Geodesic Dome

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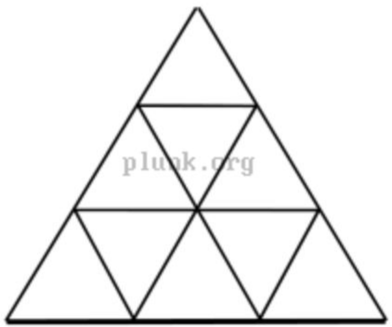
3V Geodesic Dome

- 3 is the frequency
- Frequency gets higher → more triangles → stronger



A triangle whose edges are split into 3; the result is 9 triangles

A *3v* geodesic sphere (180 triangles)

https://www.plunk.org/~grantham/public/geodesic_domes/geodesic_domes.html

3V ⅝ Geodesic Dome

- Can’t cut odd frequency directly in half - cut directly above or below
- When cut directly below half - “⅝”

A "5/8" *3v* geodesic dome

Node Geometry

1. Found coordinates for dome based on a radius of 1
2. Scaled these coordinates to radius of 20 (ft)

$$S = \begin{bmatrix} S_x & 0 & 0 & 0 \\ 0 & S_y & 0 & 0 \\ 0 & 0 & S_z & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

P' = P·S

$$[X' \quad Y' \quad Z' \quad 1] = [X \quad Y \quad Z \quad 1] \begin{bmatrix} S_x & 0 & 0 & 0 \\ 0 & S_y & 0 & 0 \\ 0 & 0 & S_z & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

$$= [X.S_x \quad Y.S_y \quad Z.S_z \quad 1]$$

https://www.tutorialspoint.com/computer_graphics/3d_transformation.htm

Global Stiffness Matrix in 3D

Since the transformations required are the same at each end of the member, the required 6×6 $[\beta]$ matrix becomes

$$[\beta] = \begin{bmatrix} [L] & [0] \\ [0] & [L] \end{bmatrix} = \begin{bmatrix} l_{11} & l_{12} & l_{13} & 0 & 0 & 0 \\ l_{21} & l_{22} & l_{23} & 0 & 0 & 0 \\ l_{31} & l_{32} & l_{33} & 0 & 0 & 0 \\ 0 & 0 & 0 & l_{11} & l_{12} & l_{13} \\ 0 & 0 & 0 & l_{21} & l_{22} & l_{23} \\ 0 & 0 & 0 & l_{31} & l_{32} & l_{33} \end{bmatrix} \quad (5.4)$$

As previously derived,

$$[k_e]_{global} = [\beta]^T [k_e]_{element} [\beta] \quad (5.5)$$

Using equations (5.1) and (5.4) in equation (5.5) we find

$$[k_e]_{global} = EA/L \begin{bmatrix} l_{11}^2 & l_{11}l_{12} & l_{11}l_{13} & -l_{11}^2 & -l_{11}l_{12} & -l_{11}l_{13} \\ l_{11}l_{12} & l_{12}^2 & l_{12}l_{13} & -l_{11}l_{12} & -l_{12}^2 & -l_{12}l_{13} \\ l_{13}l_{11} & l_{13}l_{12} & l_{13}^2 & -l_{11}l_{13} & -l_{12}l_{13} & -l_{13}^2 \\ -l_{11}^2 & -l_{11}l_{12} & -l_{11}l_{13} & l_{11}^2 & l_{11}l_{12} & l_{11}l_{13} \\ -l_{11}l_{12} & -l_{12}^2 & -l_{12}l_{13} & l_{11}l_{12} & l_{12}^2 & l_{12}l_{13} \\ -l_{13}l_{11} & -l_{13}l_{12} & -l_{13}^2 & l_{11}l_{13} & l_{13}l_{12} & l_{13}^2 \end{bmatrix} \quad (5.6)$$

Local stiffness matrix

$$[k_e]_{element} = EA/L \begin{bmatrix} 1 & 0 & 0 & -1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ -1 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix}$$

Components for K_{global}

Identifying terms with those of equation (5.7) we have

$$l_{11} = \lambda_x = (x_B - x_A)/AB$$

$$l_{12} = \lambda_y = (y_B - y_A)/AB$$

$$l_{13} = \lambda_z = (z_B - z_A)/AB$$

Results

- Applied 200 kips downward (-z) on top node of dome
- E = 1600 ksi, A = 20 in^2
- Max displacement @ top node in z direction - about ½ in down