

AIM Cantilever Beam Modal Analysis - Pre-Analysis & Start-Up

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Pre-Analysis & Start-Up

Pre-Analysis

The following equations give the frequencies of the modes and the mode shapes and are derived from Euler-Bernoulli Beam Theory.

$$w_n = \alpha_n^2 \sqrt{\frac{EI}{ml^3}}$$

$$n = 1, 2, 3, \dots$$

$$\alpha_n = 1.875, 4.694, 7.855, \dots$$

$$m = \rho V = \rho \cdot l \cdot h \cdot w$$

$$I = \frac{w \cdot h^3}{12}$$

$$w_1 = 1.875^2 \sqrt{\frac{70 \text{ E9} \frac{\text{kg}}{\text{m} \cdot \text{s}^2} \cdot \frac{0.346 \text{ m} \cdot (0.346 \text{ m})^3}{12}}{2.7 \text{ E3} \frac{\text{kg}}{\text{m}^3} \cdot 4 \text{ m} \cdot 0.346 \text{ m} \cdot 0.346 \text{ m} \cdot (4 \text{ m})^3}} = 111.7 \frac{\text{rad}}{\text{s}} = 17.8 \text{ Hz}$$

$$w_2 = 4.694^2 \sqrt{\frac{70 \text{ E9} \frac{\text{kg}}{\text{m} \cdot \text{s}^2} \cdot \frac{0.346 \text{ m} \cdot (0.346 \text{ m})^3}{12}}{2.7 \text{ E3} \frac{\text{kg}}{\text{m}^3} \cdot 4 \text{ m} \cdot 0.346 \text{ m} \cdot 0.346 \text{ m} \cdot (4 \text{ m})^3}} = 700.4 \frac{\text{rad}}{\text{s}} = 111.5 \text{ Hz}$$

