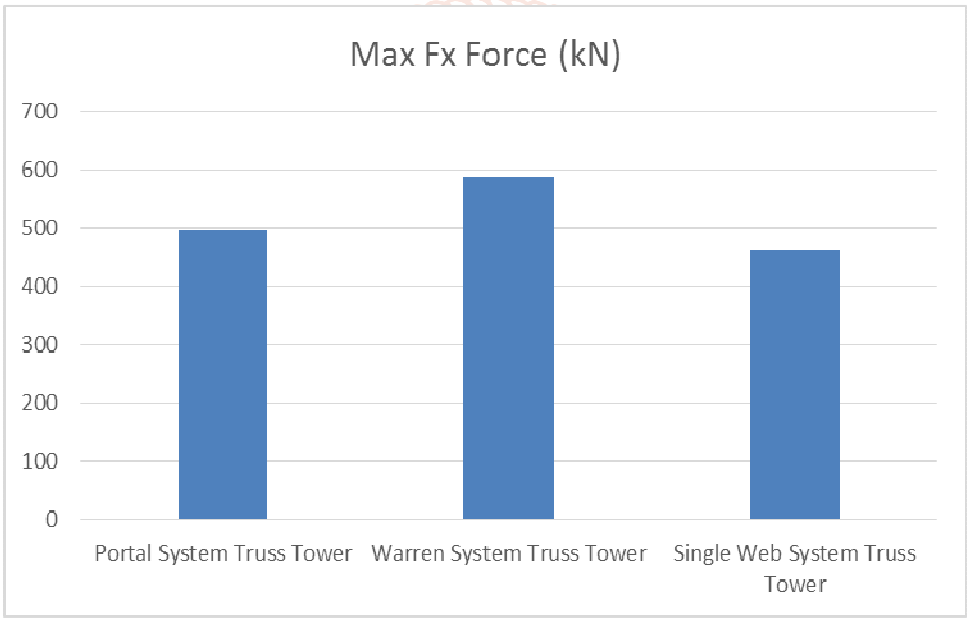


Graph: Max. Bending Moment in Y Direction

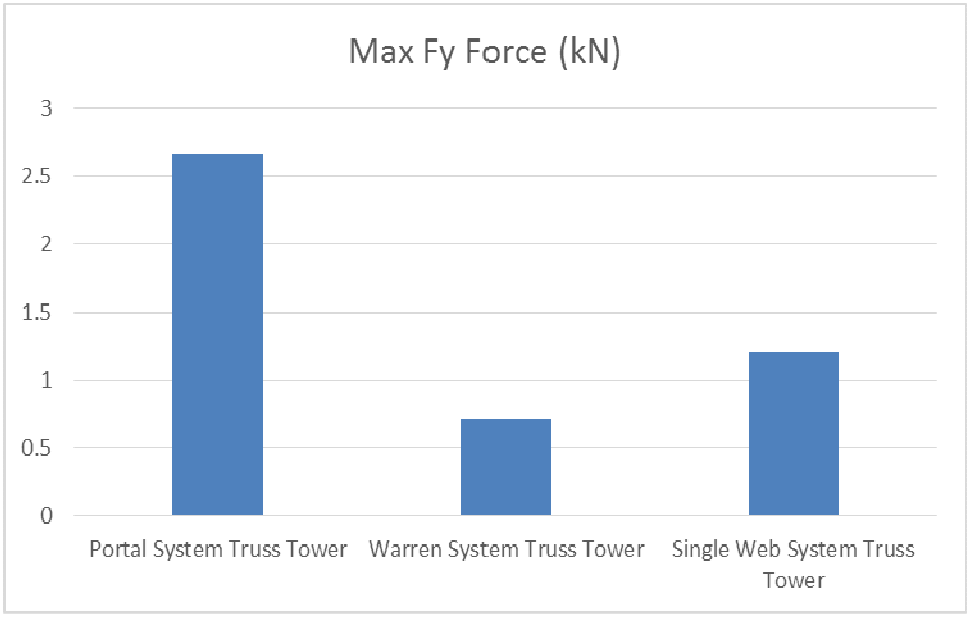


Graph: Max. Bending Moment in Y Direction

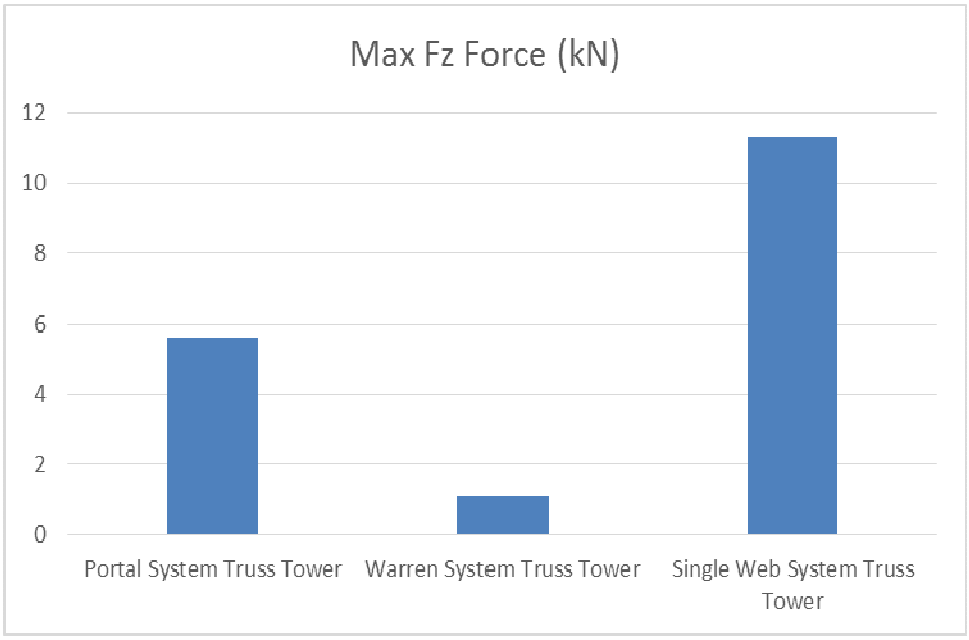
Graphs for Tower Height 48.5 m for Seismic Zone III



