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Elastostatic approximation of the locus of the loaded tip of a cantilever beam

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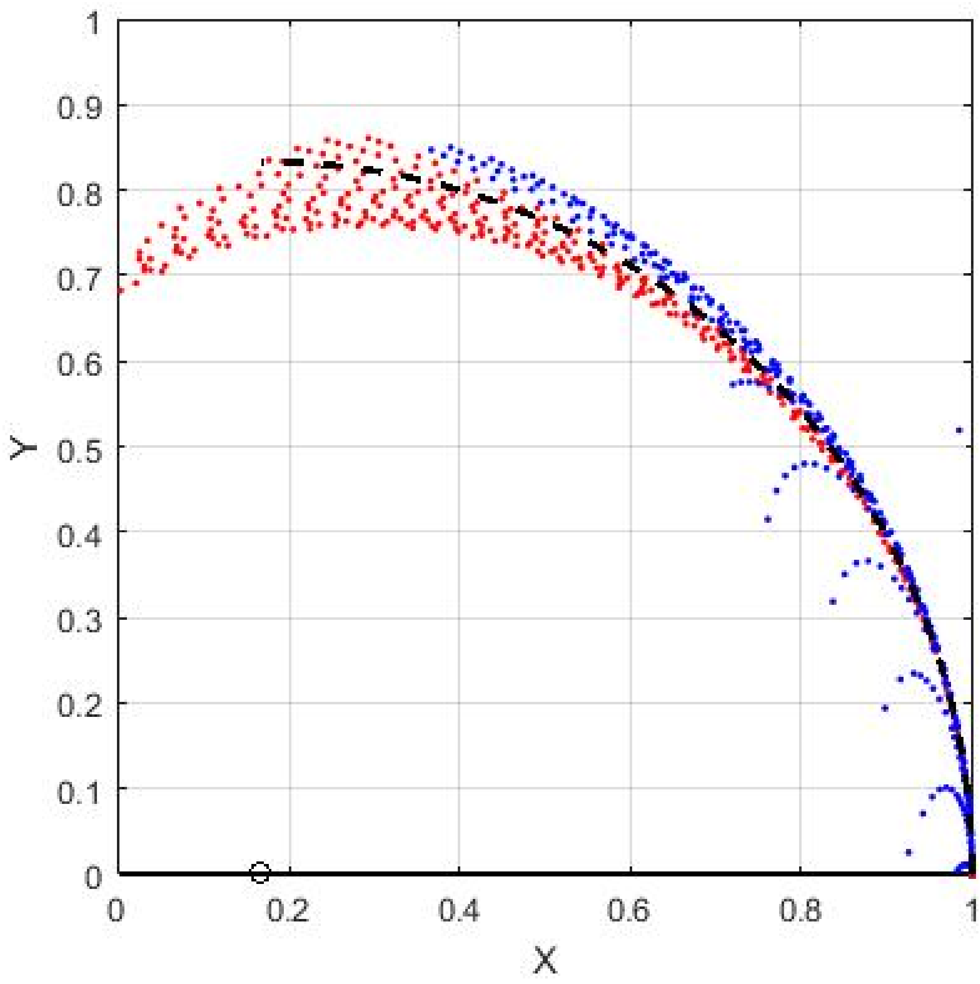
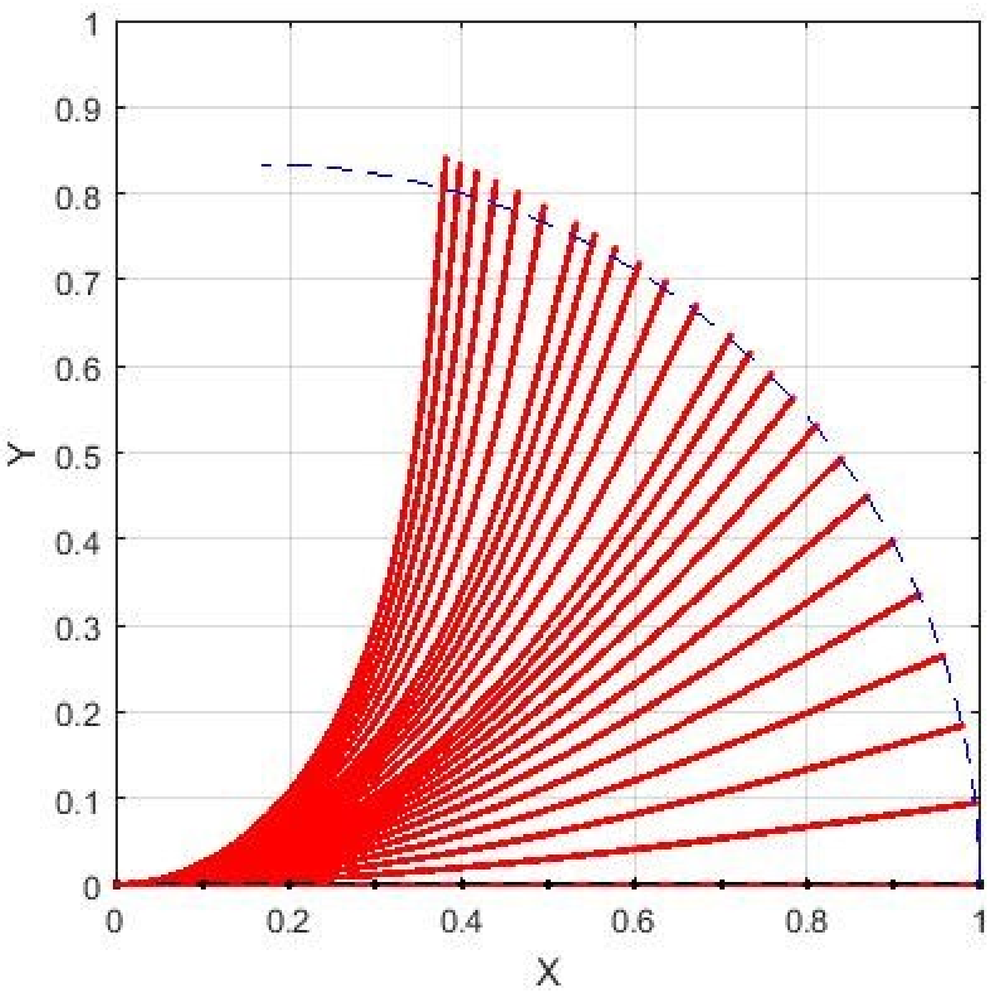
“Eureka” moment:
I see a circle there!

