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Analysis of Geodesic dome structure

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Abstract - *Domes are a type of ambient structure that dates back to the A.D. period and is designed to extract a great amount of volume from the construction. Domes are typically intended to distribute consistent loads across the plates.*

In these study, the concrete dome structure was analyzed & design using both E-tab with the help of Autocad. There were two separate dome designed as well as analysed named as Dome-A & Dome –B and they both compared with respect to displacement. The assumed dimension for dome-A are central rise 4m, diameter 8m, support beam 230x250,slab thickness 110 where as for dome-B are central rise 6m,diameter 12m,support beam 230x250,slab thickness 110. The dome structure was analyzed to carry dead load varying live load & wind load for wind speed 39 km/s over nodal joints. Final result obtained from E-tab software export in Microsoft excel and separate spreadsheet and their respective graphs were prepared.

Key Words: **Domes, Design, E-Tab, Autocad, Loads.**

1. INTRODUCTION

One of the most basic types of structures, the geodesic dome has a very distinctive spherical or partially globular shape. To create its multiple stable triangle rudiments and to provide resistance to the gravitational, wind, and seismic stresses, the structure's shell is made up of a number of unstable and straight structural components. The geodesic dome has the ability to reach vast spans without the use of internal supports, walls that support the weight of the cargo, deep shafts, or trusses; instead, the load is distributed unevenly across the face of the dome. On the other hand, a traditional structure would require more room and material to attain a bigger span, and the conventional form may have difficulties with deviation control and bracing demands. However, the geodesic is actually very effective.

1.1 ADVANTAGES OF GEODESIC DOME STRUCTURE

Geodesic dome can withstand with harsh weather and natural disasters. People choose these structures because these structures are more energy and cost-efficient than standard square dwellings. The Dome form is very useful for slippery rudiments such as snow and wind. Because of the high volume to face area ratio, fewer construction accessories are needed, and more room is available inside the structure. Geodesic polls are superior to square homes from an engineering standpoint. They're the only man-made structure that grows in strength proportionally as it grows in size. They're also smaller, lighter, and have better structural integrity. Geodesic polls made of bio-ceramic are also fire-resistant to a significant extent.

1.2 EFFICIENCY OF GEODESIC DOME STRUCTURE

Geodesic Domes are useful structures in a variety of ways :

They're built around a network of triangles that are extremely stable. If a force is applied to the corner of a triangle, however, it will preserve its shape, unlike other shapes. Geodesic Dome structures are therefore strong and resistant to stresses such as snow loads, earthquakes, and wind. Geodesic domes have a lesser material bearing capacity than conventional constructions due to their structural effectiveness. Geodesic domes have a substantially smaller face area than traditional 'box-shaped' buildings for the volume they encompass. As a result, the area exposed to external temperature variations is minimised, making them less expensive to heat and cool.

2. SYSTEM DEVELOPMENT

2.1 Data Input

Specification for Dome –A : Diameter-8m,Central Rise-4m

Specification for Dome –B : Diameter-12m,Central Rise-6m

Constant data for both dome : Support beam-230x250,Grade of steel-Fe250,Fe415,Grade of concrete-M30,Slab thickness-110mm,Shell division in 30 parts.

2.2 ASSUMPTION

In order to determine the loading on the structure, the following assumptions were made based on conservative and reasonable considerations. a)The connections of the structure were assumed to be frictionless and will not carry any moment. The structure was treated as 3D space Dome. b)The boundary conditions assume that the all the ground level nodes were fully fixed. c)Load combination through envelope : (D.L+L.L)+Wind d)Support Beam dimension : 230x250The basic wind pressure was equivalent to a high wind zone which equivalent to 39m/s.

2.3 STEPWISE DESIGN PROCEDURE

For design & analysis of dome structure following procedure can adopt : 1)Open Autocad software and simply draw a circle having a specific radius .(Here we assume radius of circle as 4m & 6M). 2)Draw a line along a dia of circle which divide circle into two hemisphere. 3)Trim the half circle which is below the line. 4)Divide the arc of circle into 30 equal part. 5)Save the file in dxf. Format in folder. And close overall autocad software. 6)Open E tab software and define the various code reqd. which we have to use in construction. 7)Take a simple blank sheet , Because Grid patter cannot read 3D drawing. 8)Import the file through DXF file of 3D model. 9)Convert single beam into shell through radial extrude.(Take angle=10 ^{0} & Number =20) 10)Define dead load And Live load of 1 & 1.5 KN/m^2 respectively in addition with wind speed for region wise. 11)Define Slab of 110 mm thikness. 12)Apply various load defined previously. 13)Do Run analysis.(After Run analysis shape of dome become compressed.)