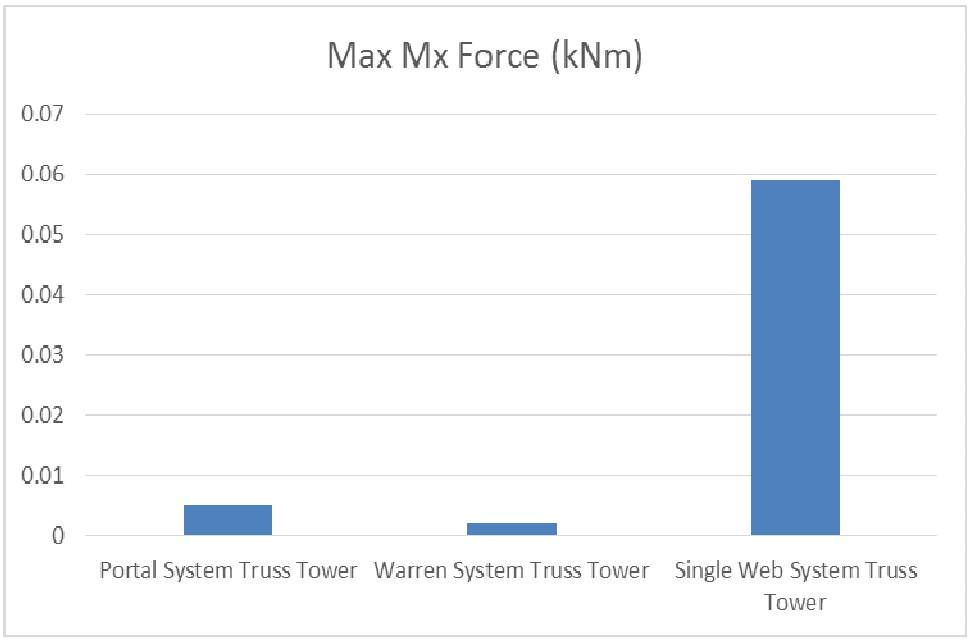
Graph: Max. Force in X Direction



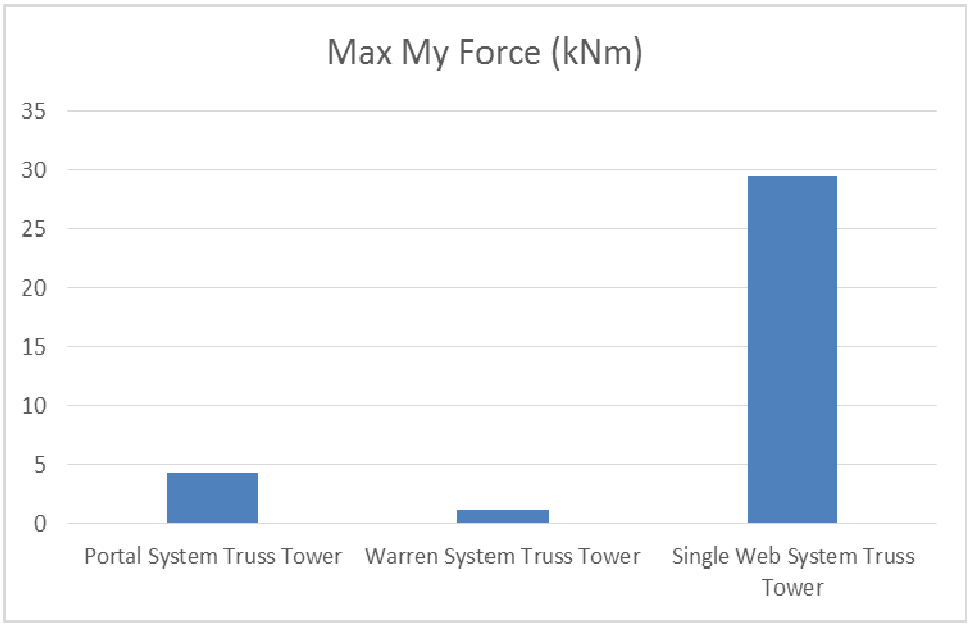
Graph: Max. Force in Y Direction



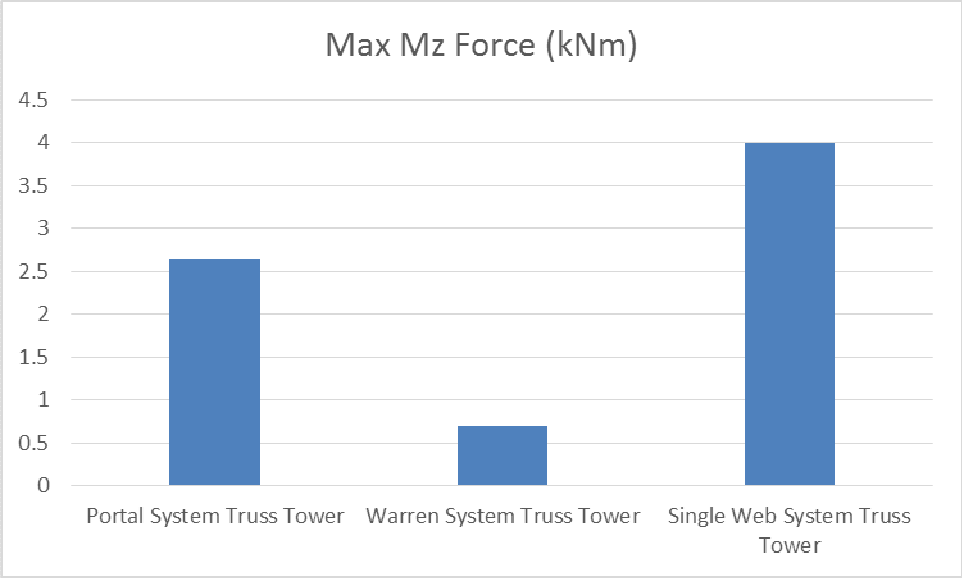
Graph: Max. Force in Z Direction



Graph: Max. Bending Moment in X Direction



Graph: Max. Bending Moment in Y Direction



Graph: Max. Bending Moment in Z Direction

CONCLUSIONS

The Geometry parameters of the tower can efficiently be treated as design Variables and considerable weight reduction can often be achieved as a result of geometry changes. The tower with angle section and bracing has the greater reduction in weight after optimization. Tube section is not economic to use in this type of tower.

Some of the key points of conclusion:

- Warren System Truss Tower shows least displacement in all conditions i.e. 79mm, 20.5 mm, 290.76 mm in X, Y & Z directions in comparison to other truss systems.
- Warren System Truss Tower shows least bending in all conditions i.e. 1.36 kN-m, 1.27kN-m in X& Z directions in comparison to other truss systems.
- Different Seismic zones i.e. Zone II & Zone III shows almost similar results for all the models & load conditions.

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