Comparative Analysis and Design of Flat and Grid Slab System with Conventional Slab System

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Abstract:

Structural Engineering is a branch of Civil Engineering where the study is done to know how the structure behave when building is constructed at real environment and to identify the various forces like axial force and shear force, bending moment and displacement etc. acting on the structure. When the analysis come to complex structure or multistory structure the manual calculation will be difficult to perform and hence there is various software available to perform these calculations, this software are STAAD Pro V8i, ANSYS, ETAB, SAP-2000 etc. In the present study, "Comparative analysis and design of flat slab and grid slab system" comparison of parameter like, bending moment, shear force and displacement of flat slab system and grid slab system with conventional slab system. In this study, slab system design and analysis for Low rise ,medium and High rise building for different seismic zones and having medium soil condition by using ETABS 9.7.4 The analysis and design of slab system is done as per IS 456-2000 and IS 1983-2002. Design of the slab system is done for different spacing/ grid size of column to find out which grid size of the column or plan area which slab is economical.

keywords: grid slab, medium soil, flat slab, ETABS9.7.4.

I.INTRODUCTION

The flat slab arrangement of structure is one in which the beam is used in the conventional procedures of construction through away with the directly rests on column as well as the load from the slabs is directly conveyed to the columns and then to the footing. Drops or columns are generally provided using column heads or capitals. Floor systems consisting of flat slabs are very famous in countries where cast-in place building is prime form of construction because of numerous advantages in terms of architectural flexibility, use of space, easier formwork, and shorter creation time. Flat slabs are being used chiefly in office buildings due to reduced formwork cost, fast excavation, and easy establishment. That's why it's crucial to think what you're getting into (or under) so you can maximize the comeback on your investment. Grid floor systems comprising of beams move apart at regular intervals in perpendicular directions, monolithic with slab.GRID SLAB Interconnected grid systems are being commonly used or supporting building floors bridge decks and overhead water tanks slabs. A grid is a planar structural system composed of continuous members that either intersect or cross each other. Grids are used to cover large column free areas and have been constructed in number of areas in India and abroad. Is subjected to loads applied normally to its plane, the structure is referred as Grid. It is composed of continuous member that either intersect or cross each other. Grids in addition to their aesthetically pleasing appearance provide a number of advantages over the other types of roofing systems

OBJECTIVE OF THE STUDY

The following are the objective of the present study:

1) To design various form of slab system for example conventional slab, flat slab and grid slab for the given plan area and their comparative study.

2) To perform dynamic analysis of multistoried RCC buildings with Flat slab & Grid slab (20 Storey) having Square geometry, using Response Spectrum Analysis, considering earthquake Zone II as per the Indian Standard code of practice IS 1893-2002 part-I: Criteria for Earthquake resistant structure. To model different structures with aforementioned configuration and compare them using design aids like ETABS

3) To compare seismic behavior of multistoried RCC building with Flat slab & Grid slab for different earthquake intensities in terms of various responses such as, base shear, Story displacements, Story Drift, Axial Force. To find the relationship between earthquake intensities and responses.

SCOPE OF THE STUDY

To perform dynamic analysis for seismic and wind loading of multistoried RCC buildings with Flat slab & Grid slab using Response Spectrum Analysis, considering different earthquake Zones as per the Indian Standard code of practice IS 1893-2002 part-I: Criteria for Earthquake resistant structure (Zone II, III, IV, V).

To compare seismic behavior of multistoried RCC building with Flat slab & Grid slab for different earthquake intensities in terms of various responses such as, base shear, Story displacements, Story Drift, Etc.

To find the relationship between earthquake intensities and responses.

II.LITERATURE REVIEW

Amit A. Sathwane et all,.(2014) They studied that the among flat slab , flat slab with drop and grid slab which is economical for the nexus point opposite to vidhan bhavan and beside NMC office. The analysis of flat slab, flat slab without drop and grid slab done both manually by IS 456-2000 and by STAAD PRO V8i. It is found in the study that flat slab with drop is economical then rest of other considered slab for the nexus point.

It is also revealed in the study that concrete required for grid slab is more than the flat slab with and without drop and steel required for the flat slab without drop is more than the flat slab with drop and grid slab.

D. Ramya et all,. (October 2015) analyzed the multi-story (G+10) building by both STAAD PRO V8i and ETABS software. In the study comparison between these two software is done to find out which give economy of multi storied (G+10) building. It is show that in the study STAAD PRO is much simple to work with as compare to ETABS software. It is also show that quantity of steel given by the ETABS is 9.25% less than by STAAD Pro when analyzed G+10 multistory building. The quantity of concrete show by both the software's is found same for multistory building. In the study it is revealed that the most economical section given by ETABS.

III. METHODOLOGY

1 PROBLEM STATEMENT:

The study is done on 24 different models of a Low (G+5), Medium (G+10), High (G+15) building are modeled. The building plan has 8 bays in X and Y direction with spacing of 3meters in each direction. The height of each floor is 3.0m and height of ground floor is 3.3 , thus total height of the building in low level is 18.3 Mts, Medium level is 33.3 Mts. And High rise building is 48.3 Mts.

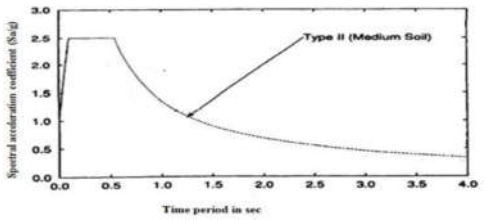
Salient Features:

The design data shall be as follows.

Utility of Buildings	:	Residential Building
No of Storey	:	G+5,G+10,G+15
Shape of the Building	:	Rectangular
Types of Walls	:	Brick Wall
Geometric Details		
Ground Floor	:	3.3 mts
Floor-To-Floor Height	:	3 mts
Material Details	:	M40,fe 415
Beam	:	0.45x0.45
Column	:	0.6x0.6
SLAB	:	150 mm
WALL	:	External wall: 230 MM
Type Of Construction structure	:	R.C.C FRAMED

Response spectrum method:

The representation of maximum response of idealized single degree freedom system having certain period and damping, during earthquake ground motions. This analysis is carried out according to the code IS 1893-2002 (part1). Here type of soil, seismic zone factor should be entered from IS 1893-2002 (part1). The standard response spectra for type of soil considered is applied to building for the analysis in ETABS 2013 software. Following diagram shows the standard response spectrum for medium soil type and that can be given in the form of time period versus spectral acceleration coefficient (Sa/g).



Response spectrum for medium soil type for 5% damping

Approach permits the multiple modes of response of a building to be taken in to account (in the frequency domain). This is required in many building codes for all except very simple or very complex structures. The response of a structure can be defined as a combination of many special shapes (modes) that in a vibrating string correspond to the "harmonic" computer analysis can be used to determine these modes for a structure. For each mode, a response is read from the design spectrum, based on the modal frequency and the modal mass, and they are then combined to provide an estimate of the total response of the structure. In this we have to calculate the magnitude of forces in all directions i.e. X, Y & Z and then see the effects on the building. Combination methods include the following:

absolute - peak values are added together

square root of the sum of the squares (SRSS)

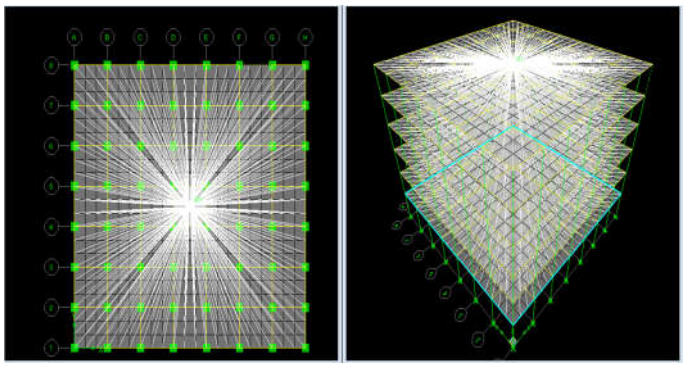
complete quadratic combination (CQC) - a method that is an improvement on SRSS for closely spaced modes

The result of a response spectrum analysis using the response spectrum from a ground motion is typically different from that which would be calculated directly from a linear dynamic analysis using that ground motion directly, since phase information is lost in the process of generating the response spectrum.

