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STUDENT > # Compare PEtension to PEbending
STUDENT > #  For simply-supported shaft of length L, diameter D
STUDENT > #  mat properties rho, E
STUDENT > #  Applied tension is T
STUDENT > #  Assumed mode-shape is y(x)=Y0*sin(pi*x/L)
STUDENT >
STUDENT > # Symbols
STUDENT > #  x = axial coordinate
STUDENT > #  y(x) = transverse displacement
STUDENT > #  T = applied tension
STUDENT > #  Yp(x) = 1st deriv of y wrt x
STUDENT > #  Ypp(x)= 2nd derivative of y wrt x
          #    (p for prime)
STUDENT > # PEtension = PE due to tension
STUDENT > # PEbending = PE due to bending
STUDENT > restart;
STUDENT >
STUDENT > y(x):=Y0*sin(Pi*x/L);
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$$\mathrm{y}(x) := Y0 \sin\left(\frac{\pi x}{L}\right)$$

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STUDENT > Yp(x):=diff(y(x),x);
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$$\mathrm{Yp}(x) := \frac{Y0 \cos\left(\frac{\pi x}{L}\right) \pi}{L}$$

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STUDENT > Ypp(x):=diff(Yp(x),x);  #Ypp = 2nd derivative o
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$$\mathrm{Ypp}(x) := -\frac{Y0 \sin\left(\frac{\pi x}{L}\right) \pi^2}{L^2}$$

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STUDENT > PEbending:=(1/2)*E*Id*int(Ypp(x)^2,x=0..L);
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$$PEbending := \frac{1}{4} \frac{E\, Id\, \pi^4\, Y0^2}{L^3}$$

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STUDENT > PEtension:= (1/2)*T*int(Yp(x)^2,x=0..L);
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$$PEtension := \frac{1}{4} \frac{T\, \pi^2\, Y0^2}{L}$$

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STUDENT > PEtension/PEbending;
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$$\frac{T L^2}{\pi^2 E\, Id}$$

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STUDENT > Id:=Pi*D^4/64;
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$$Id := \frac{1}{64} \pi D^4$$

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STUDENT > PEtension/PEbending;
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$$64 \frac{T L^2}{\pi^3 E D^4}$$

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STUDENT > # What is highest reasonable loading T?
STUDENT > # Let's say 30Kpsi stress level which is 1/1000 of
          E=30MPSI
STUDENT > # Substitute this loading level
STUDENT > simplify(subs(T=0.001 *
          E*(pi*D^2/4),PEtension/PEbending));
```

$$.0005160245506 \frac{\pi L^2}{D^2}$$

```
STUDENT > # This is very small number
STUDENT > # Even if it is as high as 10%, the change in resonant
          frequency would be 1%
STUDENT > # Conclude this is negligible effect.  Comments?
STUDENT >
```