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Effect of Inertia of Constraint in Longitudinal and Transverse Vibrations Formulas

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List of 12 Effect of Inertia of Constraint in Longitudinal and Transverse Vibrations Formulas

Effect of Inertia of Constraint in Longitudinal and Transverse Vibrations

Longitudinal Vibration

1) Length of Constraint for Longitudinal Vibration

$$\text{fx } l = \frac{V_{\text{longitudinal}} \cdot x}{v_s}$$

[Open Calculator !\[\]\(cbe2492b119e39e02a1dab2af4a4b296_img.jpg\)](#)

$$\text{ex } 7.32\text{mm} = \frac{4\text{m/s} \cdot 3.66\text{mm}}{2\text{m/s}}$$

2) Longitudinal Velocity of Free End for Longitudinal Vibration

$$\text{fx } V_{\text{longitudinal}} = \sqrt{\frac{6 \cdot \text{KE}}{m_c}}$$

[Open Calculator !\[\]\(870f5d5e9c0d57485634be3ecf52f3ca_img.jpg\)](#)

$$\text{ex } 4.008919\text{m/s} = \sqrt{\frac{6 \cdot 75\text{J}}{28\text{kg}}}$$



3) Natural Frequency of Longitudinal Vibration

[Open Calculator !\[\]\(2bdfe261b986065ee0ac76460d6528c9_img.jpg\)](#)

$$fx \quad f = \sqrt{\frac{S_{\text{constrain}}}{W_{\text{attached}} + \frac{m_c}{3}}} \cdot \frac{1}{2 \cdot \pi}$$

$$ex \quad 0.18281\text{Hz} = \sqrt{\frac{13\text{N/m}}{0.52\text{kg} + \frac{28\text{kg}}{3}}} \cdot \frac{1}{2 \cdot \pi}$$

4) Total Kinetic Energy of Constraint in Longitudinal Vibration

[Open Calculator !\[\]\(c694a3ff3b077d76910920a6a1593ab4_img.jpg\)](#)

$$fx \quad KE = \frac{m_c \cdot V_{\text{longitudinal}}^2}{6}$$

$$ex \quad 74.66667\text{J} = \frac{28\text{kg} \cdot (4\text{m/s})^2}{6}$$

5) Total Mass of Constraint for Longitudinal Vibration

[Open Calculator !\[\]\(dd161862f9164df98f62b726e9846241_img.jpg\)](#)

$$fx \quad m_c = \frac{6 \cdot KE}{V_{\text{longitudinal}}^2}$$

$$ex \quad 28.125\text{kg} = \frac{6 \cdot 75\text{J}}{(4\text{m/s})^2}$$



6) Velocity of Small Element for Longitudinal Vibration

$$fx \quad v_s = \frac{x \cdot V_{\text{longitudinal}}}{l}$$

[Open Calculator !\[\]\(bd1a142de767a21e5362c595f844a4ff_img.jpg\)](#)

$$ex \quad 1.997271\text{m/s} = \frac{3.66\text{mm} \cdot 4\text{m/s}}{7.33\text{mm}}$$

Transverse Vibration

7) Length of Constraint for Transverse Vibrations

$$fx \quad l = \frac{m_c}{m}$$

[Open Calculator !\[\]\(0b5e7e25e8775f7e7e80906ada4f0021_img.jpg\)](#)

$$ex \quad 7\text{mm} = \frac{28\text{kg}}{4000\text{kg/m}}$$

8) Natural Frequency of Transverse Vibration

$$fx \quad f = \frac{\sqrt{\frac{s_{\text{constrain}}}{W_{\text{attached}} + m_c \cdot \frac{33}{140}}}}{2 \cdot \pi}$$

[Open Calculator !\[\]\(bd3b31712ad9bab5a241210fa6925cdd_img.jpg\)](#)

$$ex \quad 0.215056\text{Hz} = \frac{\sqrt{\frac{13\text{N/m}}{0.52\text{kg} + 28\text{kg} \cdot \frac{33}{140}}}}{2 \cdot \pi}$$



9) Total Kinetic Energy of Constraint for Transverse Vibrations

$$\text{fx } KE = \frac{33 \cdot m_c \cdot V_{\text{traverse}}^2}{280}$$

[Open Calculator !\[\]\(eafc244b53721dd1ec133f0772f70fc7_img.jpg\)](#)

$$\text{ex } 118.8\text{J} = \frac{33 \cdot 28\text{kg} \cdot (6\text{m/s})^2}{280}$$