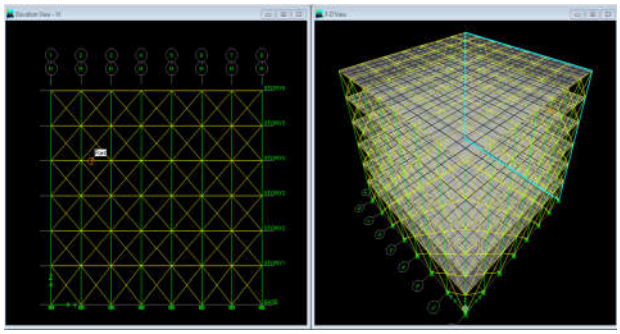
In cases where structures are either too irregular, too tall or of significance to a community in disaster response, the response spectrum approach is no longer appropriate, and more complex analysis is often required, such as non-linear static analysis or dynamic analysis.

A.Low rise building (G+5)

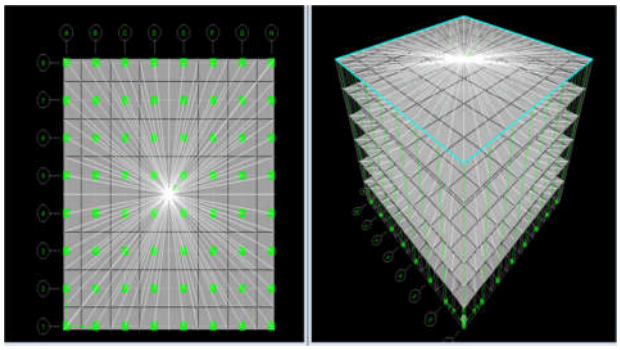
GRID SLAB WITHOUT BRACINGS



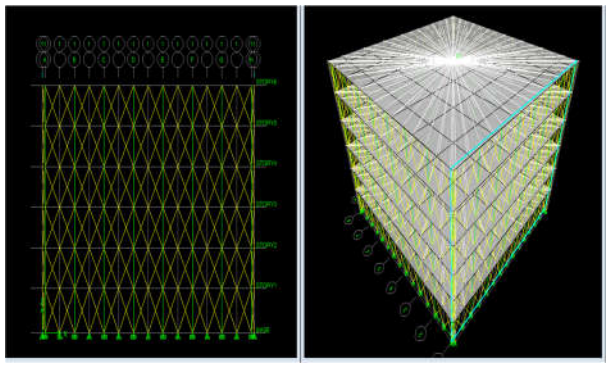
2.GRID SLAB WITH BRACINGS



3.FLAT WITHOUT BRACINGS

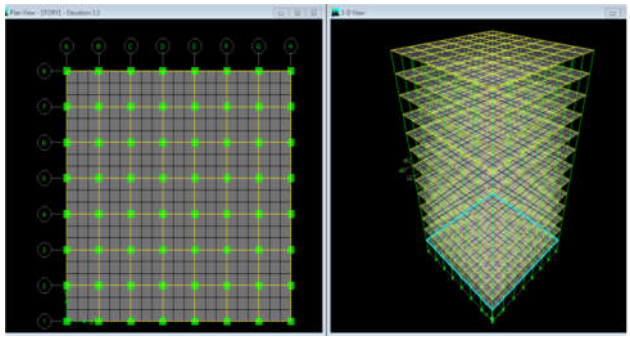


4. FLAT SLAB WITH BRACINGS

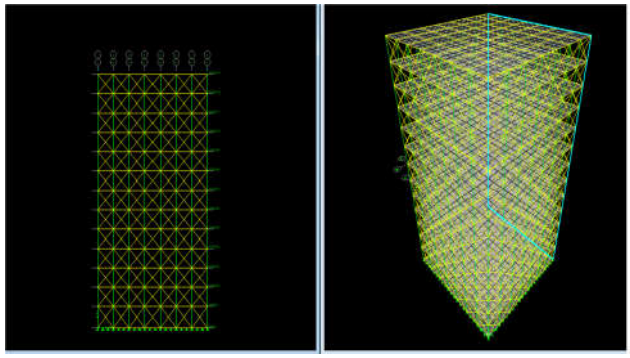


MEDIUM RISE BUILDING

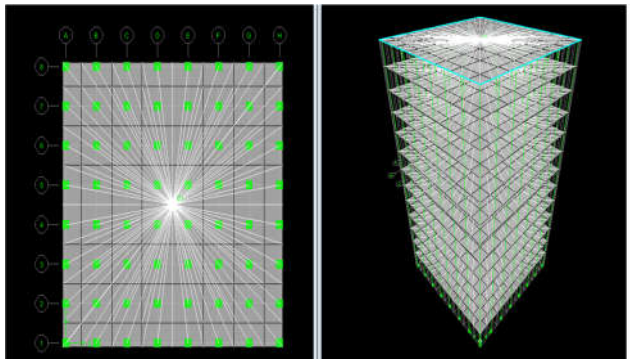
1.GRID SLAB WITHOUT BRACINGS



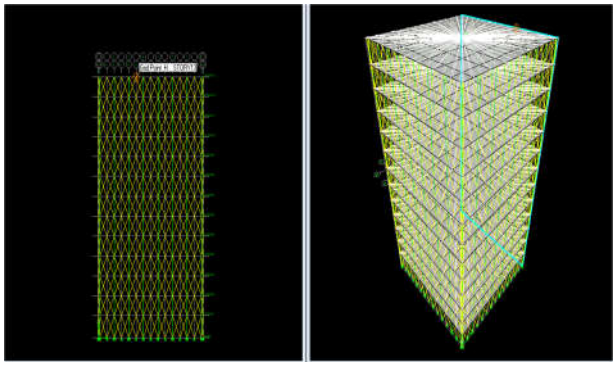
2. GRID SLAB WITH BRACINGS



3. FLAT SLAB WITHOUT BRACINGS

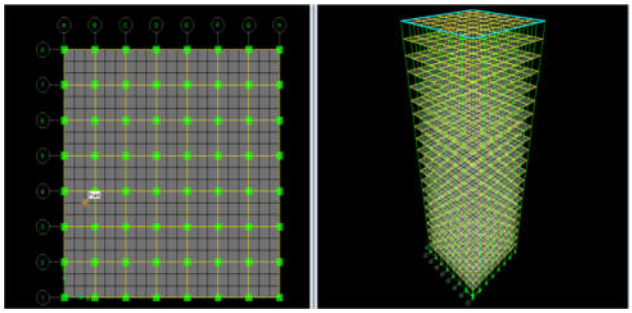


4. FLAT SLAB WITH BRACINGS

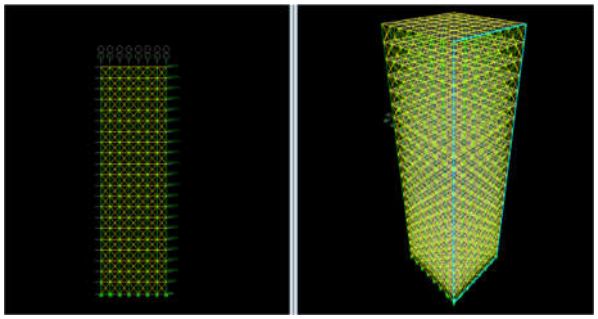


C. HIGH RISE BUILDINGS

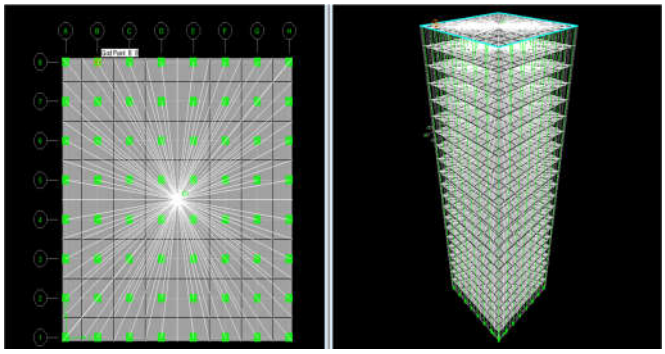
1. GRID SLAB WITHOUT BRACINGS



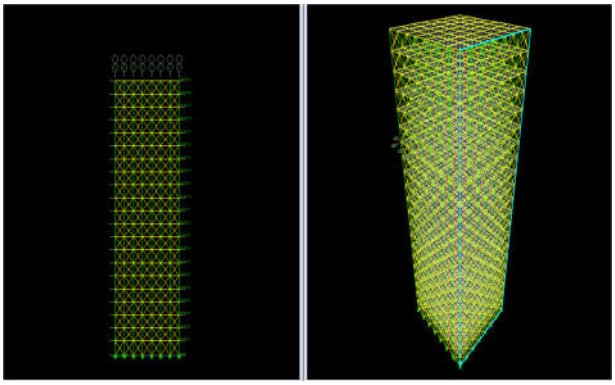
GRID SLAB WITH BRACINGS



3.FLAT SLAB WITHOUT BRACINGS



4. FLAT SLAB WITH BRACINGS



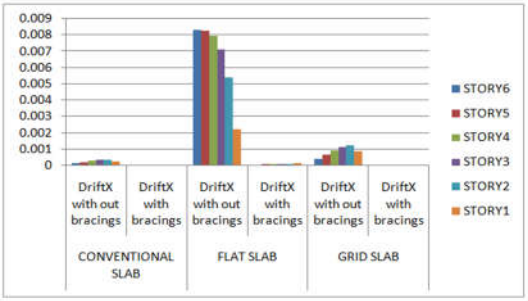
IV.RESULTS AND ANALYSIS

COMPARASION RESULTS OF THE FLAT SLAB AND GRID SLABS

A.LOW RISE BUILDINGS

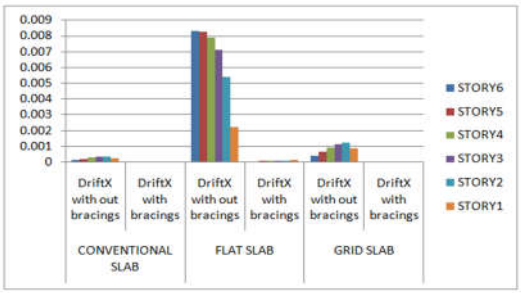
1.STORY DRIFT IN X DIRECTION

Story	Load	CONVENTIONAL SLAB		FLAT SLAB		GRID SLAB	
		Drift X without bracings	Drift X with bracings	Drift X without bracings	Drift X with bracings	Drift X without bracings	Drift X with bracings
STORY6	RSA	0.000116	0.000022	0.00833	0.00003	0.000362	0.000018
STORY5	RSA	0.000199	0.000035	0.008274	0.000057	0.000639	0.000028
STORY4	RSA	0.000278	0.000045	0.007973	0.000082	0.000906	0.000036
STORY3	RSA	0.000336	0.000052	0.007146	0.000101	0.001118	0.00004
STORY2	RSA	0.000361	0.000058	0.005432	0.000118	0.001219	0.000043
STORY1	RSA	0.000257	0.00005	0.002211	0.000125	0.00088	0.000036



