EARTHQUAKE ANALYSIS OF DIFFERENT CONFIGURATION OF STEEL DOMES USING COMPUTER PROGRAMME

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Abstract

Domes are one of the oldest magnificent structural systems. They consist of one or more layers of elements that are arched in all directions. Domes are used to cover large areas such as exhibition halls, stadium and concert halls. In this paper one double-layer steel and two single-layer steel common types of lattice domes have been studied under gravity and earthquake load. The domes have span of 50m, and their height-to-span ratio is 1/2. Here, domes have been analyzed statically under self-weight. Also, for earthquake loads equivalent Seismic Co-efficient and Response Spectrum Analysis (RSA) methods have been employed according to IS 1893:2002. All the three types of steel dome being analyzed by Seismic Co-efficient Method and Response Spectrum Method for Base shear and Modal time periods. Each analysis should be carried out in structural software SAP2000 v18.

Keywords: *Seismic Co-efficient Method, Response Spectrum Method, SAP2000, Lattice Dome*

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1. INTRODUCTION

Domes are among the oldest forms of three-dimensional structural systems. The earliest record of the existence of a dome was found on an Assyrian bas-relief discovered in the ruins of a palace of Senna-cheribbo in Nineveln around 705 - 681 B.C. (Makowski, 1984) This relief showed a group of buildings covered with both sharply pointed and circular dome structures[3]. They consist of one or more layers of elements that are arched in all directions. Domes are used to cover large areas such as exhibition halls, stadium and concert halls. They provide a completely unobstructed inner space and economy in terms of materials. They are lighter compared with the more conventional forms of structures. Structural systems, which enable the designers to cover large spans, have always been popular during the history. Beginning with the worship places in the early times, sports stadia, assembly halls, exhibition centres, swimming pools, shopping centres and industrial buildings have been the typical examples of structures with large unobstructed areas nowadays[2]. The earliest domes were mostly all based on a circular floor plan and appeared as roofing systems (Makowski, 1984). The domes of antiquity developed to become religious symbols for pagans, Christians, and Islamic believers[3]. Nowadays it is very common to use steel in order to enclose large spans such as 200 m length[2].

1.1Types of Domes

There are different types of domes according to pattern of bracings. Below is list of most popular type of domes:

1. Ribbed domes
2. Schwedler domes
3. Lamella domes
4. Two- and three-way (also four-way) grid domes
5. Geodesic domes

2. METHODOLOGY

Here two different types of analysis should be carried out for seismic load. Dome is analyzed as per Seismic Co-efficient method and response spectrum method.

Seismic co-efficient method is linear static analysis and Response spectrum method is linear dynamic analysis. Both the methods are applied according to IS 1893:2002.

3. PROBLEM

Different types of steel domes were modeled and analyzed.

1. Spherical Dome
2. Diamatic Dome
3. Trimmed Schwedler Dome

Different types of domes are analyzed in SAP200. The properties of the dome configurations are considered in the present work are summarized below.

Table 1: Specification Dome

Material Property	Dimension
Material	Steel,E = $2x10^8$ kN/m^3 μ = 0.3, Fy = 250000 kN/m^3
Frame Section (Pipe Section)	Outer Diameter = 0.3 m Thickness = 0.025 m
Diameter of Dome	50 m
Height of Dome	25 m
H/S ratio	1/2
Loads Acting on Dome	1. Dead Load = Self Weight of Dome 2. Seismic Load as per IS 1893:2002

