

Study of Dome Structure Using Finite Element-Based Software E-Tab for Dynamic Loading

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Abstract—In recent years, there is been an increasing number of structures using steel domes as it is one of the most efficient shapes in the world. It covers maximum volume with the minimum area with no interrupting columns in the middle an efficient shape would be more efficient and economic. Dome roofs are the lightest structure to cover circular shapes. In this research paper, the analysis of steel dome is examined using computer software E-tabs. This paper conducts a deep study of major features of structural analysis of E-tab software. E-tab software has the analysis of its own features option, output option, limitation, and advantages. Dome is one of the powerful architectural representations. This element resembles the hollow upper half of a sphere. In the age of civilizations, the form of the dome was stuck in the public's minds as an iconic sign of a sacred building, but in the present time architects have built domes to achieve new purposes using new building technologies. This paper, therefore, investigates these technologies and outlines the new role of domes following a scientific methodology. It is an element of architecture that resembles the hollow upper half of a sphere. The thickness of the dome is very small compared to its other dimensions -it varies from 75mm to 150mm. A dome is a self-supporting structural element that resembles the curved hollow upper half of a sphere. A dome can rest directly upon walls, columns, a drum, or a system of squinches or pendentives used to support the transition of shape from a square or rectangle to the round or polygonal base of the dome.

Keywords—Efficient shape, Economic, Lightweight structure, E-tab

Introduction

Dome is one of the oldest and well established structural forms and has been used in architecture since ancient times. As the world's population is growing fast, it is important to design urban living spaces according to the needs of modern times. The main goal of this project is to study the need for cheap housing in India, where the maximum percentage of the population is still detained in poverty. It also provides safety and is a cost-effective shelter for middle-income people in households. To achieve greater flexibility.

Dome structures have been proven to be long-lasting efficient structures due to their capability to carry the

applied loads. The vertical loads will be resisted mainly by the internal compression stresses and outer tension.

Importance of dome in the construction industry:

High strength: Dome structures are highly durable and strong. If we talk about the strength and average building life of dome structures, then their life is longer and strength is more than only other types of structure in the space frame industry.

Fireproof: After getting practical data from decades of performing the firelighter test, it is concluded that domes have more excellent fireproofing capability than other similar structures.

Extremely energy efficient: Dome structure does not need any interior support and thereby wide space inside them cater them the advantage of more support.

Cost-effective & good structural integrity: Dome structure comprises great structural tightness with minimal space and structural components and its geometrical shape gives an advantage to conserving energy in form of heat, which makes the dome structure cost-effective.

Very Low Maintenance: Dome structures are comparatively easier to maintain than any other building, therefore the cost of maintenance on dome structures is lesser.

Good Acoustic Quality: In Most places where sound needs to travel continuously, dome structures are preferable to other structures due to the good acoustic nature of dome structures.

Resistant to adverse weather conditions: Due to their hemispherical Structure and absence of angles, flat surfaces make them highly resistant to adverse weather conditions such as Storms, Hurricanes, etc.

Highly aesthetic and versatile: We at Hindustan are also limited, one of the modern dome manufacturers uses the combination of its basic features and the latest technology to make the dome structure more appealing and highly versatile in installation/reinstallation as well as in maintenance.

Problem Statement

In real situations without calculation by software, it might be difficult for the engineer to calculate all the calculations starting from the foundation until the roof. The calculation is consisting of long calculations to make sure the design is safe and economical. Manual calculations can cause a lot of mistakes. In this case, E-tab software is used to analyze circular dome structures 50m in diameter. E-tab is used to define the strength behavior of the element in the dome structure by modeling and analyzing the dome structure

The introduction of E-tab software has resulted in considerable advanced in the analysis and design of any structure. Therefore, it is a great encouragement to study and understand the use and importance of software in solving practical problems.

Literature Review

- 1) State of the Art Report – A Comparative Study of Structural Analysis and Design Software – STAAD Pro, SAP-2000 & ETABS Software.

Balwinder Lallotra #1, Dhirendra Singhal*2

(Professor and Chairperson, Department of Civil Engineering, D.C.R. University of Science and Technology, Murthal, India. April 2017)

This paper aims to conduct an in-depth study of the major features of three structural analysis and design software programs STAAD Pro, SAP-2000, and ETABS software which are generally used. Each software program has its features, analysis options, design and output options, limitations, and advantages. The user must exploit all the advantageous features of a particular software program but also the software program should not be used beyond its applicability to avoid any catastrophic failure. Therefore, this paper discusses the main features of all these software programs with an emphasis on the applicability and limitations of this software. This will enable a designer to choose the required software according to the requirements of a structure with confidence.