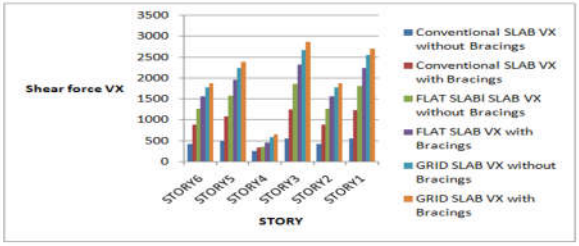
STORY DRIFT IN Y DIRECTION

Story	Load	CONVENTIONAL SLAB		FLAT SLAB		GRID SLAB	
		Drift Y with bracings	Drift Y with bracings	Drift Y without bracings	Drift Y with bracings	Drift Y in without bracings	Drift Y in with bracings
STORY6	RSA	0.000116	0.000022	0.00833	0.00003	0.000362	0.000018
STORY5	RSA	0.000199	0.000035	0.008274	0.000057	0.000639	0.000028
STORY4	RSA	0.000278	0.000045	0.007973	0.000082	0.000906	0.000036
STORY3	RSA	0.000336	0.000052	0.007146	0.000101	0.001118	0.00004
STORY2	RSA	0.000361	0.000058	0.005432	0.000118	0.001219	0.000043
STORY1	RSA	0.000257	0.00005	0.002211	0.000125	0.00088	0.000036



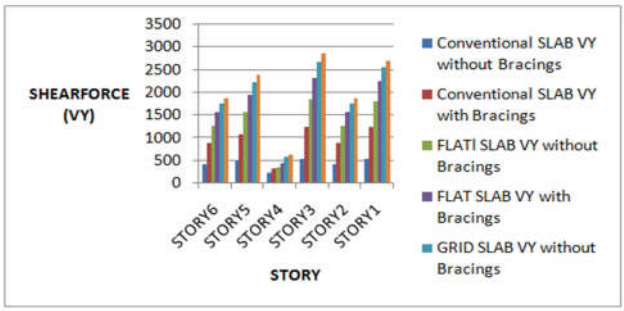
SHEAR FORCE IN X DIRECTION

Story	Load	Loc	Conventional SLAB		FLAT SLAB		GRID SLAB	
			VX without bracings	VX with bracings	VX without bracings	VX with bracings	VX without bracings	VX with bracings
STORY6	RSA	Bottom	419.77	488.75	242.9	546.21	419.77	546.65
STORY5	RSA	Bottom	881.74	1076.88	334.54	1249.33	881.74	1233.24
STORY4	RSA	Bottom	1263.43	1570.75	345.41	1850.04	1263.43	1802.91
STORY3	RSA	Bottom	1562.73	1960.66	443.23	2329.77	1562.72	2244.52
STORY2	RSA	Bottom	1772.92	2237.3	578.03	2676.16	1772.92	2550.14
STORY1	RSA	Bottom	1878.36	2389.45	641.71	2868.01	1878.35	2706.1



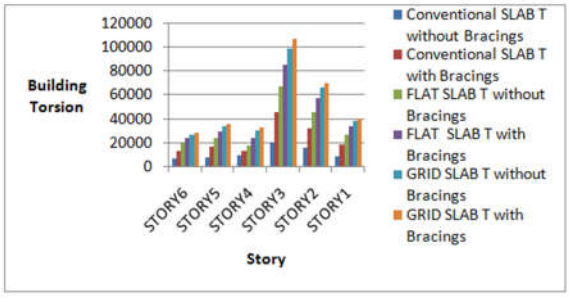
SHEAR FORCE IN Y DIRECTION

Story	Load	Loc	Conventional SLAB		FLAT SLAB		GRID SLAB	
			VY without bracings	VY with bracings	VY without bracings	VY with bracings	VY without bracings	VY with bracings
STORY6	RSA	Bottom	419.77	487.19	242.9	546.22	419.77	547.76
STORY5	RSA	Bottom	881.74	1076.4	334.54	1249.33	881.74	1233.59
STORY4	RSA	Bottom	1263.43	1570.63	345.41	1850.04	1263.42	1803.01
STORY3	RSA	Bottom	1562.73	1960.08	443.23	2329.77	1562.72	2244.93
STORY2	RSA	Bottom	1772.92	2237.25	578.03	2676.17	1772.92	2550.16
STORY1	RSA	Bottom	1878.36	2389.15	641.71	2868.01	1878.35	2706.36