10) Total Mass of Constraint for Transverse Vibrations

$$\text{fx } m_c = \frac{280 \cdot KE}{33 \cdot V_{\text{traverse}}^2}$$

[Open Calculator !\[\]\(10f8862fc183b400327470ea85afe9ae_img.jpg\)](#)

$$\text{ex } 17.67677\text{kg} = \frac{280 \cdot 75\text{J}}{33 \cdot (6\text{m/s})^2}$$

11) Transverse Velocity of Free End

$$\text{fx } V_{\text{traverse}} = \sqrt{\frac{280 \cdot KE}{33 \cdot m_c}}$$

[Open Calculator !\[\]\(35dc653d59570f8f891c312eeece91a2_img.jpg\)](#)

$$\text{ex } 4.767313\text{m/s} = \sqrt{\frac{280 \cdot 75\text{J}}{33 \cdot 28\text{kg}}}$$



12) Velocity of Small Element for Transverse Vibrations 

$$fx \quad v_s = \frac{(3 \cdot l \cdot x^2 - x^3) \cdot V_{\text{traverse}}}{2 \cdot l^3}$$

[Open Calculator !\[\]\(feabb98897b440bc8695a03336a6e2df_img.jpg\)](#)

$$ex \quad 1.870398\text{m/s} = \frac{(3 \cdot 7.33\text{mm} \cdot (3.66\text{mm})^2 - (3.66\text{mm})^3) \cdot 6\text{m/s}}{2 \cdot (7.33\text{mm})^3}$$










Variables Used

- **f** Frequency (Hertz)
- **KE** Kinetic Energy (Joule)
- **l** Length of Constraint (Millimeter)
- **m** Mass (Kilogram per Meter)
- **m_c** Total Mass of Constraint (Kilogram)
- **S_{constrain}** Stiffness of Constraint (Newton per Meter)
- **V_{longitudinal}** Longitudinal Velocity of Free End (Meter per Second)
- **v_s** Velocity of Small Element (Meter per Second)
- **V_{traverse}** Transverse Velocity of Free End (Meter per Second)
- **W_{attached}** Load Attached to Free End of Constraint (Kilogram)
- **x** Distance between Small Element and Fixed End (Millimeter)



Constants, Functions, Measurements used

- **Constant:** **pi**, 3.14159265358979323846264338327950288
Archimedes' constant
- **Function:** **sqrt**, sqrt(Number)
Square root function
- **Measurement:** **Length** in Millimeter (mm)
Length Unit Conversion 
- **Measurement:** **Weight** in Kilogram (kg)
Weight Unit Conversion 
- **Measurement:** **Speed** in Meter per Second (m/s)
Speed Unit Conversion 
- **Measurement:** **Energy** in Joule (J)
Energy Unit Conversion 
- **Measurement:** **Frequency** in Hertz (Hz)
Frequency Unit Conversion 
- **Measurement:** **Surface Tension** in Newton per Meter (N/m)
Surface Tension Unit Conversion 
- **Measurement:** **Linear Mass Density** in Kilogram per Meter (kg/m)
Linear Mass Density Unit Conversion 



Check other formula lists

- [Load for Various Types of Beams and Load Conditions Formulas](#) 
- [Critical or Whirling Speed of a Shaft Formulas](#) 
- [Effect of Inertia of Constraint in Longitudinal and Transverse Vibrations Formulas](#) 
- [Frequency of Free Damped Vibrations Formulas](#) 
- [Frequency of Under Damped Forced Vibrations Formulas](#) 
- [Magnification Factor or Dynamic Magnifier Formulas](#) 
- [Natural Frequency of Free Transverse Vibrations Formulas](#) 
- [Natural Frequency of Free Transverse Vibrations Due to Uniformly Distributed Load Acting Over a Simply Supported Shaft Formulas](#) 
- [Natural Frequency of Free Transverse Vibrations For a Shaft Subjected to a Number of Point Loads Formulas](#) 
- [Natural Frequency of Free Transverse Vibrations of a Shaft Fixed at Both Ends Carrying a Uniformly Distributed Load Formulas](#) 
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