- 2) Analysis and design of steel dome using the software.

Anju Chandivali

(Assistant Professor, Civil Engineering Department, Chhotubai Gopalbhai Patel Institute of Technology, Gujarat, India-August 2016.)

In recent years, there have been an increasing number of structures using steel domes of one of the most efficient shapes in the world. It covers the maximum volume with the minimum larger volumes with no interrupting columns in the middle with efficient shapes

would be more efficient and economic. Dome roofs are the lightest structure to cover circular shape

- 3) Structural Analysis of Dome Structure by STAAD Pro

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Dome is one of the oldest and most well-established structural forms and has been used in architecture since ancient times. They are of particular interest to engineers because they cover the maximum amount of space with a minimum surface and have proved to be very economical in terms of the consumption of building materials. This paper compares the dome with different spans and column heights using STAAD-PRO software

- 4) An experimental and analytical study on dome forming of seamless Al tube by spinning

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The thickness distribution of a spin-formed dome in an Al-pressure vessel was studied experimentally and a simple formulation to predict the thickness distribution of the dome was proposed. The thickness of the boss part of the dome may not be sufficient after forming operations Thus, a two-step spin forming of the Al tube end closure was proposed to improve and thicken the boss. First, the boss was deformed to a diameter smaller than the desired one. Experimental work was carried out to compare the thickness distribution obtained with the conventional process and use the proposed two-step spin-forming process. A simple analytical model, which was based on geometrical shape changes and an assumption of material constancy during forming, was formulated to predict the final thickness distribution of the dome. The results indicate that the proposed two-step spin forming provides a greater boss thickness than that of conventional forming.

- 4) Finite element analysis of a geodesic dome structure by using STAAD PRO software

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(Faculty of Civil Engineering and Earth Resources University Malaysia Pahang)

Finite element analysis (FEA) has become commonplace in recent years and is now widely used in the construction industry during the analysis and design of a structure.

Numerical solutions to very complicated stress problems can now be obtained routinely using FEA. The Dome structure is unique due to the ability to withstand a larger span with minimum interference. Geodesic domes are efficient structure because it consists of the triangular element along the hemisphere to resist the load. The Triangle element is the most effective shape in a truss and the combination of the triangle element the and dome makes a geodesic dome a strong structure to resist the load. STAAD-Pro software is based on finite element analysis and this software is widely used in industry because it is accurate during the analysis of a structure by using the finite element method (FEM). This study is about analysis of the structural behavior of the Geodesic Dome Structure by using STAAD-Pro Software to determine the maximum deflection and all the reaction force on the structure when the load is applied to the model

5) Analysis and design of steel dome using the software.

Anju Chandivali (Assistant Professor, Civil Engineering Department, Chhotubai Gopalbhai Patel Institute of Technology, Gujarat, India-August 2016.)

In recent years, there have been an increasing number of structures using steel domes of oof of the most efficient shapes in the world. It covers the maximum volume with the minimum larger volumes with no interrupting columns in the middle with an efficient shape would be more efficient and economic. Dome roofs are the lightest structure to cover circular shapes. Dome can be used when the internal pressure is higher; do not have problems with mounting an internal floating of Supplementary foundations are not necessary for dome roofs. In other words, always when it is possible the dome roofs are recommended. In this research paper, the analysis of steel ds was examined by the use of the computer software STAAD-Pro. For the analysis of different diameters of the steel tube member and the behavior of the steel.

6) State of the Art Report – A Comparative Study of Structural Analysis and Design Software – STAAD Pro, SAP-2000 & ETABS Software.

Balwinder Lallotra 1, Dharendra Singhal2 (Professor and Chairperson, Department of Civil Engineering, D.C.R. University of Science and Technology, Murthal, India. April 2017)

This paper aims to conduct an in-depth study of the major features of three structural analysis and design software programs STAAD Pro, SAP-2000, and ETABS software which are generally used. Each software program has its features, analysis options, design and output options, limitations, and advantages. The user must exploit all the advantageous features of a particular software program but also the software program should not be used beyond

its applicability to avoid any catastrophic failure. Therefore, this paper discusses the main features of all these software programs with an emphasis on the applicability and limitations of this software. This will enable a designer to choose the required software according to the requirements of a structure with confidence.

