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Seismic Evaluation of Dome Structure for Different Zones

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ABSTRACT

'Dome' is a component of architecture that bears a resemblance to a void upper part of a sphere. It is erected using an assortment of materials which will have a longer 'architectural- lineage' that will extend into prehistory. It may be also defined as a thin- shell that is generated by the revolving a normal curve about one of its common axis. The outline of the dome depends on the type of the 'curve' & the path of revolving axis. When the part of a 'regular curve' orbits about its own vertical diameter, a spherical geometrical shape is generated. These structures are used in various kinds of structures like circular shaped roof, circular shaped tanks, exhibition halls, auditorium areas, bottom part of tanks & bunkers. With the introduction of monolithic- domes wide applications were done in many subdivisions of engineering & technology. From the view point of an architect, the growth of dome proffers unexpected opportunities & openings for the combinations of awareness of functional plus economic & also aesthetic facets. Energy-efficiency of any building designs need a consideration and is it lofty in this type monolithic dome component. A monolithic cast dome is a structure component that is cast in a 'one-piece' form. The form work may be permanent as well as temporary & mayor may not stay as a part of the final structure. Monolithic is bestowed to improve individual's lives globally. By bringing in & casting monolithic Domes for both personal as well as public use that are calamity resistant, 'energy efficient' & also cost- effective.

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INTRODUCTION

Domès 1st came into viewed as solid-mounds & in tèchniques that is adaptablè only for a smallèst sizèd building like round shapèd huts & tombs in thè anciènt times in Middle East and India and also in Mèditerranean. The Románs brought in the 'largèr sixed' masonry hèmi-sphere or domès& the original monumental samplè like the Roman Panthèon needed a hèavy and strongsupporting wall.

'Byzantine' architècts inventèd a procedure to raisè theses domès on piers by lètting lighting & communication from all the 4 dirèctions. The changè from a cubical support to the hèmispherical shapèd domè was accomplishèd by 4 pendent, invèrted triangular set of masonry massès that is vertically as wèll as horizontally curvèd. Their bottoms were placèd on the 4 vèrtical columns to which forcès from the domè they conducted, their sidès were connected so that archès are crèated over available opènings between thèse columns on the 4 sidès of thè cubè and thèir bottoms were madè such a way that thèy make a complète circle that acts as a foundation for the domè. The pendant- domè could be placed on its circular foundation dirèctly or on a cylindrical shapèd wall which is callèd as drum which is insèrted in bètween the twò to augment height.

Displaced by thè light architecturally,. Vèrtical stylès of Gothic-architècture the domè rèsumed attractivèness during the 'Europèan Renaissance' & 'Baroque times'. The yèarning to observe convèntion protected the domè in thè èarlier iron & steel time. The contèmporary R,C slab usèd in the vaulting & domès had vanished from its unusual worth bèing based barèly on the type of bènd in the slab. In thiś- study thè 'Gèodesic' Domè is analyzed & it is built-up of triangulár & polygonál plates thát contributè in the distributiòn of strèsses within thè structure. It is erected as a 'load bearing' structure with the stabilising componènts that can uphold both horizontal

& vèrtical loads. The structurè must be strong & satisfactorily designèd against any structural failurè, cracks& damaging dèformations.

Objectives of the Study

The key/main goal of the wòrk is to analyse a domè structurè such as shèll structure, ring-beam,column & the reactions at base-level.

1. To study & analyse Monolithic-Concrete Domè using STAAD-Pro.
2. To analysè the model for zone ─II & V carrying load likes dèad, lìve and seìsmicload.
3. To create two models & compare for zone ─II & V by provìding bracìngs to keepthe dìsplacement within the lìmit.