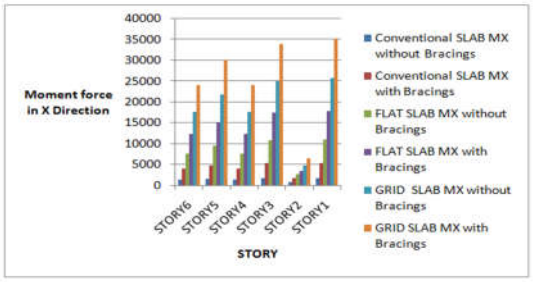
BUILDING TORSION

Story	Load	Loc	Conventional SLAB		FLAT SLAB		GRID SLAB	
			T without Bracings	T with Bracings	T without bracings	T with bracings	T without bracings	T with bracings
STORY6	RSA	Bottom	6233.212	7254.152	8853.463	19908.81	15048.34	8112.777
STORY5	RSA	Bottom	13093.22	15989.77	12904.84	45568.12	31671.58	18311.51
STORY4	RSA	Bottom	18760.99	23324.09	17214.27	67688.93	45730.29	26771.37
STORY3	RSA	Bottom	23205.32	29113.04	24054.94	85796.51	57351.72	33327.96
STORY2	RSA	Bottom	26326.5	33221.98	30321.19	99321.93	65961.75	37867.62
STORY1	RSA	Bottom	27892.22	35481.07	33036.1	107011	70425.54	40182.3



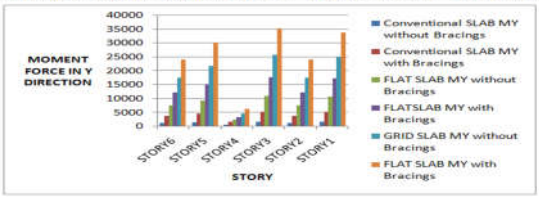
BENDING MOMENT IN X DIRECTION

Story	Load	Loc	Conventional SLAB		FLAT SLAB		GRID SLAB	
			MX without bracings	MX with Bracings	MX without bracings	MX with bracings	MX without bracings	MX with bracings
STORY6	RSA	Bottom	1259.302	1461.56	1259.316	1643.289	728.694	1638.652
STORY5	RSA	Bottom	3901.383	4688.857	3901.389	5340.804	1713.707	5384.937
STORY4	RSA	Bottom	7672.905	9389.202	7672.893	10733.63	2595.16	10923.86
STORY3	RSA	Bottom	12309.49	15236.79	12309.46	17430.47	3469.833	17879.44
STORY2	RSA	Bottom	17546.19	21893.11	17546.15	25022.24	4660.069	25848.25
STORY1	RSA	Bottom	24028.87	30187.79	24028.8	33887.4	6371.856	35241.74



BUILDING MOMENT IN Y DIRECTION

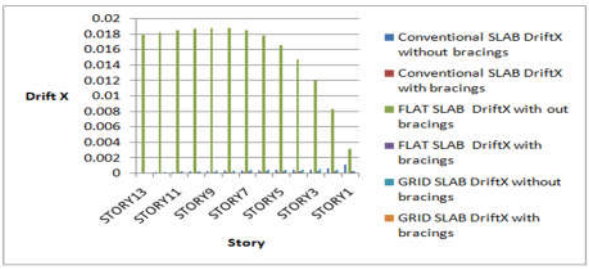
Story	Load	Loc	Conventional SLAB		FLAT SLAB		GRID SLAB	
			MY without bracings	MY with Bracings	MY Without Bracings	MY with bracings	MY without bracings	MY with bracings
STORY6	RSA	Bottom	1259.301	1466.248	728.695	1638.636	1259.299	1639.942
STORY5	RSA	Bottom	3901.382	4693.702	1713.706	5384.926	3901.369	5337.374
STORY4	RSA	Bottom	7672.904	9390.432	2595.159	10923.86	7672.886	10732.82
STORY3	RSA	Bottom	12309.49	15236.81	3469.833	17879.44	12309.46	17430.48
STORY2	RSA	Bottom	17546.19	21893.19	4660.069	25848.24	17546.14	25022.23
STORY1	RSA	Bottom	24028.87	30187.99	6371.855	35241.74	24028.78	33887.21



MEDIUM RISE BUILDING

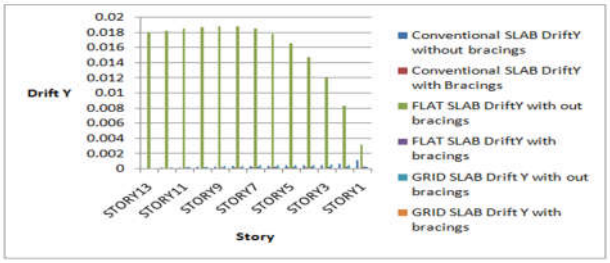
1. STORY DRIFT IN X DIRECTION

STORY	LOAD	Conventional SLAB		FLAT SLAB		GRID SLAB	
		Drift X without bracings	Drift X with bracings	Drift X with out bracings	Drift X with bracings	Drift X without bracings	Drift X with bracings
STORY13	RSA	0.000106	0.000086	0.018041	0.000071	0.000123	0.00008
STORY12	RSA	0.000157	0.000098	0.018235	0.000102	0.000184	0.00009
STORY11	RSA	0.000212	0.00011	0.0185	0.000133	0.000249	0.000098
STORY10	RSA	0.000264	0.00012	0.018736	0.000161	0.000308	0.000104
STORY9	RSA	0.00031	0.000128	0.018872	0.000185	0.00036	0.000109
STORY8	RSA	0.000351	0.000135	0.018833	0.000207	0.000404	0.000111
STORY7	RSA	0.000387	0.000139	0.018524	0.000226	0.000443	0.000113
STORY6	RSA	0.000418	0.000141	0.017831	0.000242	0.000476	0.000112
STORY5	RSA	0.000447	0.00014	0.016619	0.000254	0.000504	0.00011
STORY4	RSA	0.000475	0.000137	0.014743	0.000264	0.000525	0.000106
STORY3	RSA	0.000517	0.00013	0.012047	0.000268	0.000535	0.000101
STORY2	RSA	0.000636	0.00012	0.008365	0.000275	0.000511	0.000093
STORY1	RSA	0.001179	0.000129	0.003167	0.000272	0.000327	0.00009



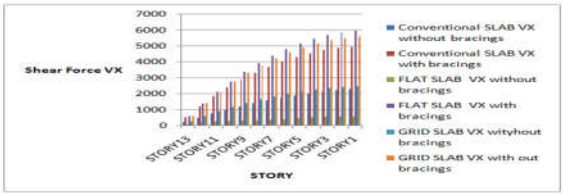
STORY DRIFT IN Y DIRECTION

Story	LOAD	Conventional SLAB		FLAT SLAB		GRID SLAB	
		Drift Y without bracings	Drift Y with Bracings	Drift Y with out bracings	Drift Y with bracings	Drift Y with out bracings	Drift Y with bracings
STORY13	RSA	0.000106	0.000086	0.018041	0.000071	0.000123	0.00008
STORY12	RSA	0.000157	0.000098	0.018235	0.000102	0.000184	0.00009
STORY11	RSA	0.000212	0.00011	0.0185	0.000133	0.000249	0.000098
STORY10	RSA	0.000264	0.00012	0.018736	0.000161	0.000308	0.000104
STORY9	RSA	0.00031	0.000128	0.018872	0.000185	0.00036	0.000109
STORY8	RSA	0.000351	0.000135	0.018833	0.000207	0.000404	0.000112
STORY7	RSA	0.000387	0.000139	0.018524	0.000226	0.000443	0.000113
STORY6	RSA	0.000418	0.00014	0.017831	0.000242	0.000476	0.000112
STORY5	RSA	0.000447	0.00014	0.016619	0.000254	0.000504	0.00011
STORY4	RSA	0.000475	0.000137	0.014743	0.000264	0.000525	0.000106
STORY3	RSA	0.000517	0.00013	0.012047	0.000268	0.000535	0.000101
STORY2	RSA	0.000636	0.00012	0.008365	0.000275	0.000511	0.000093
STORY1	RSA	0.001179	0.000129	0.003167	0.000272	0.000327	0.00009