7) Seismic response analysis of K8 pattern single-layer reticulated Domes under vertical rare earthquakes

De-Min Weia, Sheng-Fu GAO b (School of civil engineering and transportation, South China University of Technology, State Key Laboratory of Subtropical Building Science, Guangzhou and 510640, China. December 2017)

The nonlinear response of K8 pattern single-layer reticulated domes of different rise-span ratios under vertical rare earthquakes are analyzed by using the dynamic time-history analysis method and the pseudo-static elasto-plastic analysis method. A comparison of these analysis results indicates that the structural members would be in different plastic deformation states under vertical rare earthquakes because of different rise-span ratios. The analysis results of the dynamic time-history method indicates that the vertical displacement response decreases with the increase of the rise-span ratio in the condition of the same member section. Through the comparison of the analytical results of the pseudo-static elasto-plastic analysis with the analytical results of dynamic time-history analysis, it is found that the difference of plastic members and region and error of the vertical displacement response, which may be a reference for future vertical seismic study of single-layer reticulated domes.

Methodology

The theoretical background discussed so far represents the backbone of the methodology we have applied to some of the relevant domed structures in the world.

As mentioned in the paper, domes are difficult to investigate and analyze. Throughout history, many methods have been applied to measure their surface and to assess their geometry and shape. Whereas, domes are quite difficult even to reach.

Step 1-Topic Name -Comparative Analysis of Dome Structure using Finite Element based on Software E-tab and Staad for Dynamic Analysis.

Step 2-What is Dome and its types?

Dome- Hemispherical structure evolved from the arch, usually forming a ceiling /roof.

Types- Geodesic dome, Onion dome, Hemispherical dome.

Step 3-Type of dome used in the project

Step 4- Hemispherical dome

Step 5-Design the dome using the software E-tab.

Step 6- Steps to design the dome-

Using AutoCAD to create the semicircle by providing Coordinates.

Save the file in AutoCAD

Import it to E-tabs

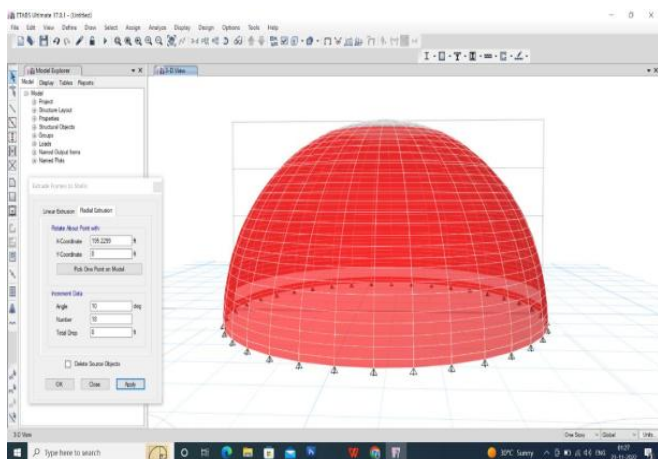
Select the semicircle and edit

Extrude frame to the shell

Radial extrusion

Select angle midpoint

Apply

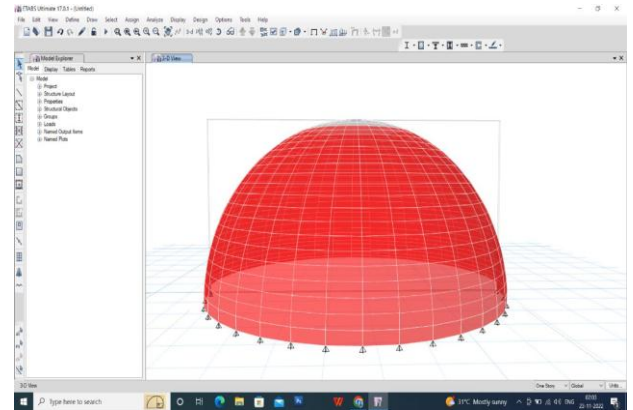


Step 7-applying dynamic load to the Dome

Step 8-To analyze the dome

Step 9- analyze and see what changes occur

Step 10- Final result



Conclusion

- [1] The dome is one of the best architectural solutions to cover universal space containing multi functions in one enclosure.
- [2] Now it has become easier to analyze the dome structure Using ETABS software.
- [3] In this study, we have created a dome model.
- [4] ETABS is specialized in the analysis of the structure
- [5] The dome structure allows for a wide variety of floor plans design because it needs no interior support.

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