DEFINING THE PROBLEM

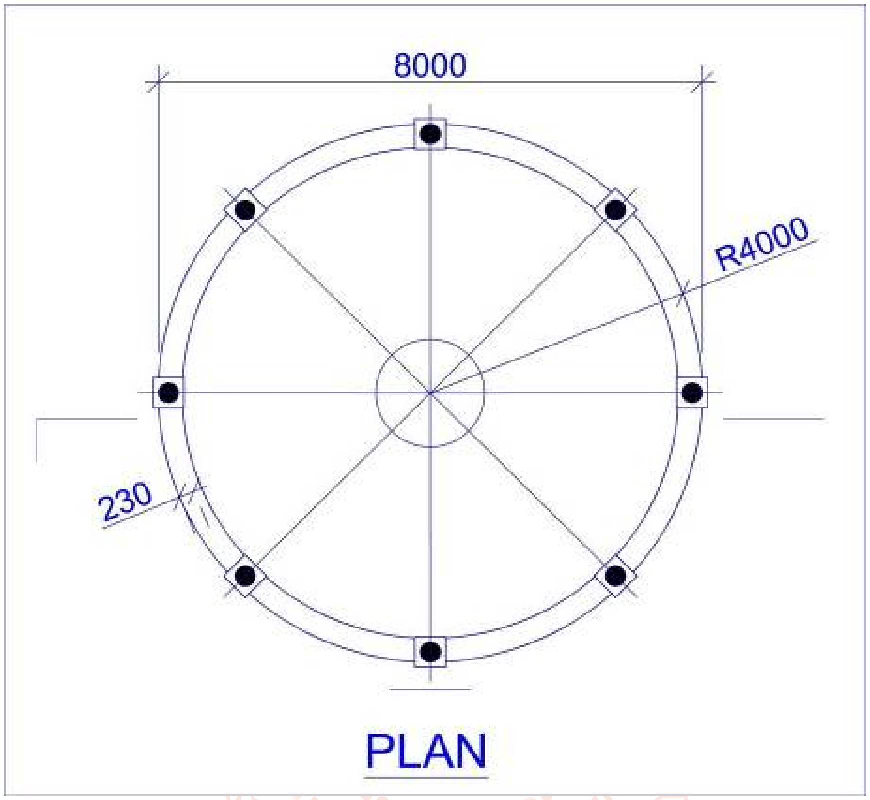


Figure 1 Dome plan dimension

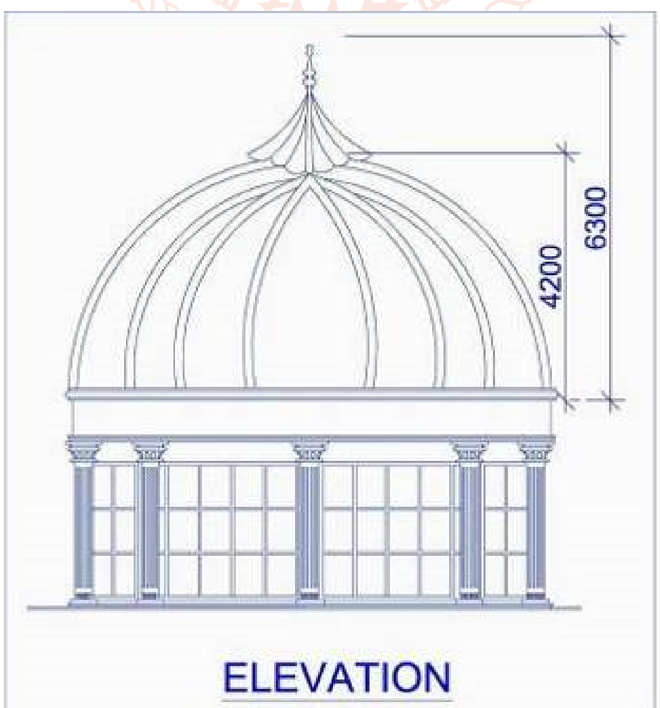


Figure 2 dome elevation & heights

METHODOLOGY

The 'meditation hall' domè is analyzed and then check designed is carried out. All the members are designed with the column as fixed. The methodology followed for this domè & their components design are shown below.