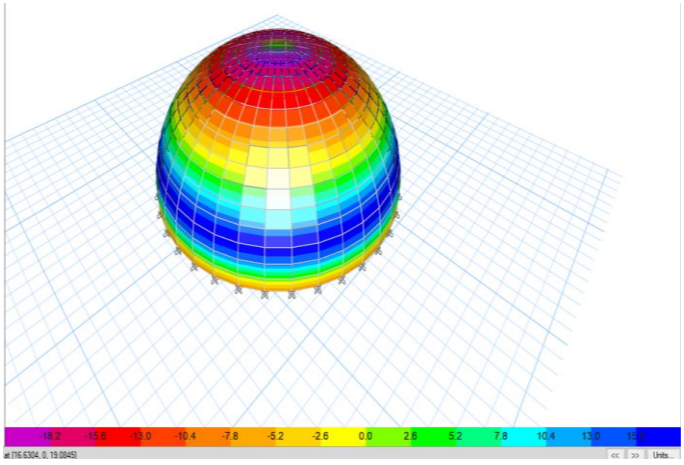


Fig.1 Final 3D model of dome.

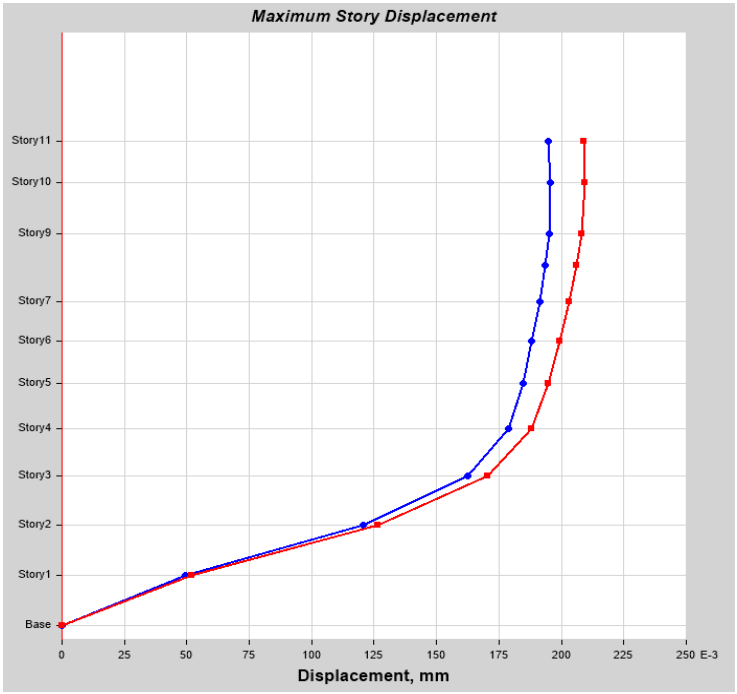
2.4 PERFORMANCE ANALYSIS

2.4.1) For Dome –A

Maximum Story Displacement Dome

Story	Elevation	Location	X-Dir	Y-Dir
	m		mm	mm
Story11	14.1111	Top	0.195	0.209
Story10	13.7652	Top	0.196	0.209
Story9	13.3471	Top	0.195	0.208
Story8	13.0836	Top	0.194	0.206
Story7	12.7876	Top	0.191	0.203
Story6	12.4622	Top	0.188	0.199
Story5	12.1111	Top	0.185	0.195
Story4	11.738	Top	0.179	0.188
Story3	11.3471	Top	0.162	0.17
Story2	10.9427	Top	0.121	0.126
Story1	10.5292	Top	0.049	0.052
Base	10.1111	Top	0	0

TABLE 1. Maximum Story Displacement Dome - A



GRAPH 1. Maximum story Displacement for dome-A

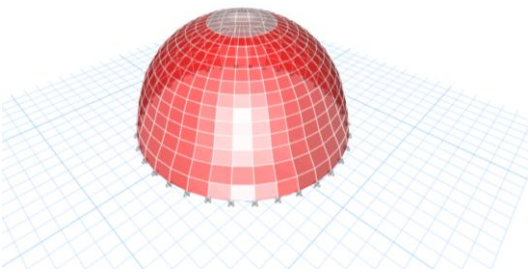


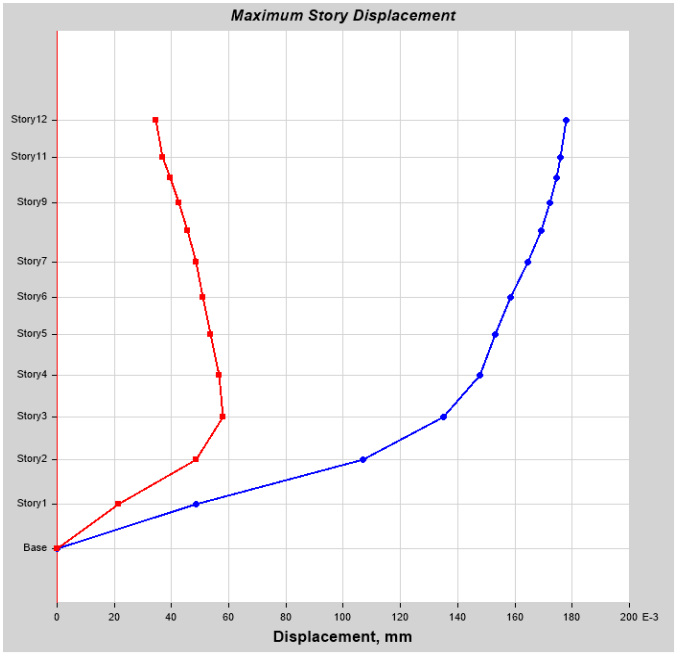
Fig 2. Deformed shape of Dome –A after analysis

