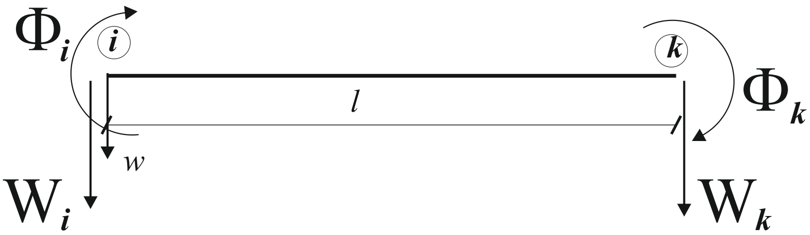
Wzory transformacyjne drgań harmonicznych



$$\lambda = l\sqrt[4]{\frac{\mu\omega^2}{EJ}}$$

$$\Phi_i = \frac{EJ}{l}[\alpha(\lambda)\varphi_i + \beta(\lambda)\varphi_k + \vartheta(\lambda)\frac{w_i}{l} - \delta(\lambda)\frac{w_k}{l}]$$

$$\Phi_k = \frac{EJ}{l}[\beta(\lambda)\varphi_i + \alpha(\lambda)\varphi_k + \delta(\lambda)\frac{w_i}{l} - \vartheta(\lambda)\frac{w_k}{l}]$$

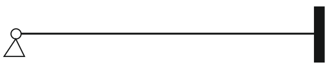
$$W_i = \frac{EJ}{l^2}[\vartheta(\lambda)\varphi_i + \delta(\lambda)\varphi_k + \gamma(\lambda)\frac{w_i}{l} - \varepsilon(\lambda)\frac{w_k}{l}]$$

$$W_k = -\frac{EJ}{l^2}[\delta(\lambda)\varphi_i + \vartheta(\lambda)\varphi_k + \varepsilon(\lambda)\frac{w_i}{l} - \gamma(\lambda)\frac{w_k}{l}]$$

$$\Phi_i = \frac{EJ}{l}[\alpha'(\lambda)\varphi_i + \vartheta'(\lambda)\frac{w_i}{l} - \delta'(\lambda)\frac{w_k}{l}]$$

$$W_i = \frac{EJ}{l^2}[\vartheta'(\lambda)\varphi_i + \gamma'(\lambda)\frac{w_i}{l} - \varepsilon'(\lambda)\frac{w_k}{l}]$$

$$W_k = -\frac{EJ}{l^2}[\delta'(\lambda)\varphi_i + \varepsilon'(\lambda)\frac{w_i}{l} - \chi'(\lambda)\frac{w_k}{l}]$$



$$\Phi_k = \frac{EJ}{l}[\alpha'(\lambda)\varphi_k + \delta'(\lambda)\frac{w_i}{l} - \vartheta'(\lambda)\frac{w_k}{l}]$$

$$W_i = \frac{EJ}{l^2}[\delta'(\lambda)\varphi_k + \chi'(\lambda)\frac{w_i}{l} - \varepsilon'(\lambda)\frac{w_k}{l}]$$

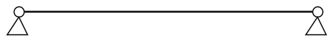
$$W_k = -\frac{EJ}{l^2}[\vartheta'(\lambda)\varphi_k + \varepsilon'(\lambda)\frac{w_i}{l} - \gamma'(\lambda)\frac{w_k}{l}]$$

$$\Phi_i = \frac{EJ}{l}[\alpha''(\lambda)\varphi_i + \vartheta''(\lambda)\frac{w_i}{l}]$$

$$W_i = \frac{EJ}{l^2}[\vartheta''(\lambda)\varphi_i + \gamma''(\lambda)\frac{w_i}{l}]$$

$$\Phi_k = \frac{EJ}{l}[\alpha''(\lambda)\varphi_k - \vartheta''(\lambda)\frac{w_k}{l}]$$

$$W_k = -\frac{EJ}{l^2}[\vartheta''(\lambda)\varphi_k - \gamma''(\lambda)\frac{w_k}{l}]$$



$$W_i = \frac{EJ}{l^2}[\gamma'''(\lambda)\frac{w_i}{l} - \varepsilon'''(\lambda)\frac{w_k}{l}]$$

$$W_k = -\frac{EJ}{l^2}[\varepsilon'''(\lambda)\frac{w_i}{l} - \gamma'''(\lambda)\frac{w_k}{l}]$$

