Review on Comparative Study on Behaviour of Various Dome Structures for Different Parameters

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Abstract - *A dome is a distinctive structural arrangement that gains strength and stiffness based on its shape and form. Traditionally, stone masonry domes were constructed and are now mostly made of RCC Steel because of its re-usability. Traditionally, a dome is a hollow upper half of a sphere, made of various materials, with a history dating from prehistory. It encompasses the maximum volume with the smallest sized volumes without interruption by columns. The main goal of architects and engineers has always been to solve the problem of space enclosure. Architects and engineers look for new structural forms to accommodate large unobstructed areas.*

As a result, space structures, in which the three-dimensional function is realized, are of considerable importance. These structures are increasingly used in construction. They entail essentially analysis and design in three dimensions, as opposed to two dimensions.

Key Words: Ribbed Dome, Schwedler Dome, Kiewitt Dome, lattice system, Reticulated domes

1.INTRODUCTION

The dome is a majestic structure that dates back thousands of years. Each element is arranged in layers that are arched in all directions. Dome structures are used for covering large areas such as exhibition halls, stadiums, and concert halls. In terms of materials, they are economical and provide a completely unobstructed interior space. Comparatively to more conventional forms of structures, they are lighter [1, 2].

Engineers are particularly interested in them because they contain a great deal of space with a minimum amount of surface area and are extremely efficient regarding construction materials. An affixed dome has a mainly membrane and compressive stress distribution, except for circumferential tensile stresses near the edges and small bending moments at the junction of the shell and the ring beam. [1].

Over the years, domes have been built out of a diverse range of materials, including mud, stone, wood, brick, concrete, metal, glass, and plastic. During the last three decades, braced steel dome structures have been widely used all over the world. During the Industrial Revolution, new production processes enabled forecast iron and wrought iron to be produced in greater quantities and at lower prices [2].

In recent the majority of domes in the past were made of stone masonry, but currently RCC Steel domes are being built all across India because of the material's reusability. These structures enclose the most amount of space with the least amount of surface and steel truss. Because of its skilled structural shape, the lattice system has gained popularity among engineers. [5].

The space structure in which the aforementioned three-dimensional function is achieved is thus extremely important. These structures are increasingly being employed in the building industry. They generally entail three-dimensional analysis and design rather than two-dimensional analysis and design. [7].

1.1 Braced type domes:

(a) Ribbed Dome

(b) Schewedler Dome

(c) Kiewitt Dome

(d) Kiewitt-ribbed Dome

(a) Ribbed Dome:

A ribbed dome is made up of intersecting "ribs" and "rings." A "rib" is a group of elements that form a meridional line, whereas a "ring" is a group of elements that form a horizontal polygon. Ribs can be solid or radially trussed. They usually connect at the crown, and the ribs are stiffened by a tension ring at the foundation.

Fig 1: Ribbed Dome

b) Schewedler Dome:

J.W.Schwedler, a German engineer who pioneered the braced dome in 1863, created many braced domes during his lifetime. A Schwedler dome, one of the most common varieties of braced dome, is made up of meridional ribs that are connected to a series of horizontal polygonal rings. Each trapezium generated by crossing meridional ribs with horizontal rings is partitioned into two triangles by introducing a diagonal member to stiffen the resulting structure so that it can resist unsymmetrical loads.

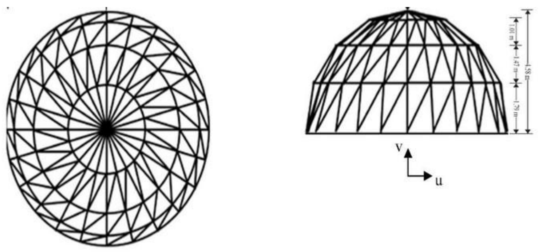

Fig -2: Schewedler Dome

c) Kiewitt Dome :

Kiewitt dome structure is commonly used in spatial structures Reticulated domes (i.e., domes composed of bars) with various patterns have been built to span large surfaces, demonstrating their material efficiency. A Kiewitt dome's pattern is made up of a sequence of subdivided triangles that go around the circumference.

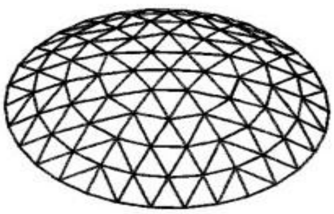

Fig -3: Kiewitt Dome

d) Kiewitt-Ribbed Dome :

Kiewitt This dome combines the Kiewitt dome with ribbed domes. The crown of the dome contains Kiewitt bracing, whereas the bottom has ribs.

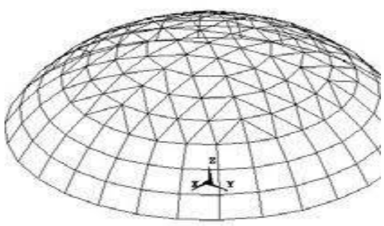

Fig -4: Kiewitt-Ribbed Dome

2. LITERATURE REVIEW

Many researchers have studied the behavior and performance of the Braced type dome structure. The present theories published by various researchers related to the behavior of dome structures are presented in the following section.