1. CREATING THE DRAWING AS PER THE DIMENTION NEEDED
2. CREATING THE MODEL IN STAAD AS PER THE CAD
3. CREATE & APPLYING THE MATERIALS
4. APPLYNG THE END CONDITIONS AT BASE
5. GENERATNG THE PRIMRY LOADS AND THEIR COMBINATIONS
6. APPLYNG THESE PRIMRY LOADS
7. PERFORMING THE ANALYSIS
8. PERFORMING DESIGN OF SHELL TO ENSURE SECTIONS ARE ENOUGH
9. DESIGN OF ŔING BEAM TO ENSURE SECTIONS ARE ENOUGH
10. DESIGN OF COLUMN TO ENSURE SECTIONS ARE ENOUGH

RESULTS AND DISCUSSION

Absolute displacement in X

In STAAD Pro, absolute displacement is a value that can be specified as a displacement control for the first analysis step.

Table 1 Absolute Displacement

Absolute Displacement, mm		
1.20(Dead+Lat-Load-X)		
Node	Zone--II	Zone--V
131	4.042	4.575
144	4.039	4.572
118	4.035	4.573
157	4.024	4.564
105	4.015	4.565
170	3.997	4.551
92	3.985	4.553
183	3.96	4.534
79	3.944	4.536
196	3.913	4.513
66	3.893	4.515
209	3.857	4.488
53	3.835	4.491
222	3.794	4.461
40	3.769	4.464
235	3.725	4.433
27	3.699	4.435
248	3.653	4.301
13	3.625	4.306
14	3.614	4.306
261	3.578	4.273
469	3.55	4.276
274	3.504	4.145
456	3.477	4.147
287	3.432	4.018
443	3.407	4.032
300	3.365	4.013
430	3.343	3.95

313	3.306	3.902
417	3.287	3.914
326	3.257	3.906
404	3.242	3.857
339	3.219	3.643
391	3.209	3.644
352	3.195	3.536
378	3.189	3.636
365	3.185	3.833