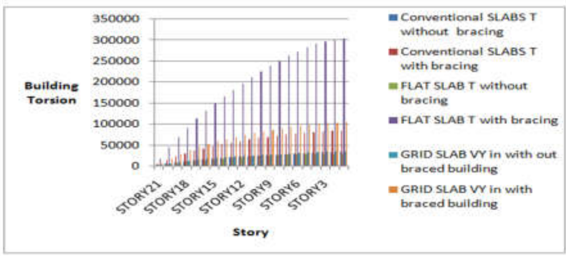
SHEAR FORCE IN X DIRECTION

Story	LOAD	LOC	Conventional SLAB		FLAT SLAB		GRID SLAB	
			VX without bracings	VX with bracings	VX without bracings	VX with bracings	VX without bracings	VX without bracings
STORY13	RSA	Bottom	235.82	549.19	118.19	597.7	285.94	621.17
STORY12	RSA	Bottom	516.57	1234.63	219.71	1393.84	622.29	1427.42
STORY11	RSA	Bottom	778.72	1853.81	281.53	2131.23	930.1	2150.13
STORY10	RSA	Bottom	1017.69	2405	312.85	2801.41	1203.44	2786.59
STORY9	RSA	Bottom	1231.81	2892.57	328.05	3402.1	1441.83	3341.11
STORY8	RSA	Bottom	1422.39	3322.94	344.6	3935.81	1649.7	3822.53
STORY7	RSA	Bottom	1593.02	3701.53	375.86	4407.58	1833.95	4241.18
STORY6	RSA	Bottom	1748.15	4031.78	423.36	4821.96	2000.48	4605.34
STORY5	RSA	Bottom	1891.39	4315.43	478.13	5180.49	2151.12	4918.68
STORY4	RSA	Bottom	2024.11	4552.54	528.5	5480.59	2282.43	5179.46
STORY3	RSA	Bottom	2144.59	4740.96	565.81	5716.15	2386.96	5382.03
STORY2	RSA	Bottom	2247.69	4876.73	586.66	5880.38	2456.35	5520.02
STORY1	RSA	Bottom	2324.82	4959.76	593.47	5967.58	2486.86	5591.22



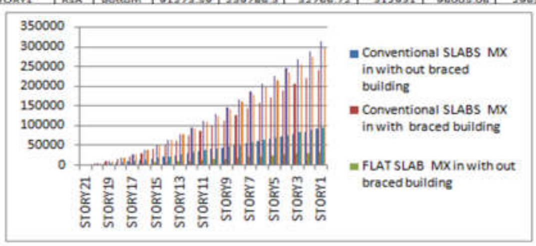
BUILDING TORSION

Story	Load	Loc	Conventional SLAB		FLAT SLAB		GRID SLAB	
			T without bracings	T with bracings	T without bracings	T with bracings	T with bracings	T with out bracings
STORY13	RSA	Bottom	3501.825	8160.263	4308.142	21785.63	4246.168	9269.795
STORY12	RSA	Bottom	7670.783	18341.53	8030.779	50812.8	9240.67	21267.26
STORY11	RSA	Bottom	11563.45	27534	10429.6	77741.73	13811.4	31980.85
STORY10	RSA	Bottom	15111.93	35714.9	12142.2	102351.2	17870.13	41396.78
STORY9	RSA	Bottom	18291.35	42952.59	13903.96	124691	21409.98	49613.02
STORY8	RSA	Bottom	21121.31	49343.85	16074.06	144999.4	24496.79	56772.64
STORY7	RSA	Bottom	23655.02	54967.96	18708.55	163547.6	27232.84	63011.02
STORY6	RSA	Bottom	25958.58	59873.16	21611.33	180467	29705.68	68425.59
STORY5	RSA	Bottom	28085.77	64083.93	24424.95	195648.1	31942.48	73063.56
STORY4	RSA	Bottom	30056.6	67602.67	26790.32	208747.3	33892.38	76916.07
STORY3	RSA	Bottom	31845.6	70399.63	28465.06	219273.6	35444.52	79920.2
STORY2	RSA	Bottom	33376.49	72416.94	29382.51	226747.3	36475.04	81983.76
STORY1	RSA	Bottom	34521.73	73652.03	29680.62	230772.7	36927.98	83057.93



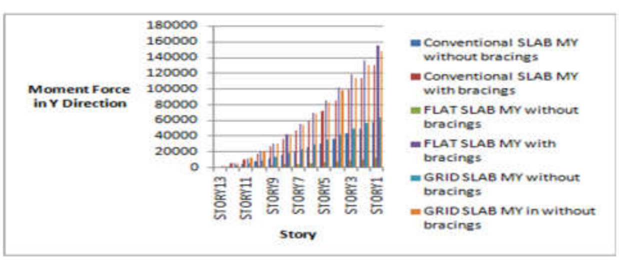
BUILDING MOMENT IN X DIRECTION

Story	Load	Loc	Conventional SLABS		FLAT SLAB		GRID SLAB	
			MX in without braced building	MX in with braced building	MX in without braced building	MX in with braced building	MX in without braced building	MX in with braced building
STORY21	RSA	Bottom	576.611	1391.512	232.691	1595.315	654.931	1692.88
STORY20	RSA	Bottom	1838.758	4526.607	720.648	5321.374	2020.856	5594.487
STORY19	RSA	Bottom	3743.712	9253.446	1435.14	11045.79	4104.318	11499.32
STORY18	RSA	Bottom	6237.863	15413.56	2341.429	18623.68	6817.972	19197.26
STORY17	RSA	Bottom	9259.083	22849.81	3419.298	27902.96	10084.29	28484.34
STORY16	RSA	Bottom	12739.82	31413.39	4643.521	38729.76	13820.34	39171.12
STORY15	RSA	Bottom	16610.6	40969.32	5994.185	50953.69	17942.96	51088.73
STORY14	RSA	Bottom	20803.65	51399.75	7454.808	64432.62	22374.15	64091.75
STORY13	RSA	Bottom	25256.37	62604.98	9012.2	79036.38	27045.9	78058.07
STORY12	RSA	Bottom	29914.6	74502.56	10656.09	94649.23	31904.22	92886.46
STORY11	RSA	Bottom	34735.13	87025.02	12378.5	111170.7	36911.72	108492.8
STORY10	RSA	Bottom	39687.4	100117.1	14173.06	128514.8	42048.52	124806.4
STORY9	RSA	Bottom	44754.2	113733	16034.19	146608.1	47311.01	141766.4
STORY8	RSA	Bottom	49930.93	127833.7	17956.38	165386.1	52708.59	159319
STORY7	RSA	Bottom	55223.73	142384	19953.7	184789.4	58258.78	177414.8
STORY6	RSA	Bottom	60646.39	157350.5	21959.49	204759.5	63981.22	196006.7
STORY5	RSA	Bottom	66216.42	172698.5	24026.32	225235.1	69891.51	215045.9
STORY4	RSA	Bottom	71950.88	188389.1	26126.3	246149.2	75995.97	234480.1
STORY3	RSA	Bottom	77862.08	204377.4	28251.55	267427.7	82288	254250
STORY2	RSA	Bottom	83953.81	220611.7	30394.89	288989.7	88746.84	274289.2
STORY1	RSA	Bottom	91273.59	239786.3	32766.72	312931	96005.06	296555



