Step-Up 공법에 의한 단층레티스돔의 시공시 안정성 연구


Abstract

The large-space single-layer lattice dome is relatively simpler in terms of the arrangement of the various framework members and of the design of the junction than the multi-layered lattice dome, can reduce the numbers and quantity of the framework members, and has the merit of exposing the beauty of the framework as it stands. The single-layer lattice dome, however, requires a stability investigation of the whole structure itself, along with an analysis of the stress of the framework members, because an unstable phenomenon called “buckling” occurs when its weight reaches critical levels.

Many researchers have systematically conducted researches on the stability evaluation of the single-layer lattice dome. No construction case of a single-layer lattice dome with a 300-m-long span, however, has yet been reported anywhere in the world.

The large-space dome structure is difficult to erect due to the gigantic span and higher ceiling compared with other common buildings, and its construction cost is generally huge. The method of erecting a structure causes major differences in the construction cost and period. Therefore, many researchers have been conducting various researches on the method of erecting such structure. The step-up method developed by these authors can reduce the construction cost and period to a great extent compared with the other general methods, but the application of this method inevitably requires the development of system supports in the center section as well as pre-existing supports in the boundary sections.

In this research, the safety during the construction of a single-layer lattice dome with 300-m-long span using pre-existing materials was examined in the aspect of structural strength, and the basic data required for manufacturing the supports in the application of the step-up method developed by these authors during the erection of the roof structure were obtained.

Keywords: Single-layer lattice dome, step-up erection method, stability, support

1. Introduction

The large-space single-layer lattice dome is a structure with dynamic, functional, and aesthetic characteristics, and its uses are constantly expanding.

Lattice domes are largely classified into single- and multiple-layer domes. The single-layer dome, which displays the framework members in a particular pattern on the surface to form a curved surface as an spatial structure, is similar to the continuum shell structures in both appearance and dynamics.

It is therefore considered a structure that can minimize material losses by effectively using the axial stiffness of the framework members and resisting the external forces on the surface, which are not considerably strong.

The large-space single-layer lattice dome is relatively simpler in terms of the arrangement of the various framework members and of the
design of the cupolas compared to the multi-layer lattice dome, reduces the number of framework members, and has the merit of exposing the beauty of the skeleton as it stands. An unstable phenomenon called “buckling,” however, can appear at the single-layer dome when its weight reaches critical levels.

Many researchers have been conducted on the erection method, and Nagoya Dome in Japan has been constructed as a single-layer lattice dome with a 187-m-long span. No construction case of a single-layer lattice dome with a 300-m-long span, however, has yet been reported anywhere in the world.

The large-space dome structure is difficult to erect due to the gigantic span and higher ceiling compared with other common buildings, and its construction cost is generally huge. Therefore, various researches have been conducted on the method of erecting such structure. The step-up method developed by these authors can reduce the construction cost and period to a great extent compared with the other general methods, but the application of this method inevitably requires the development of system supports in the center section and of pre-existing supports in the boundary sections.

In this research, the safety during the construction of a single-layer lattice dome with 300-m-long span using preexisting materials was examined in the aspect of structural strength, and the basic data required for manufacturing the supports in the application of the step-up method developed by these authors during the erection of the roof structure were obtained.

2. Analytical Model

2.1 Model Geometry and Network Pattern

<Figure 1> (a) shows a section of the dome and network pattern. r is the radius of the dome at the base, h is height of dome, R is the radius of curvature.