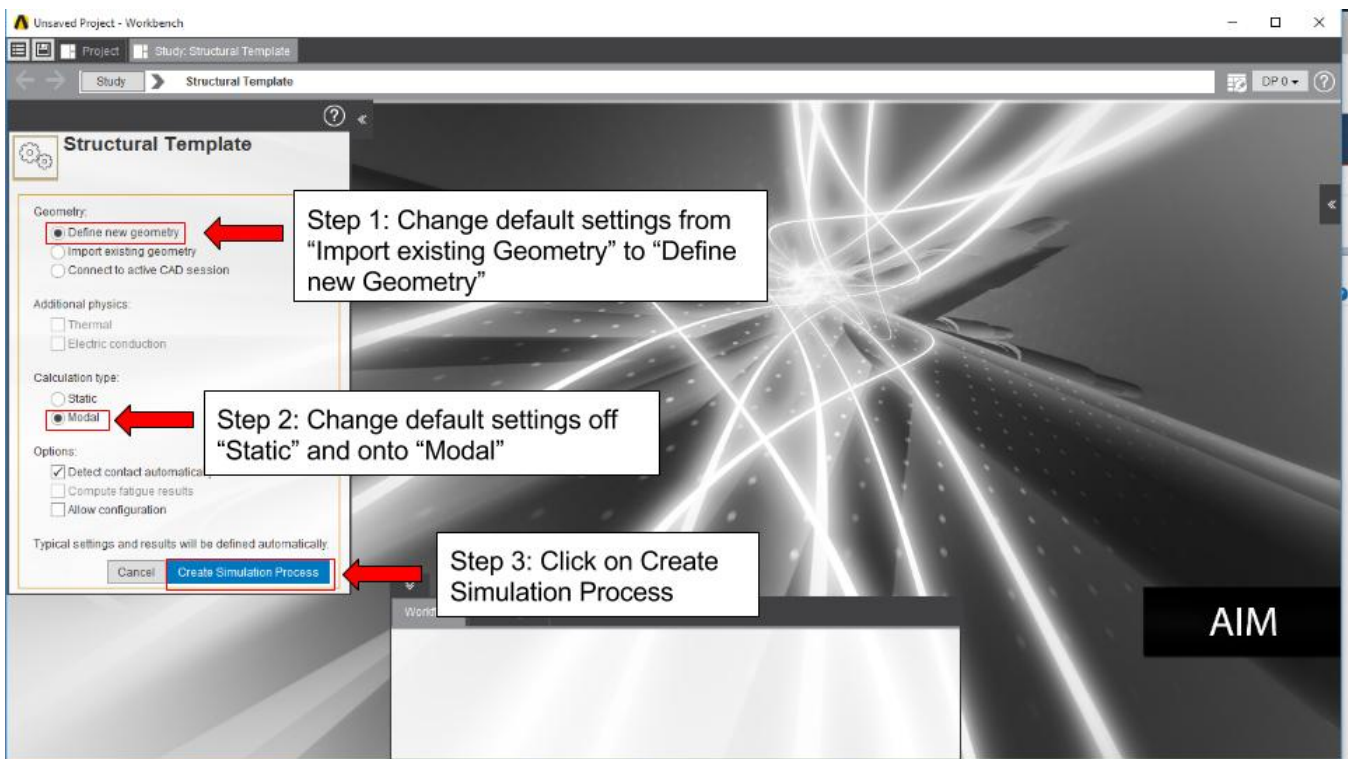
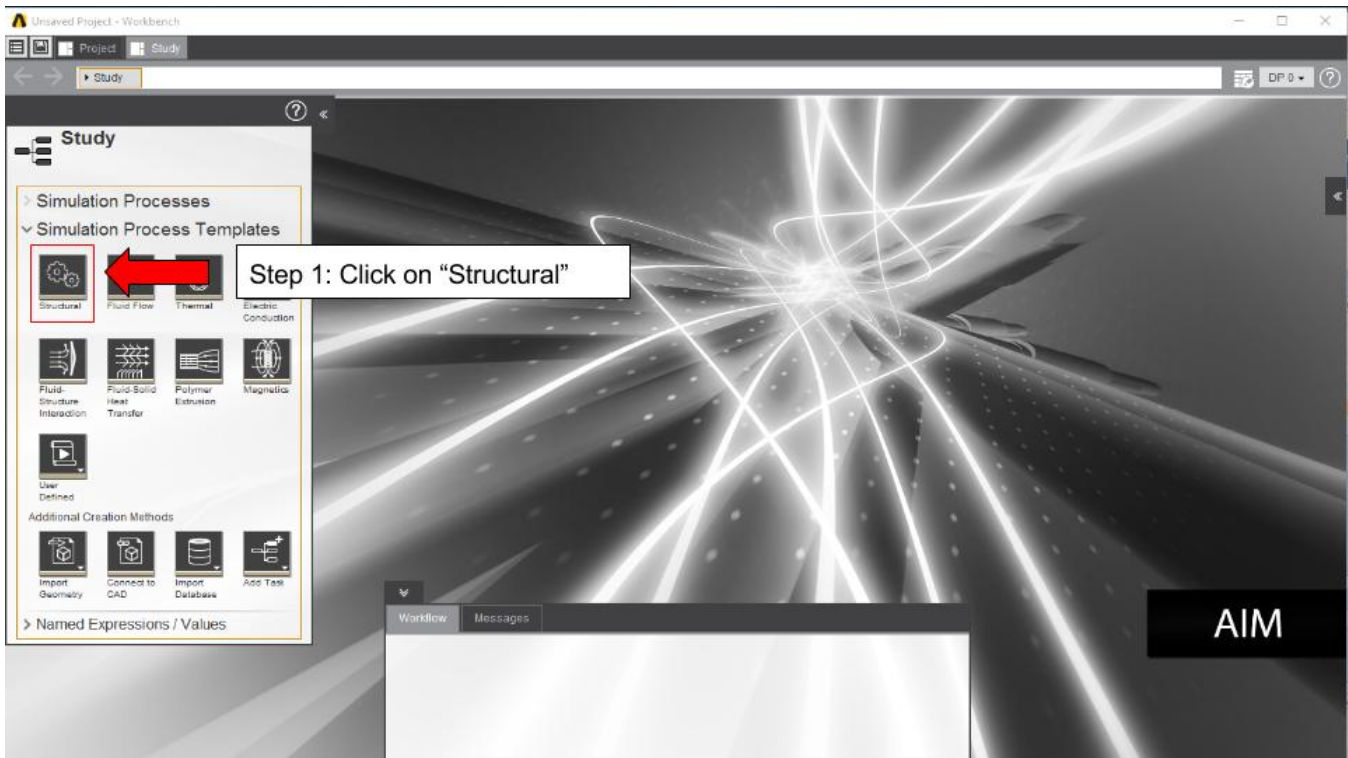
$$w_3 = 7.855^2 \sqrt{\frac{70 \text{ E9} \frac{\text{kg}}{\text{m} \cdot \text{s}^2} \cdot \frac{0.346 \text{ m} \cdot (0.346 \text{ m})^3}{12}}{2.7 \text{ E3} \frac{\text{kg}}{\text{m}^3} \cdot 4 \text{ m} \cdot 0.346 \text{ m} \cdot 0.346 \text{ m} \cdot (4 \text{ m})^3}} = 1961.2 \frac{\text{rad}}{\text{s}} = 312.1 \text{ Hz}$$

$$y_i(x) = \cosh\left(\frac{\alpha_i x}{L}\right) - \cos\left(\frac{\alpha_i x}{L}\right) - \sigma_i \left(\sinh\left(\frac{\alpha_i x}{L}\right) - \sin\left(\frac{\alpha_i x}{L}\right) \right)$$

$$\alpha_i = 1.875, 4.694, 7.855, \dots$$

$$\sigma_i = 0.73409, 1.018647, 0.9992245, \dots$$

Start-Up



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