BUILDING MOMENT IN Y DIRECTION

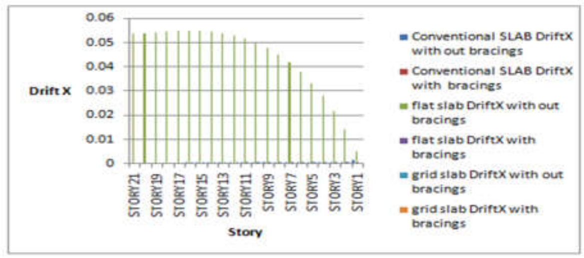
Story	Load	Loc	Conventional SLAB		FLAT SLAB		GRID SLAB	
			MY without bracings	MY with bracings	MY without bracings	MY with bracings	MY without bracings	MY in without bracings
STORY13	RSA	Bottom	707.46	1647.561	354.584	1793.087	857.834	1863.505
STORY12	RSA	Bottom	2257.015	5350.614	1012.774	5974.166	2724.422	6144.951
STORY11	RSA	Bottom	4592.112	10906.93	1852.133	12365.03	5512.702	12590.75
STORY10	RSA	Bottom	7641.033	18104.58	2771.88	20758.96	9114.952	20934.85
STORY9	RSA	Bottom	11524.59	26740.59	3705.682	30937.77	13417.54	30918.52
STORY8	RSA	Bottom	15564.49	36630.03	4619.821	42686.42	18315.25	42304.5
STORY7	RSA	Bottom	20290.36	47606.78	5534.295	55802.82	23720.93	54884.77
STORY6	RSA	Bottom	25444.09	59519.59	6492.308	70100.93	29567.86	68480.45
STORY5	RSA	Bottom	30980.45	72227.41	7548.147	85407.39	35804.34	82934.73
STORY4	RSA	Bottom	36864.07	85595.31	8739.881	101553.7	42382.76	98101.47
STORY3	RSA	Bottom	43063.25	99490.37	10074.34	118366.8	49247.51	113834
STORY2	RSA	Bottom	49541.2	113778.3	11529.36	135664.5	56326.6	129977.9
STORY1	RSA	Bottom	57368.65	130762.3	13226.54	155014.6	64258.5	148018.1



C. HIGH RISE BUILDINGS

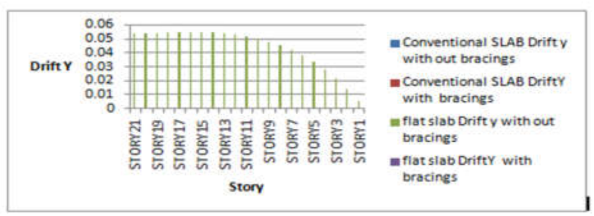
1. STORY DRIFT IN X DIRECTION

Story	LOAD	Conventional SLAB		flat slab		grid slab	
		Drift X without bracings	Drift X with bracings	Drift X with out bracings	Drift X with bracings	Drift X with out bracings	Drift X with bracings
STORY21	RSA	0.00015	0.000207	0.053515	0.00016	0.000158	0.000223
STORY20	RSA	0.00019	0.000216	0.053736	0.000188	0.000202	0.00023
STORY19	RSA	0.000235	0.000226	0.054071	0.000216	0.000251	0.000237
STORY18	RSA	0.000278	0.000234	0.054413	0.000241	0.000296	0.000243
STORY17	RSA	0.000317	0.000242	0.054679	0.000264	0.000337	0.000248
STORY16	RSA	0.00035	0.000249	0.054801	0.000286	0.000372	0.000252
STORY15	RSA	0.000379	0.000254	0.054725	0.000305	0.000402	0.000255
STORY14	RSA	0.000403	0.000257	0.054405	0.000322	0.000426	0.000256
STORY13	RSA	0.000423	0.000259	0.053787	0.000337	0.000445	0.000255
STORY12	RSA	0.000439	0.000259	0.052861	0.00035	0.000461	0.000253
STORY11	RSA	0.000452	0.000257	0.051555	0.000361	0.000475	0.000249
STORY10	RSA	0.000463	0.000254	0.049835	0.000371	0.000487	0.000243
STORY9	RSA	0.000473	0.000248	0.047654	0.000379	0.000499	0.000235
STORY8	RSA	0.000483	0.000241	0.044962	0.000385	0.000511	0.000226
STORY7	RSA	0.000492	0.000232	0.041703	0.000389	0.000523	0.000214
STORY6	RSA	0.000502	0.000221	0.037812	0.000391	0.000534	0.000201
STORY5	RSA	0.000513	0.000208	0.033219	0.000389	0.000544	0.000186
STORY4	RSA	0.000525	0.000193	0.027834	0.000385	0.000549	0.000169
STORY3	RSA	0.000554	0.000174	0.021552	0.000375	0.000544	0.000153
STORY2	RSA	0.000665	0.000154	0.014239	0.000373	0.000511	0.000139
STORY1	RSA	0.001214	0.00016	0.005191	0.000361	0.000323	0.00013



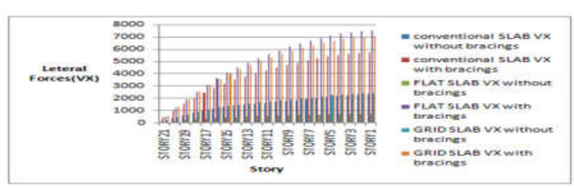
STORY DRIFT IN Y DIRECTION

Story	LOAD	Conventional SLAB		flat slab		grid slab	
		Drift y without bracings	Drift Y with bracings	Drift y without bracings	Drift Y with bracings	Drift Y without bracings	Drift Y with bracings
STORY21	RSA	0.00015	0.000207	0.053515	0.00016	0.000158	0.000223
STORY20	RSA	0.00019	0.000216	0.053736	0.000188	0.000202	0.00023
STORY19	RSA	0.000235	0.000226	0.054071	0.000216	0.000251	0.000237
STORY18	RSA	0.000278	0.000234	0.054413	0.000241	0.000296	0.000243
STORY17	RSA	0.000316	0.000242	0.054679	0.000264	0.000337	0.000248
STORY16	RSA	0.00035	0.000249	0.054801	0.000286	0.000372	0.000252
STORY15	RSA	0.000379	0.000254	0.054725	0.000305	0.000402	0.000255
STORY14	RSA	0.000403	0.000257	0.054405	0.000322	0.000426	0.000256
STORY13	RSA	0.000423	0.000259	0.053787	0.000337	0.000445	0.000255
STORY12	RSA	0.000439	0.000259	0.052861	0.00035	0.000461	0.000253
STORY11	RSA	0.000452	0.000257	0.051555	0.000361	0.000475	0.000249
STORY10	RSA	0.000463	0.000254	0.049835	0.000371	0.000487	0.000243
STORY9	RSA	0.000473	0.000248	0.047654	0.000379	0.000499	0.000235
STORY8	RSA	0.000483	0.000241	0.044962	0.000385	0.000511	0.000226
STORY7	RSA	0.000492	0.000232	0.041703	0.000389	0.000523	0.000214
STORY6	RSA	0.000502	0.000221	0.037812	0.000391	0.000534	0.000201
STORY5	RSA	0.000513	0.000208	0.033219	0.000389	0.000544	0.000186
STORY4	RSA	0.000525	0.000193	0.027834	0.000385	0.000549	0.000169
STORY3	RSA	0.000554	0.000174	0.021552	0.000375	0.000544	0.000153
STORY2	RSA	0.000665	0.000154	0.014239	0.000373	0.000511	0.000139
STORY1	RSA	0.001214	0.00016	0.005191	0.000361	0.000323	0.00013