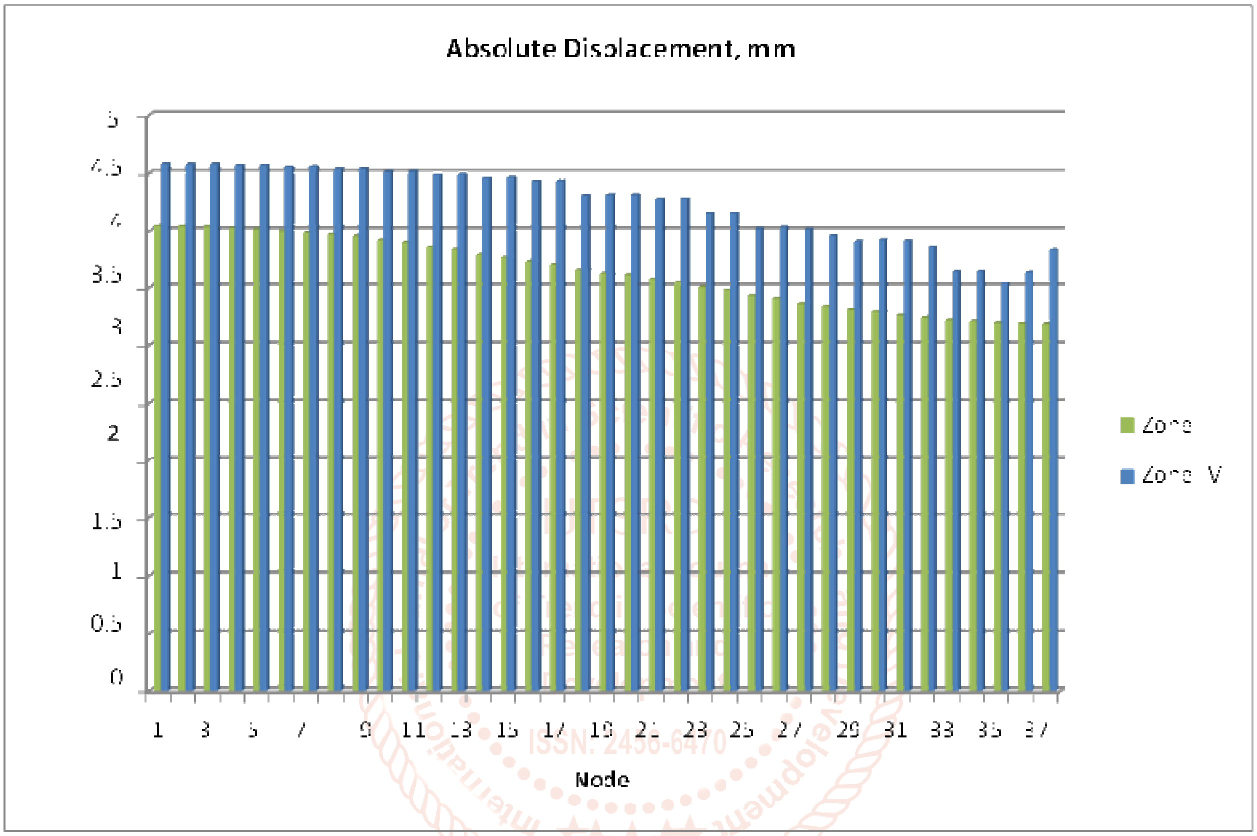


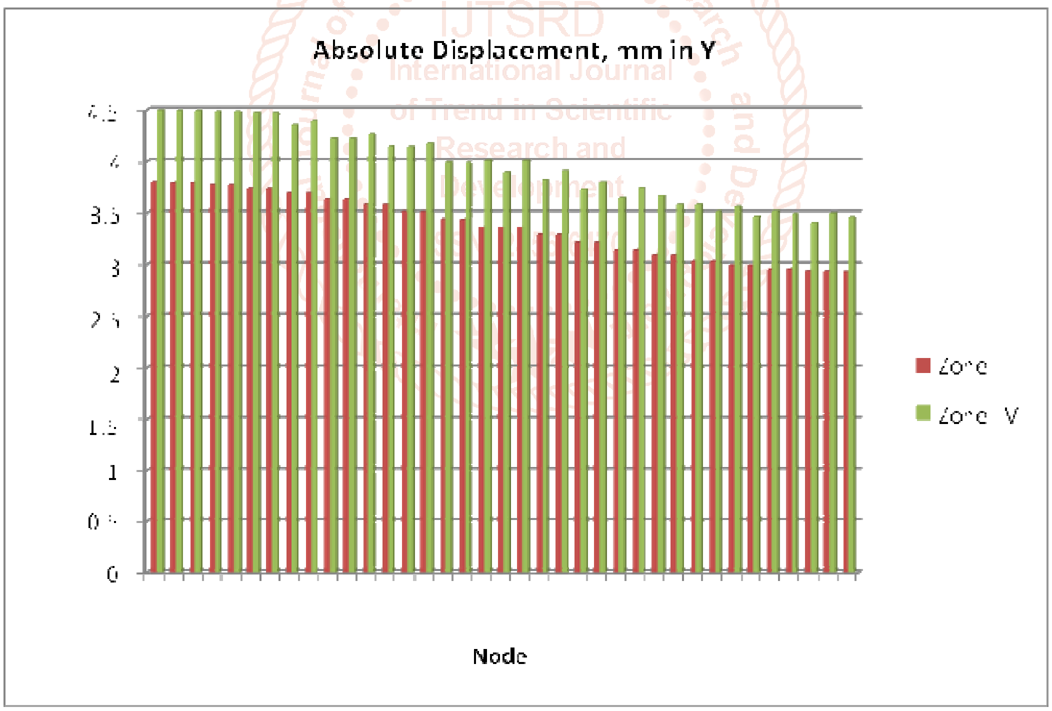
Figure 2 Absolute Displacement Chart in x

Absolute Displacement in Y

Table 2 Absolute Displacement in Y

Absolute Displacement, mm		
1.20(Dead+Lat-Load-Y)		
Node	Zone--II	Zone--V
13	3.798	4.494
469	3.791	4.492
27	3.791	4.491
456	3.772	4.484
40	3.771	4.483
443	3.741	4.472
53	3.739	4.471
430	3.698	4.36364
66	3.696	4.39824
417	3.644	4.22704
79	3.642	4.22472
404	3.583	4.26377
92	3.58	4.1528
391	3.515	4.1477

