Configuration based on meshes derived from Crystallographic concepts and study of system stability of domes

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Abstract

Single layer domes are part of many structural systems. Low dead load makes it more economical without compromising on the stiffness. Conventional way of dome configuration is based on triangulation as the basic unit. Much research has been carried out for different domes with triangulation as the basic mesh. Geodesic dome, lamella dome and Schwedler dome are few of the domes available where the triangulation concept is used. These systems are treated as pinned at their interfaces. One can see in the topology of spatial structural systems, different polygonal shapes such as kite geometry can be utilized as a basic unit. Varieties of patterns can be evolved which can be utilized as dome configuration. Two such typical patterns based on kite geometry is given in Fig 1. Here, concepts in crystallography are utilized for creating the given patterns. Based on crystallographic principles, a structural shape is made up of elements like vertices, edges, faces and cells. They are expressed with the help of three parameters – dimensionality, valency and extent. Here dimensionality gives the degree of freedom of an element and valency gives the number of elements of given dimensionality that meets an element of another dimensionality. Extent explains about the measurable quantities like length, area and volume. Euler-Schlaefli relation (Equation 1) gives the relationship between elements of different dimensionality in a structure.

$$\sum_{i=0}^{j}(-1)^{i}N_{i} = 1 + (-1)^{i} \quad (1)$$

Here N_i refers to the number of elements of dimensionality 'i'. This equation makes sure that the structure formed is of closed form. Here we are combining these relations together with the relations, which can be derived from the parameters of structures to obtain the configuration of domes. The domes derived like above are different from the existing patterns and they are architecturally pleasing.

This paper describes the system stability aspects of typical domes with respect to the rise to span ratio. Optimum rise to span ratio is investigated with respect to the limit state buckling of few varieties of dome configurations which are based on the new polygonal meshes.

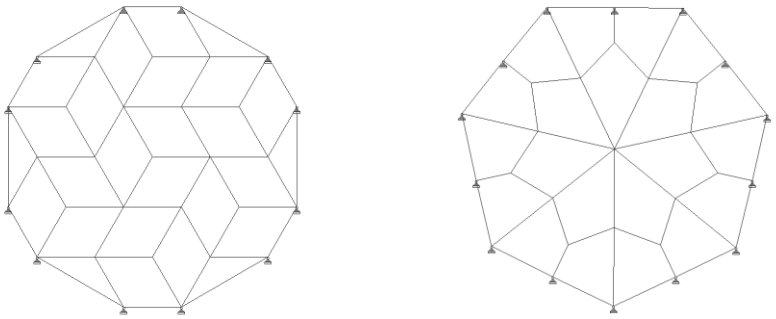

Fig. 1 Patterns with kite geometry used for configuration of domes

References

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