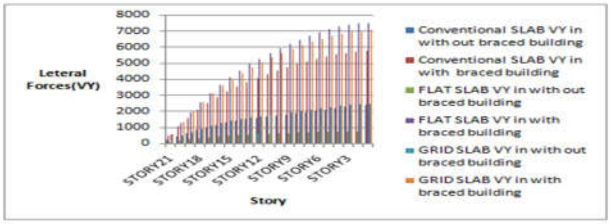
SHEAR FORCE IN X DIRECTION

Story	Load	Loc	conventional SLAB		FLAT SLAB		GRID SLAB	
			VX without bracings	VX with bracings	VX without bracings	VX with bracings	VX without bracings	VX with bracings
STORY21	RSA	Bottom	192.2	462.79	77.56	531.77	211.66	559.7
STORY20	RSA	Bottom	420.73	1043.19	162.71	1242.1	462.03	1281.97
STORY19	RSA	Bottom	635.09	1574.04	237.72	1908.55	684.67	1859.24
STORY18	RSA	Bottom	831.77	2053.75	303.42	2527.35	905.15	2360.65
STORY17	RSA	Bottom	1008.18	2483.54	360.75	3096.66	1090.46	3098.5
STORY16	RSA	Bottom	1163.9	2868.99	410.86	3618.67	1249.41	3577.62
STORY15	RSA	Bottom	1295.83	3209.42	455.01	4089.51	1382.85	4004.72
STORY14	RSA	Bottom	1408.38	3517.06	494.42	4518.9	1495.88	4387.43
STORY13	RSA	Bottom	1503.17	3786.07	530.18	4909.72	1586.63	4733.39
STORY12	RSA	Bottom	1584.11	4053.9	563.18	5267.31	1667.71	5049.43
STORY11	RSA	Bottom	1655.87	4288.91	593.79	5596.78	1743.34	5341.07
STORY10	RSA	Bottom	1723.54	4510.25	622.33	5902.26	1815.28	5612.27
STORY9	RSA	Bottom	1790.88	4717.88	648.61	6188.38	1859.48	5865.31
STORY8	RSA	Bottom	1862.05	4912.55	672.36	6449.95	1885.31	6100.82
STORY7	RSA	Bottom	1938.15	5093.85	692.85	6681.82	2075.38	6317.8
STORY6	RSA	Bottom	2018.81	5260.24	709.88	6900.39	2165.9	6516.71
STORY5	RSA	Bottom	2102.15	5408.58	723.13	7098.92	2251.5	6683.82
STORY4	RSA	Bottom	2183.45	5535.16	732.54	7255.27	2328.31	6828.75
STORY3	RSA	Bottom	2261.27	5635.85	738.39	7377.66	2384.82	6935.31
STORY2	RSA	Bottom	2327.48	5707.55	741.28	7460.57	2422.87	7007.55
STORY1	RSA	Bottom	2375.99	5750.43	742.14	7503.84	2439.35	7032.74



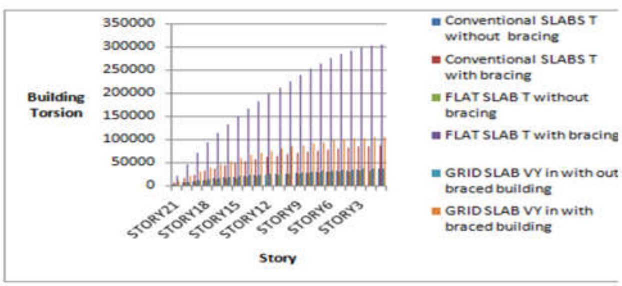
SHEAR FORCE IN Y DIRECTION

Story	Load	Loc	Conventional SLAB		FLAT SLAB		GRID SLAB	
			VY in with out braced building	VY in with braced building	VY in with out braced building	VY in with braced building	VY in with out braced building	VY in with braced building
STORY21	RSA	Bottom	192.2	463.84	77.56	531.77	211.64	564.29
STORY20	RSA	Bottom	420.73	1045.18	162.71	1242.1	462	1300.75
STORY19	RSA	Bottom	635.09	1576.37	237.73	1909.56	694.64	1969.35
STORY18	RSA	Bottom	831.77	2055.86	305.42	2527.35	905.13	2569.48
STORY17	RSA	Bottom	1008.18	2485.03	360.75	3096.68	1090.45	3104.41
STORY16	RSA	Bottom	1162.89	2867.75	410.86	3616.67	1249.42	3580.33
STORY15	RSA	Bottom	1295.84	3209.63	455.01	4089.51	1382.87	4005.22
STORY14	RSA	Bottom	1408.37	3517.07	494.42	4518.9	1492.7	4387.5
STORY13	RSA	Bottom	1503.17	3796.28	530.18	4909.72	1586.65	4734.74
STORY12	RSA	Bottom	1584.12	4052.57	563.13	5267.31	1667.72	5053.03
STORY11	RSA	Bottom	1655.88	4290.06	593.79	5596.78	1743.34	5346.76
STORY10	RSA	Bottom	1723.35	4511.68	622.33	5902.27	1819.28	5618.9
STORY9	RSA	Bottom	1790.98	4719.25	648.61	6186.38	1899.47	5871.33
STORY8	RSA	Bottom	1862.05	4913.6	672.26	6449.93	1985.31	6105
STORY7	RSA	Bottom	1938.14	5094.47	692.83	6691.81	2075.39	6319.76
STORY6	RSA	Bottom	2018.91	5260.38	709.88	6909.39	2165.9	6514.08
STORY5	RSA	Bottom	2102.19	5408.59	723.13	7098.91	2251.5	6684.89
STORY4	RSA	Bottom	2184.45	5535.31	732.54	7256.27	2326.3	6827.92
STORY3	RSA	Bottom	2261.27	5636.36	738.39	7377.66	2384.81	6938.5
STORY2	RSA	Bottom	2327.48	5708.35	741.28	7460.57	2422.87	7012.77
STORY1	RSA	Bottom	2376.88	5751.59	742.14	7503.81	2438.36	7048.15



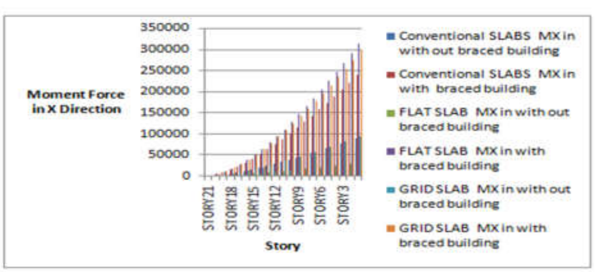
BUILDING TORSION

Story	Load	Loc	Conventional SLABS		FLAT SLAB		GRID SLAB	
			T without bracing	T with bracing	T without bracing	T with bracing	VY in with out braced building	VY in with braced building
STORY21	RSA	Bottom	2855.978	6976.179	2827.136	19582.61	3142.789	8444.523
STORY20	RSA	Bottom	6247.465	15688.46	5933.935	45277.97	6860.451	19439.72
STORY19	RSA	Bottom	9430.456	23605.5	8681.401	69591.65	10314.98	29387.13
STORY18	RSA	Bottom	12351.06	30706.16	11107.96	92214.25	13440.55	38280.55
STORY17	RSA	Bottom	14970.66	37026.37	13263.27	113128.1	16192.32	46182.23
STORY16	RSA	Bottom	17268.12	42647.31	15205.04	132411.8	18552.88	53205.65
STORY15	RSA	Bottom	19242.45	47678.73	16891.83	150234.3	20534.48	59481.71
STORY14	RSA	Bottom	20913.43	52225.86	18674.3	166830.4	22180.36	65151.94
STORY13	RSA	Bottom	22321.08	56389.28	20288.71	182460.7	23580.54	70326.87
STORY12	RSA	Bottom	23523.04	60234.38	21844.85	197361.5	24784.39	75085.15
STORY11	RSA	Bottom	24588.56	63802.46	23347.19	211701.2	25887.31	79476.55
STORY10	RSA	Bottom	25590.41	67117.42	24777.32	225554.4	27014.86	83531.05
STORY9	RSA	Bottom	26594.65	70195.93	26110.73	238895.2	28205.75	87270.81
STORY8	RSA	Bottom	27650.01	73052.57	27317.32	251606.9	29480.4	90714.28
STORY7	RSA	Bottom	28779.06	75697.14	28368.54	263500.9	30817.9	93871.54
STORY6	RSA	Bottom	29979.25	78126.06	29240.97	274541	32161.88	96734.15
STORY5	RSA	Bottom	31215.92	80313.42	29920.5	283870.8	33433.07	99266.48
STORY4	RSA	Bottom	32437.43	82208.08	30405.51	291841.3	34543.89	101406.3
STORY3	RSA	Bottom	33578.12	83741.57	30709.12	298034.7	35412.8	103077.2