105	3.512	4.17928
378	3.442	3.99272
118	3.439	3.98924
365	3.367	4.00673
131	3.364	3.90224
14	3.366	4.00554
352	3.292	3.81872
144	3.289	3.91391
339	3.219	3.73404
157	3.216	3.79488
326	3.15	3.654
170	3.148	3.74612
313	3.088	3.67472
183	3.086	3.57976
300	3.035	3.5813
196	3.033	3.51828
287	2.992	3.56048
209	2.99	3.4684
274	2.959	3.52121
222	2.959	3.49162
261	2.94	3.4104
235	2.939	3.49741
248	2.933	3.46094



Base reactions

Table 3 Base Reaction in X

Base Reaction in X		
1.20(Dead+Lat-Load-X)		
Node	Zone--II	Zone--V
470	6.077	7.544
471	17.316	21.805
472	26.07	30.93
473	20.199	26.249
474	6.24	8.524

475	17.2	24.027
476	15.81	24.261
477	19.4	23.32

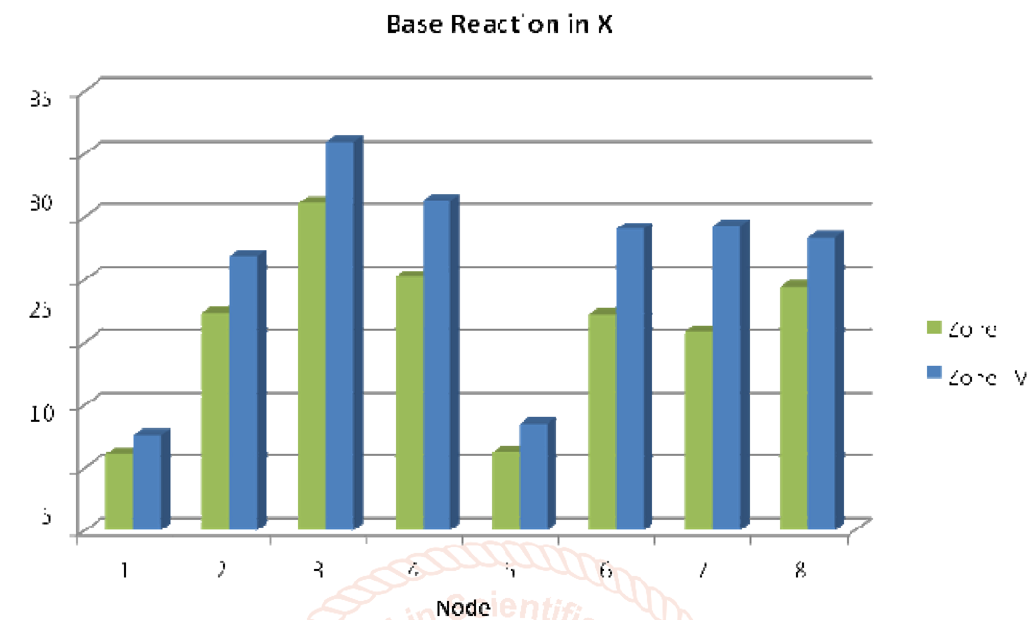
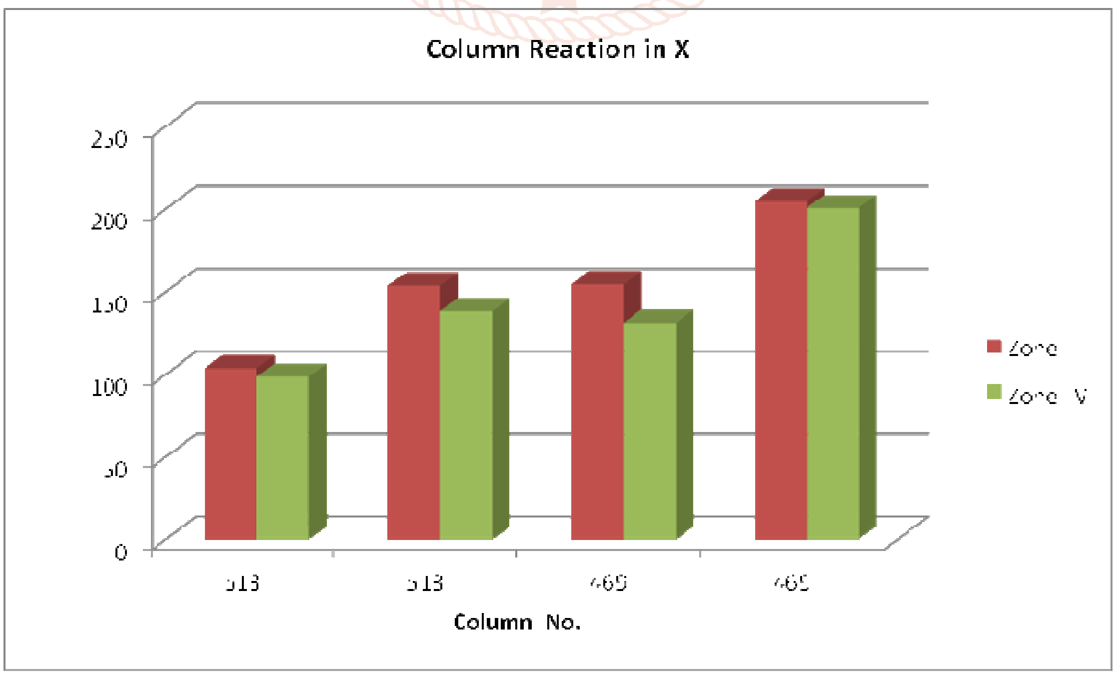