$$\alpha'(\lambda) = \alpha(\lambda) - \frac{\beta^2(\lambda)}{\alpha(\lambda)} = \lambda\frac{2sh\lambda\sin\lambda}{ch\lambda\sin\lambda - sh\lambda\cos\lambda}$$

$$\vartheta'(\lambda) = \vartheta(\lambda) - \frac{\beta(\lambda)\delta(\lambda)}{\alpha(\lambda)} = \lambda^2\frac{ch\lambda\sin\lambda + sh\lambda\cos\lambda}{ch\lambda\sin\lambda - sh\lambda\cos\lambda}$$

$$\delta'(\lambda) = \delta(\lambda) - \frac{\beta(\lambda)\vartheta(\lambda)}{\alpha(\lambda)} = \lambda^2\frac{sh\lambda + \sin\lambda}{ch\lambda\sin\lambda - sh\lambda\cos\lambda}$$

$$\gamma'(\lambda) = \gamma(\lambda) - \frac{\delta^2(\lambda)}{\alpha(\lambda)} = \lambda^3\frac{2ch\lambda\cos\lambda}{ch\lambda\sin\lambda - sh\lambda\cos\lambda}$$

$$\varepsilon'(\lambda) = \varepsilon(\lambda) - \frac{\delta(\lambda)\vartheta(\lambda)}{\alpha(\lambda)} = \lambda^3\frac{ch\lambda + \cos\lambda}{ch\lambda\sin\lambda - sh\lambda\cos\lambda}$$

$$\chi'(\lambda) = \gamma(\lambda) - \frac{\vartheta^2(\lambda)}{\alpha(\lambda)} = \lambda^3\frac{1 + ch\lambda\cos\lambda}{ch\lambda\sin\lambda - sh\lambda\cos\lambda}$$

$$\alpha''(\lambda) = \alpha'(\lambda) - \frac{\delta'^2(\lambda)}{\chi'(\lambda)} = -\lambda\frac{ch\lambda\sin\lambda - sh\lambda\cos\lambda}{1 + ch\lambda\cos\lambda}$$

$$\vartheta''(\lambda) = \vartheta'(\lambda) - \frac{\delta'(\lambda)\varepsilon'(\lambda)}{\chi'(\lambda)} = -\lambda^2\frac{sh\lambda\sin\lambda}{1 + ch\lambda\cos\lambda}$$

$$\gamma''(\lambda) = \gamma'(\lambda) - \frac{\varepsilon'^2(\lambda)}{\chi'(\lambda)} = -\lambda^3\frac{ch\lambda\sin\lambda + sh\lambda\cos\lambda}{1 + ch\lambda\cos\lambda}$$

$$\gamma'''(\lambda) = \gamma'(\lambda) - \frac{\vartheta'^2(\lambda)}{\alpha'(\lambda)} = -\frac{\lambda^3}{2}\frac{ch\lambda\sin\lambda - sh\lambda\cos\lambda}{sh\lambda\sin\lambda}$$

$$\varepsilon'''(\lambda) = \varepsilon'(\lambda) - \frac{\vartheta'(\lambda)\delta'(\lambda)}{\alpha'(\lambda)} = \frac{\lambda^3}{2}\frac{sh\lambda - \sin\lambda}{sh\lambda\sin\lambda}$$

$$\alpha(\lambda) = \lambda\frac{ch\lambda\sin\lambda - sh\lambda\cos\lambda}{1 - ch\lambda\cos\lambda}$$

$$\beta(\lambda) = \lambda\frac{sh\lambda - \sin\lambda}{1 - ch\lambda\cos\lambda}$$

$$\vartheta(\lambda) = \lambda^2\frac{sh\lambda\sin\lambda}{1 - ch\lambda\cos\lambda}$$

$$\delta(\lambda) = \lambda^2\frac{ch\lambda - \cos\lambda}{1 - ch\lambda\cos\lambda}$$

$$\gamma(\lambda) = \lambda^3\frac{ch\lambda\sin\lambda + sh\lambda\cos\lambda}{1 - ch\lambda\cos\lambda}$$

$$\varepsilon(\lambda) = \lambda^3\frac{sh\lambda + \sin\lambda}{1 - ch\lambda\cos\lambda}$$