Rashmi C Khanorkar (2020), This paper investigates the various acoustic treatments and parametric configurations of monolithic dome sizes. A geometric relationship of acoustic treatment and dome radius established to provide architects with guidelines on the correct selection of absorption needed to maintain the acoustic comfort of these special spaces guides the correct selection of absorption needed to maintain the acoustic comfort of these special spaces. Because of the size of these dome structures, focal points can be positioned across daily activities, affecting the sonic comfort of the inside environment. [1].

Willem Gythiel et al. (2020), The research focuses on hemispherical Schwedler, Kiewitt, and geodesic domes with a gravity load of 2kNm2. Full enumeration is used to optimize the discrete variables (number of rings, subdivisions along each ring, etc.), while a gradient-based technique is used to optimize the continuous variables (member sections). When all members are allocated the same size, a geodesic dome is more evenly stressed and up to 28 percent lighter than other dome types of equivalent size, according to the study. When all members are measured individually, the Schwedler dome is the lightest. [2].

Manhor K, Anuradha.P.Annigeri (2019) The investigation of the steel dome in this research is carried out in this study using the computer software STAAD. Pro. The lamella domes and Schwedler domes are modelled and compared using the STAAD. Pro programme for various rise to span ratios and load scenarios. The domes have a height-to-span ratio of 1/2 and are 50 metres long and 30 metres broad. In this study, four domes were analysed statically under self-weight. In compliance with IS1893:2002, equivalent seismic coefficient methodologies have also been utilised for earthquake and wind loads. Several steel sections were considered for various models in accordance with IS 800-2007. [3].

Keyur R. Patel et al. (2016) In this research, one double-layer steel and two single-layer steel lattice domes were tested under gravity and earthquake stresses. The domes span 50 metres and have a height-to-span ratio of half. In this work, domes were analyzed statically under self-weight. For Base shear and Modal time periods, the Seismic Co-efficient Method and Response Spectrum Method were used to examine all three types of steel domes. Each **analysis** should be done in SAP2000 v18 structural software. [5]

Riya Anna Abraham, G. Kesava Chandran (2016), The study emphasises the different advantages and fundamental features of the domes. With this goal in mind, we investigate geodesic and monolithic dome housing. Our report finds that geodesic and monolithic domes are both appropriate housing constructions, but that more research and analysis are needed. The study also looks at the potential future characteristics of domes by looking at common types, the most prominent of which are monolithic and geodesic domes.

Taruna Desaria et al. (2015) The purpose of this study is to thoroughly investigate the topic of configuration processing for grid domes and geodesic forms. To address the issue of data production for grid domes, a one-of-a-kind transformation has been designed. This permits configurations to be projected onto various surfaces such as spheres, ellipsoids, paraboloids, hyperbolic paraboloids, and cylinders. This change is known as the "tractation retronorm." Four distinct projections were used to investigate the range of conceivable shapes and form.

Anuj Chandiwala et al. (2015) This study article investigates the assessment of a steel dome using the computer software STAAD.Pro. The analysis made use of various steel tube member diameters and steel heights. Dome covers the most volume with the least amount of volume feasible, with no intervening columns in the middle and efficient forms, making it more efficient and cost-effective. A dome roof is the lightest structure for covering a circular form. A dome can be used when the internal pressure is high; establishing an internal floating roof is not a problem. No new foundations are required for dome roofing. To put it another way, whenever practicable, dome roofing should be employed. [9]

Peter Chacko et al (2014) The subject of this study is ribbed spherical domes with rigid joints. Three distinct dome spans are investigated. ANSYS and Staad software packages are used to model and analyse the proposed dome. Pro is used to compare the effects of different rise to span ratios under different load circumstances. The most common cause of dome collapse is structural buckling. When a structure reaches a critical load, which is the maximum load that a member can withstand before becoming unstable, it fails unexpectedly. [10]

H. S. Jadhav, Ajit S. Patil (2013), In this study, The "SAP-2000-14" programme is used to assess the structure for the optimal design. In the analytical portion, the forces in the top layer will be analysed in groups, and unique sections will be produced for each group, with the design based on IS800:2007. The bottom layer and bracing system will be treated in the similar manner. To establish the optimal overall arrangement, the findings are compared to alternate span-to-height ratios and support conditions for deflection, structural weight, and pedestal concrete. Wind loads are calculated for domes with a span of 75 metres, a span-to-height ratio of two, and a variety of support conditions. The dome's members are designed for axial tension and compression to attain the lightest weight achievable.

3. CONCLUSIONS

From the literature review, following conclusions can be drawn:

i. In braced types of domes, the behavior of the structure depends on the arrangement of bracings and their reticulation.

ii. The bracings of dome structures are proven to be efficient in terms of architectural purpose and structural stability.

iii. Using the software staad pro and ansys, dome structures can be conveniently analyzed and designed.

iv. There is scope to carry out a comparison between different types of braced domes with different spans and hence to select an optimized dome.

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