Figure 4 Base Reaction in X Chart

Table 4 Column Reaction in X

Column Reaction in X			
1.50(Dead+Lat-Load-X)			
Beam	Node	Zone--II	Zone--V
513	1	103.913	98.7173
513	478	153.877	138.489
469	478	154.77	131.554
469	470	204.734	200.639



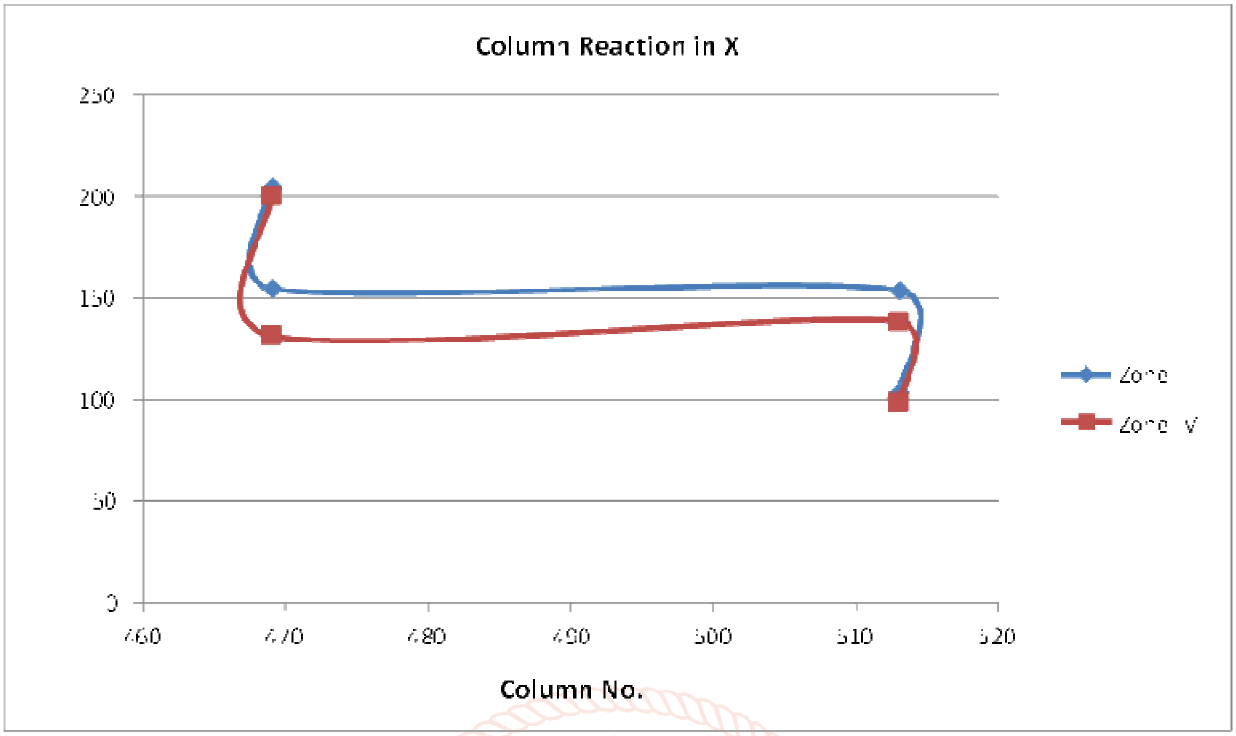
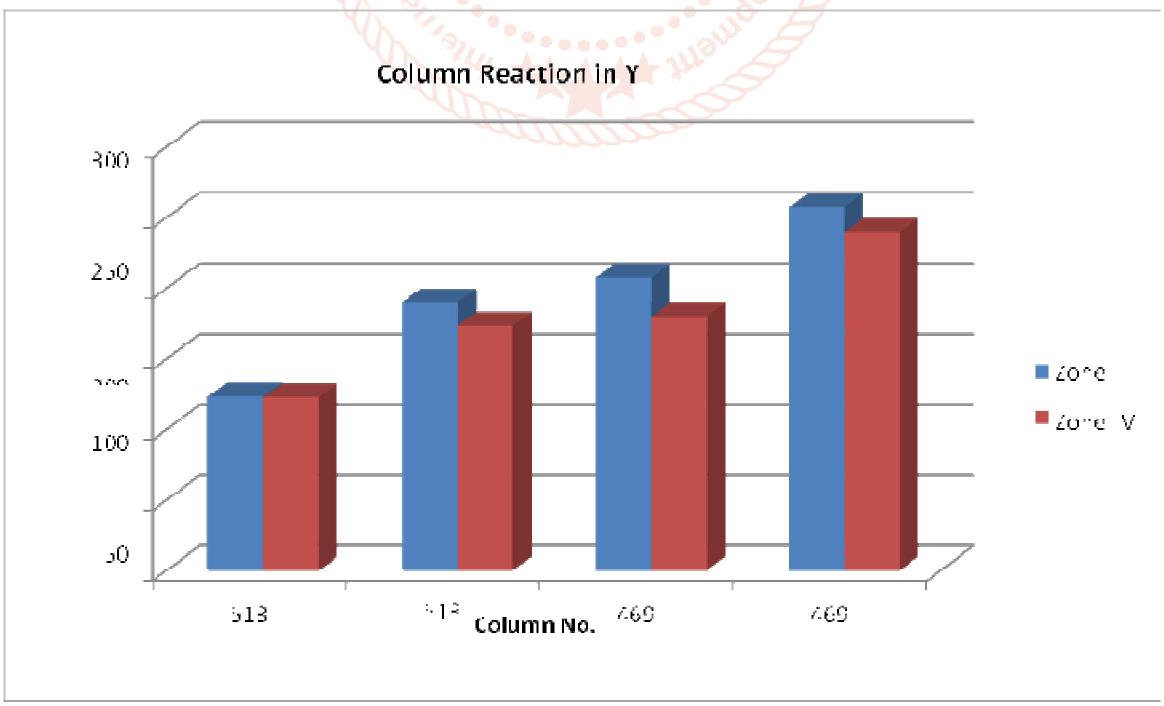
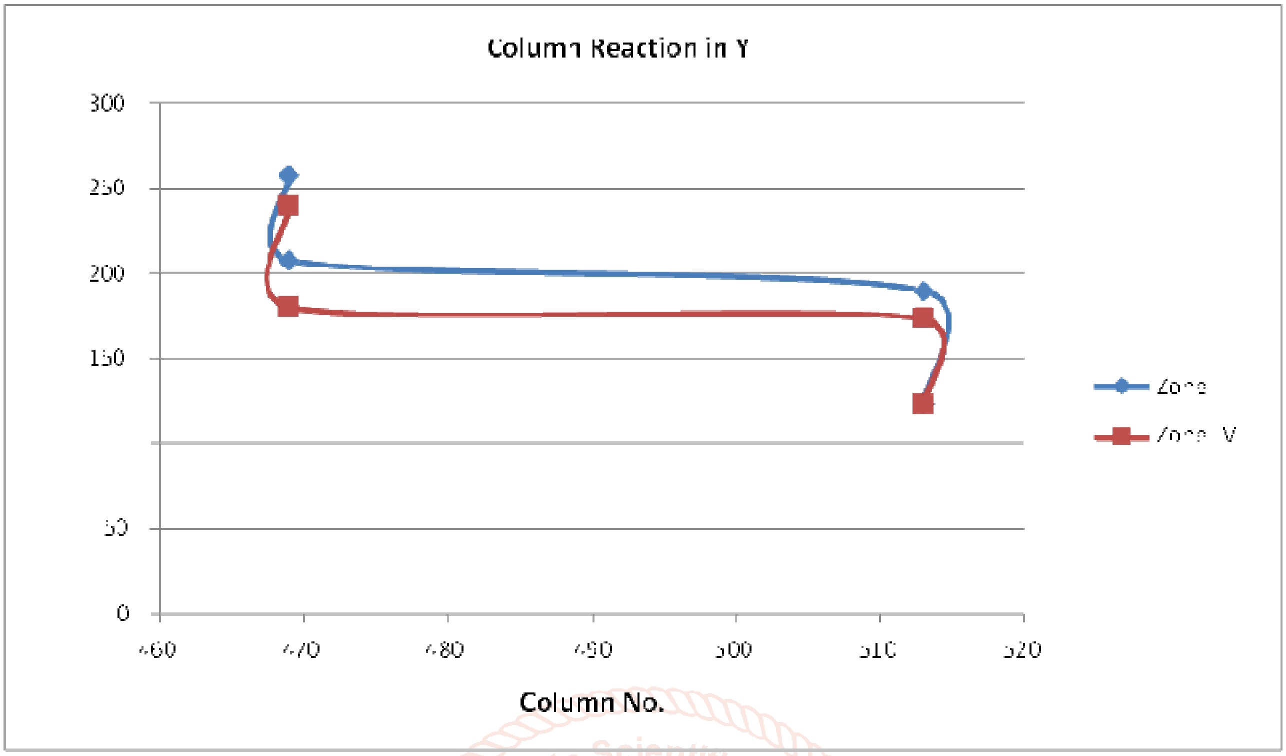