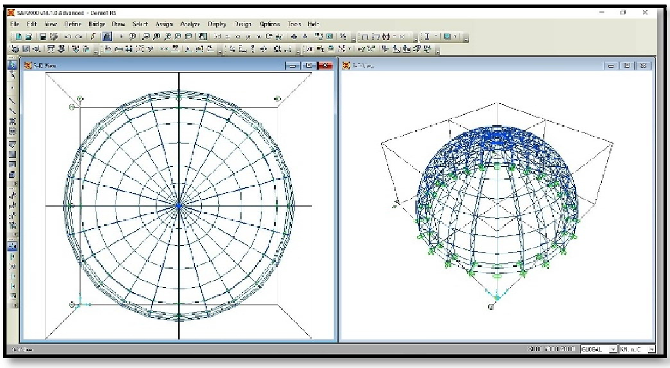

Figure 1: Spherical Dome

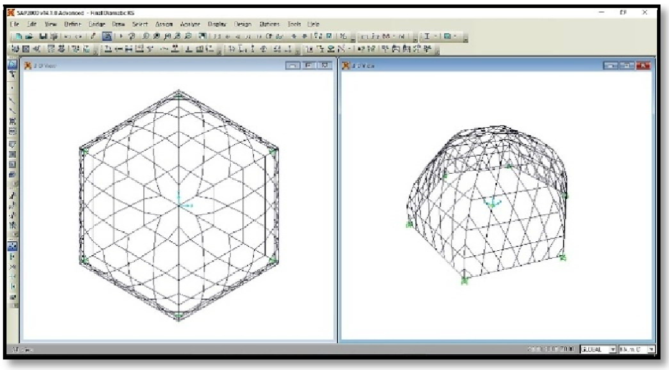

Figure 2: Diamatic Dome

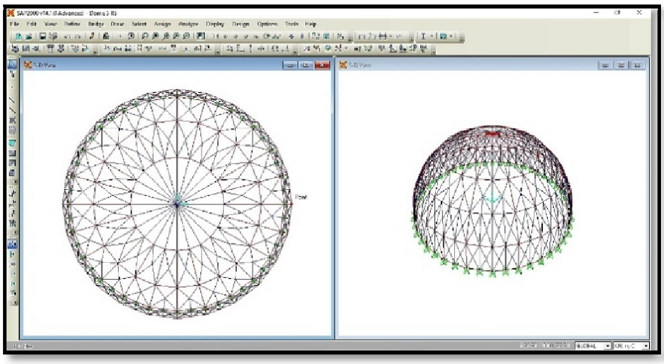

Figure 3: Trimmed Schwedler Dome

3. RESULTS

Step by step procedure of modeling of dome and analysis is done in software. After completion of analysis using Seismic co-efficient and Response spectrum method in SAP2000, Results of base shear and time period are compared for each type of dome. All the results and graph developed are given below.

Table -2: Base Shear of Dome

Types of Dome	Seismic Co-efficient	Response Spectrum
Spherical Dome	331.2	219.402
Diamatic Dome	154.833	66.1
Trimmed Schwedler Dome	1080.947	827.153

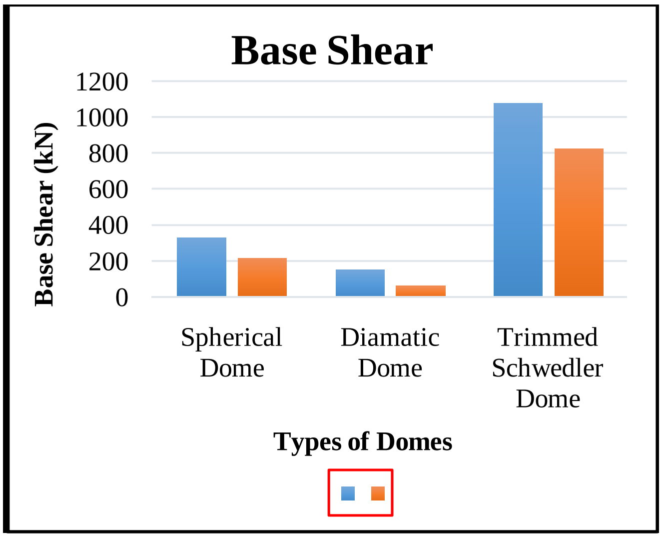

Figure 5: Comparison of Base Shear

Table 3: Modal Time Period of Dome (sec)

Number of Mode Shape	Spherical Dome	Diamatic Dome	Trimmed Schwedler Dome
1	0.749757	0.441851	0.188876
2	0.329595	0.433538	0.188855
3	0.329595	0.432047	0.14473
4	0.301823	0.416708	0.131077
5	0.18052	0.415371	0.130958
6	0.13831	0.402801	0.130747
7	0.137591	0.244931	0.126584
8	0.137591	0.242355	0.126529
9	0.135577	0.227343	0.125236
10	0.135577	0.225247	0.121555
11	0.132628	0.224058	0.121461
12	0.132628	0.206082	0.120122

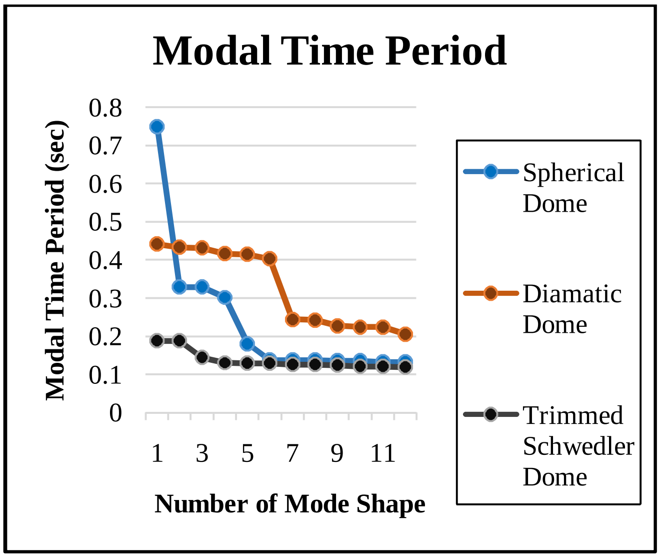

Figure 6: Comparison of Modal Time Period

4. CONCLUSIONS

Analysis was carried out for all three types of domes and results are concluded below:

- Base reaction for Seismic co-efficient method (1080.947 kN) is 30.7% more than the base reaction for response spectrum method (827.153 kN).
- Base reaction is higher for trimmed Schwedler dome than other types of dome.
- Time period is higher for mode shape number 1 in all types of dome and also as mode shape number increases the value of time period decreases.
- Maximum time period is 0.7498 sec for spherical dome than other types of domes.

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BIOGRAPHIES

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