A generation of frame structure based on Koch curve and an application to spatial frame

Toshifumi MAE*, Iasef Md RIAN[a]

**Department of Civil and Environmental Engineering, National Institute of Technology, Oita College
1666 Maki, Oita 8700152, Japan
mae@oita-ct.ac.jp

[a] Xi'an Jiaotong-Liverpool University, Suzhou, China

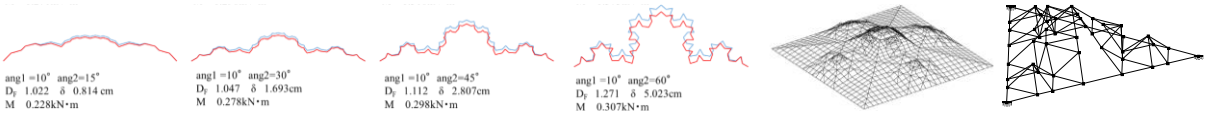
Abstract

Some shapes like a tree, cloud and topography in nature are quite complex. It seems that they have fractal geometric form. They have some rationality in their own, because they keep withstanding their own weight and external forces. Fractal geometry has self-similarity and non-integer dimension as characteristics of the form, and it seems that fractal contributes to the rationality of things in nature. Famous fractal geometric form includes Mandelbrot set, Sierpinski gasket, Koch curve, and so on.

There are few studies of application of complex figure like Koch curve [2] to an architectural structure. For example, it is easy to apply Sierpinski gasket to a building structure, because it is composed of self-similar set based on triangle. On the other hand, it is difficult to apply Koch curve to a structure, because it has large irregularities and the angle at the node of the connected segments is large. But fractal figure is composed of original figure and its self-similar mapping, and we thought that it was possible to apply it to structural form by adding another parameter to Koch curve. Therefore, the aim of this study is to show Koch curve that varies with angular change by newly setting the angle of it. Generally, Koch curve is drawn by repeating of the operation that one line is divided into three lines and equilateral triangle is placed in center. Here, a parameter is given at the base angle of the equilateral triangles and given at the angle for the line of divided both sides. Though angle1 varies 0~15 degree and angle2 varies 0~60. However, if angles are raised, the shape is larger obviously and fractal dimension is higher, which varies from 1.00 to 1.28.

Here, framework analysis was run when this figure was applied to a two-dimensional framework. On a static mechanical characteristic against to vertical load, if both angles are larger, bending moment and displacement are less in a whole. Furthermore, bending moment and vertical displacement are described through a frame analysis against vertical load. Also, bending moment and vertical displacement are suppressed by increasing of inclination in angle1 or decreasing of angle2 and shapes will be similar to an arch structure. As a result of frame analysis, it was shown that some new Koch curve was superior to a general Koch curve.

In addition, some structural examples are shown extending the Koch curve to spatial structures that maintain complexity and self-similarity followed by the fractal characters of Koch curve.



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