ANALYSIS AND DESIGN OF SPHERICAL DOME STRUCTURE
BY USING STAAD.Pro

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Abstract—Domes are ambient structure developed from A.D periods which are constructed for getting large volume from the structure. Normally domes are designed for uniform loading over the plates. In this investigation by applying point loads over the nodal joints analysis and design of concrete dome structure was done using STAAD.pro. An 8.49m rise with 30m diameter dome and a support height of 14m was considered for the design. Dead load is assigned as plate load and the live load is assigned as point load over the nodal joints. The safe loads were found from the design results against various loading cases.

Keywords—Dome, STAAD.pro, Nodal Joint Load, Shear Force and Bending Moment.

I. INTRODUCTION

A dome is typically an element of architectural that resembles the hollow upper half of a sphere. Domes are curved structure they have no angles and no corners and they enclose an enormous amount of space with the minimum of materials as they don’t require interior supports. Despite their thinness, domes are some of the strongest and stiffest structure in existence today. The precise definition has been a matter of controversy. Domes have a long architectural lineage that extends back into prehistory and they have been constructed from mud, snow, stone, wood, brick, concrete, metal, glass, and plastic over the centuries. The symbolism associated with domes includes mortuary, celestial, and governmental traditions that have likewise developed over time. The dome has a long history in the built environment, and has been a design feature of many different kinds of architecture around the world. Domes are prominent features of Persian, Roman, Byzantine, Islamic, and Italian Renaissance design.

SPHERICAL DOME

In geometry, a spherical cap, spherical dome, or spherical segment of one base is a portion of a sphere cut off by a plane. If the plane passes through the center of the sphere, so that the height of the cap is equal to the radius of the sphere, the spherical cap is called a hemisphere.

II. DIMENSIONAL ANALYSIS

2.1 Geometry

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base Diameter of dome</td>
<td>30m</td>
</tr>
<tr>
<td>Top diameter of dome</td>
<td>0</td>
</tr>
<tr>
<td>Height of dome</td>
<td>8.49m</td>
</tr>
<tr>
<td>Latitude: Divisions</td>
<td>10</td>
</tr>
<tr>
<td>Longitude: Divisions</td>
<td>16</td>
</tr>
<tr>
<td>Circular Column YD</td>
<td>0.30m</td>
</tr>
<tr>
<td>Rectangular beam YD</td>
<td>0.2m</td>
</tr>
<tr>
<td></td>
<td>ZD = 0.2m</td>
</tr>
<tr>
<td>Plate Thickness</td>
<td>0.12m</td>
</tr>
<tr>
<td>Length of beam</td>
<td>5.85m</td>
</tr>
<tr>
<td>Length of column</td>
<td>3.5m</td>
</tr>
</tbody>
</table>
2.2 Define Load to following process
The loadings were calculated partially manually and rest was generated using STAAD.Pro load generator. The loading cases were categorized as: Self-weight, Dead load and Nodal Joint load.

2.2.1 Self-weight: The self weight of the structure can be generated by STAAD.Pro itself with the self weight command in the load case details.

2.2.2 Dead load: Dead load can also be generated by STAAD.Pro by specifying the plate thickness and the load on the plate is 2.5 kN/m.

2.2.3 Nodal Joint Load: Joint loads, both forces and moments, may be applied to any free joint of a structure. These loads act in the global coordinate system of the structure. The joint loads applying on the dome structure are various loads as 1, 1.5, 2, 2.5…49 kN.

Figure 1: Modeling Dome Structure

Figure 2: Applied nodal joint load
III. DESIGN RESULTS

For the dome, analysis and design of nodal joint load, consideration results are shown below for beam no 407 and column no 419 of concrete dome.

Figure 4: Design of concrete beam for nodal load 1kN
Figure 5: Design of concrete column for nodal load 1kN

For the above analysis and design the graphical representation of deflection, Shear force, Bending moment and the support reaction are

![Graphical representation of deflection, Shear force, Bending moment and support reaction.]

Figure 6: Load vs deflection graph diagram

Figure 7: Load vs shear force graph diagram
Figure 8: Load vs bending moment graph diagram

Figure 9: Load vs support reaction graph diagram
In this study the concrete dome structure was analyzed and designed using STAAD-pro.

- The assumed dimensions of the members are Beams 200mmx200mm, Columns 300mm diameter and plate thickness 120mm.
- The Dome structure was analyzed to carry dead load and varying live load from 1kN to 49kN over the nodal joints.
- For the applied load cases over the nodal joints the structure comes under safe zone with deflection of a member from 0.002mm to 0.036mm, Bending moment 0.002kNm to 0.098kNm and Shear force 0.001kN to 0.068kN.

REFERENCES

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