Table 5 Column Reaction in Y

Column Reaction in Y			
1.50(Dead+Lat-Load-Y)			
Beam	Node	Zone--II	Zone--V
513	1	123.299	122.764
513	478	189.75	173.264
469	478	207.498	179.938
469	470	257.463	239.714





CONCLUSION

We analyzed monolithic RC Domès as per the standard codes and conclusions were drawn as below.

For model in zone ─II when analyzed various analysis results like drift, displacement etc were checked and found to be within the limits. However, these were slightly crossing acceptable limits in zone ─V. The reason for this is rise in seismic intensity. To take care of this, bracings were added as shown above and we were able to bring the results down below the recommended limits. Below we have explained the results with their values

From the above results it is observed that the average lateral Displacement (X) is found to be more for zone ─V model (4.22 mm) which is 3.63 mm zone ─II model and in Y directionit is 3.96 mm for zone ─V then 3.37 mm for zone ─II model. So both in X & Y value is more forzone ─V model (X dir - 17% more and Y dir - 18 % more than zone ─II model). However, it is still within the allowed limit.

Similarly the base reaction for zone ─V model in x is 20.83 kN (avg.) and in Y it its 9.69 kN (avg.). For zone ─II it is 16.04 kN (avg.) in X & 8.54 kN (avg.) in Y. Percentage wise in X it is 31.1% more & in Y the same is 28% for zone ─V model than zone ─II model.

The stress observed are slightly more in case of zone ─V model than the one in zone ─II for the obvious reason that the intensity of earthquake is more. However, this can be addressedin design part as these are not beyond permissible limit.

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