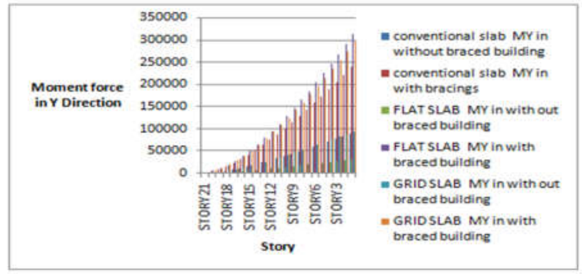
BUILDING MOMENT IN X DIRECTION

Story	Load	Loc	Conventional SLABS		FLAT SLAB		GRID SLAB	
			MX in with out braced building	MX in with braced building	MX in with out braced building	MX in with braced building	MX in with out braced building	MX in with braced building
STORY21	RSA	Bottom	576.611	1391.512	232.691	1595.315	634.931	1692.88
STORY20	RSA	Bottom	1838.756	4526.607	720.648	5521.374	2020.856	5594.487
STORY19	RSA	Bottom	3743.712	9253.446	1433.14	11045.79	4104.318	11499.32
STORY18	RSA	Bottom	6257.865	15415.56	2341.429	18623.68	6817.972	19197.26
STORY17	RSA	Bottom	9259.083	22849.81	3419.298	27902.96	10084.26	28484.34
STORY16	RSA	Bottom	12739.82	31413.59	4643.521	38729.76	13820.34	39171.12
STORY15	RSA	Bottom	16610.6	40969.32	5994.185	50953.69	17942.96	51088.73
STORY14	RSA	Bottom	20803.65	51599.75	7454.808	64432.62	22574.15	64091.75
STORY13	RSA	Bottom	25256.37	62604.98	9012.2	79036.38	27045.9	78058.07
STORY12	RSA	Bottom	29914.6	74502.56	10656.09	94649.23	31904.22	92886.46
STORY11	RSA	Bottom	34735.13	87025.02	12378.5	111170.7	36911.72	108492.8
STORY10	RSA	Bottom	39687.4	100117.1	14173.06	128514.8	42048.52	124806.4
STORY9	RSA	Bottom	44754.2	113733	16034.19	146608.1	47311.01	141766.4
STORY8	RSA	Bottom	49930.93	127832.7	17956.38	165386.1	52708.59	159319
STORY7	RSA	Bottom	55223.73	142384	19933.7	184789.4	58258.78	177414.8
STORY6	RSA	Bottom	60648.39	157350.3	21959.49	204759.5	63981.22	196006.7
STORY5	RSA	Bottom	66218.42	172698.5	24026.32	225235.1	69891.51	215045.9
STORY4	RSA	Bottom	71950.88	188389.1	26126.3	246149.2	75995.97	234480.1
STORY3	RSA	Bottom	77862.08	204377.4	28251.55	267427.7	82288	254250
STORY2	RSA	Bottom	83953.81	220611.7	30394.88	288989.7	88746.84	274289.2
STORY1	RSA	Bottom	91273.59	239786.3	32766.72	312931	96005.06	296555



BUILDING MOMENT IN Y DIRECTION

Story	Load	Loc	conventional slab		FLAT SLAB		GRID SLAB	
			MY in without braced building	MY in with bracings	MY in with out braced building	MY in with braced building	MY in with out braced building	MY in with braced building
STORY21	RSA	Bottom	576.596	1388.373	232.691	1595.311	634.983	1679.086
STORY20	RSA	Bottom	1838.74	4517.521	720.647	5521.359	2020.989	5554.425
STORY19	RSA	Bottom	3743.69	9237.465	1433.139	11045.76	4104.537	11429.39
STORY18	RSA	Bottom	6257.836	15391.6	2341.428	18623.64	6818.265	19102.53
STORY17	RSA	Bottom	9259.063	22824.27	3419.297	27902.93	10084.61	28376.25
STORY16	RSA	Bottom	12739.84	31387.41	4643.521	38729.73	13820.63	39063.88
STORY15	RSA	Bottom	16610.65	40945.95	5994.186	50953.68	17943.19	50995.33
STORY14	RSA	Bottom	20803.71	51381.21	7454.808	64432.62	22374.29	64020.81
STORY13	RSA	Bottom	25256.43	62592.24	9012.2	79036.39	27045.97	78012.22
STORY12	RSA	Bottom	29914.62	74495.28	10656.09	94649.23	31904.24	92862.66
STORY11	RSA	Bottom	34735.1	87021.88	12378.5	111170.7	36911.74	108484.3
STORY10	RSA	Bottom	39687.34	100116.4	14173.06	128514.8	42048.56	124805.2
STORY9	RSA	Bottom	44754.13	113733.1	16034.19	146608	47311.07	141766.2
STORY8	RSA	Bottom	49930.87	127833.5	17956.38	165386	52708.67	159316.2
STORY7	RSA	Bottom	55223.7	142383.2	19933.7	184789.4	58258.88	177409.3
STORY6	RSA	Bottom	60646.38	157349.4	21959.49	204759.5	63981.32	196000.1
STORY5	RSA	Bottom	66216.45	172697.4	24026.32	225235.1	69891.6	215040.6
STORY4	RSA	Bottom	71950.92	188388.5	26126.3	246149.2	75996.03	234477.3



V. CONCLUSIONS

The analysis of slab system shows the following inferences:

- The quantity of concrete required for grid slab multi story building is maximum and for the flat slab multi story building is minimum for the same span/ grid size. But when we talk about the conventional slab system the quantity of concrete required more than the flab slab multi story building.
- The maximum displacement is found to be most for flat slab system for same plan area of the structure and it is followed by grid slab and least for flat slab and flat slab with bracings also shows least values.
- The grid shows the least values in the building torsion and in the flat slab without bracings are also less and best suitable structure to over come the building torsion is grid slab with the bracings.
- The grid slab with out bracings has less moment values as compared to the other type of the structure , and due to resistant offered by the bracings the moment forces are maximum in the grid slab and flat slab.
- The comparing the flat slab and grid slab the best suitable structure in the low ,medium . and high rise construction is flat with bracings and grid slab with bracings as well.

- The best suitable as compared to one other the best suitable structure is flat slab with bracings.
- Response Spectrum Analysis (RSA) is an elastic method of analysis and lies in between equivalent force method of analysis and nonlinear analysis methods in terms of complexity
- RSA is based on the structural dynamics theory and can be derived from the basic principles (e.g. Equation of motion).
- Damping of the structures is inherently taken into account by using a design (or response) spectrum with a predefined damping level.
- ETABS is very essential tool to analyze the structure, and very fast and accurate results can be obtained .

Considering all the above inference made on analysis of all considered slab system multi story building, we finally conclude that the grid slab is most economical for all span consider in the analysis. In grid slab system it is found from the study that maximum displacement, maximum force and maximum bending moment in x, y and z direction is minimum but in case of flat slab system maximum displacement, maximum force and maximum bending moment is found to be maximum.

The quantity of steel and concrete required for flat slab system is minimum but for the grid slab system is maximum.

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