2.4.2) For Dome –B

Maximum Story Displacement Dome

Story	Elevation	Location	X-Dir	Y-Dir
	m		mm	mm
Story12	16.3476	Top	0.178	0.035
Story11	15.8289	Top	0.176	0.037
Story10	15.5437	Top	0.175	0.04
Story9	15.2017	Top	0.172	0.043
Story8	14.8064	Top	0.169	0.046
Story7	14.3624	Top	0.164	0.048
Story6	13.8743	Top	0.158	0.051
Story5	13.3476	Top	0.153	0.053
Story4	12.788	Top	0.148	0.057
Story3	12.2017	Top	0.135	0.058
Story2	11.595	Top	0.107	0.049
Story1	10.9747	Top	0.048	0.022
Base	10.3476	Top	0	0

TABLE 1. Maximum Story Displacement Dome - B



GRAPH 2. Maximum story Displacement for dome-B

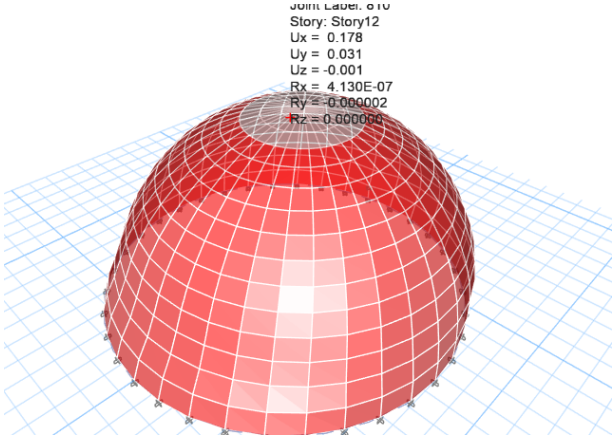
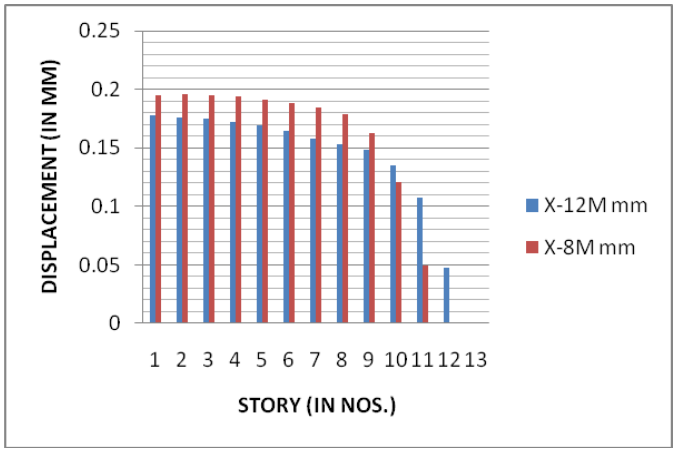


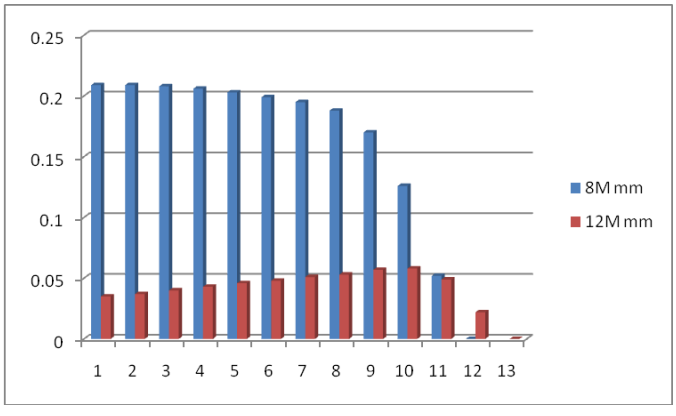
Fig 2. Deformed shape of Dome –B after analysis

Displacement in X- direction



GRAPH 2. Displacement in X- direction

Displacement in Y- direction



GRAPH 2. Displacement in Y –direction

3. CONCLUSIONS

- Displacement (in X- direction) in dome having less diameter and central rise found more as compared to dome having more diameter.
- Displacement (in Y- direction) in dome having less diameter and central rise found more as compared to dome having more diameter.
- In above both condition , we conclude that dome having larger diameter & central rise has less displacement, It is because small size & diameter dome behaves like segmental arch type dome while large size & diameter behaves like catenary arch type dome.

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