Mechanical effect of arch element composition of a fractal hexagon dome and its extension

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Abstract

Authors have pursued a fractal hexagon dome generated by seven contraction mappings on original lattice one (Asayama and Mae [1], Asayama, Mae and Takita [2]). It has six main steel arches which cross each other and seven small domes with self-similarity on them. Authors compare it with another fractal hexagon dome with nine main arches and consider the effect of them to mechanical characteristics under the condition of uniform volume of the structure. The structure can be extended to polygonal dome such as pentagon, heptagon and octagon. The fractal dimensions can be obtained as:

$\Sigma \lambda_i^D = 1$, where D and λ denote Hausdorff dimension and Contraction factor.

Since the structural geometry of the above dome is derived from a fractal tree model branching in three directions, the diameter of member in the 2nd layer is set by means of multiplying one in the 1st by contraction factor. Regarding constants of material, Young's modulus is 20500kN/cm^2 and Rigidity is 7910kN/cm^2 and Poisson ratio is 0.3. The basic geometry in the 1st later is revised to make the former model ([2]) more accurate as fractal. Vertical load is set 2kN/m^2.

Analytical results shows the maximum displacement to the load can be observed at the top of the central sub-dome. Similarly displacements of other sub-domes are much larger than those of the main arches, which can be thought the structure is derived geometrically from the fractal tree that has more flexible branches than the main stem. The structure with six main arches shown in Fig.1 has the maximum displacement of 9.76cm at the top, which is 23% smaller than that with nine main arches. Finally they summarize the effect of arch element composition.

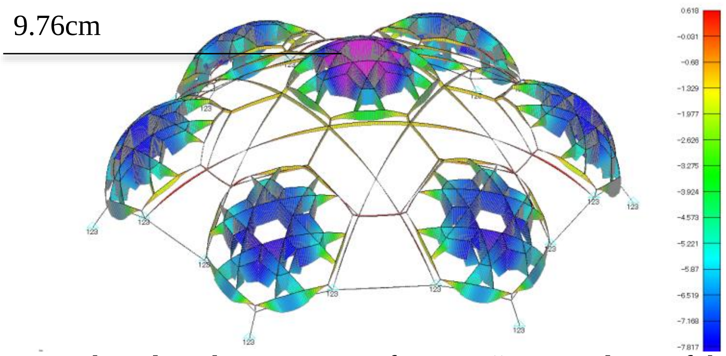

Fig.1 A fractal hexagon dome with six main arches. (span: 60m, ○-450×30, ○-135×9)

References

[1] S. Asayama and T. Mae, "Fractal Structures based on the Geometry of Nature," *Proceedings of the IASS WORKING GROUPS 12+18 International Colloquium* (Pdf PAP_15T-19).

[2] S. Asayama and T. Mae and Y. Takita, "Geometrical basis and mechanical characteristics of a fractal hexagon dome," *Proceedings of the IASS Annual Symposium 2016*, Tokyo, Japan, September 26-30, 2016, K. Kawaguchi, M. Ohsaki, T. Takeuchi (eds.), pp. 254-255.