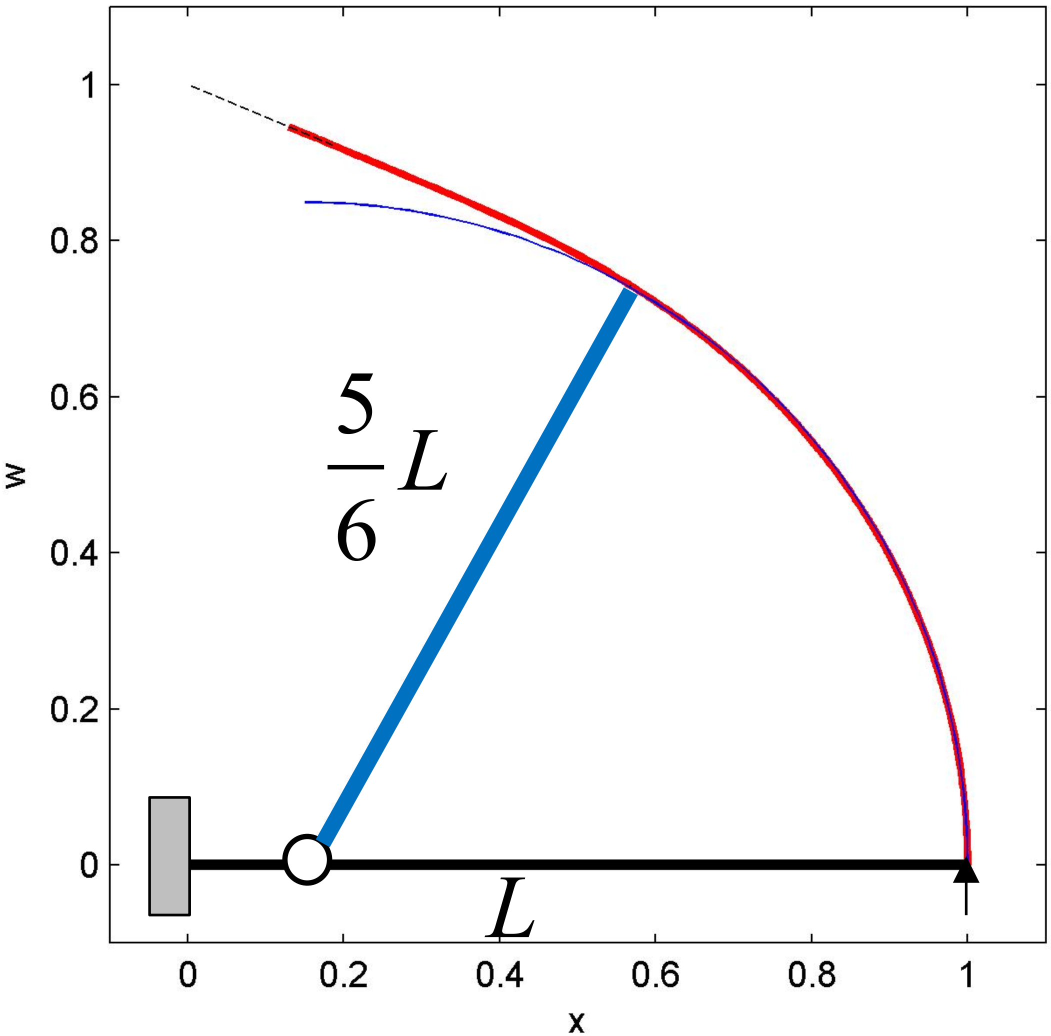


Kinematic approximation

The circle more clearly visible with only transverse loads



Kinematic approximation of the locus of the loaded tip

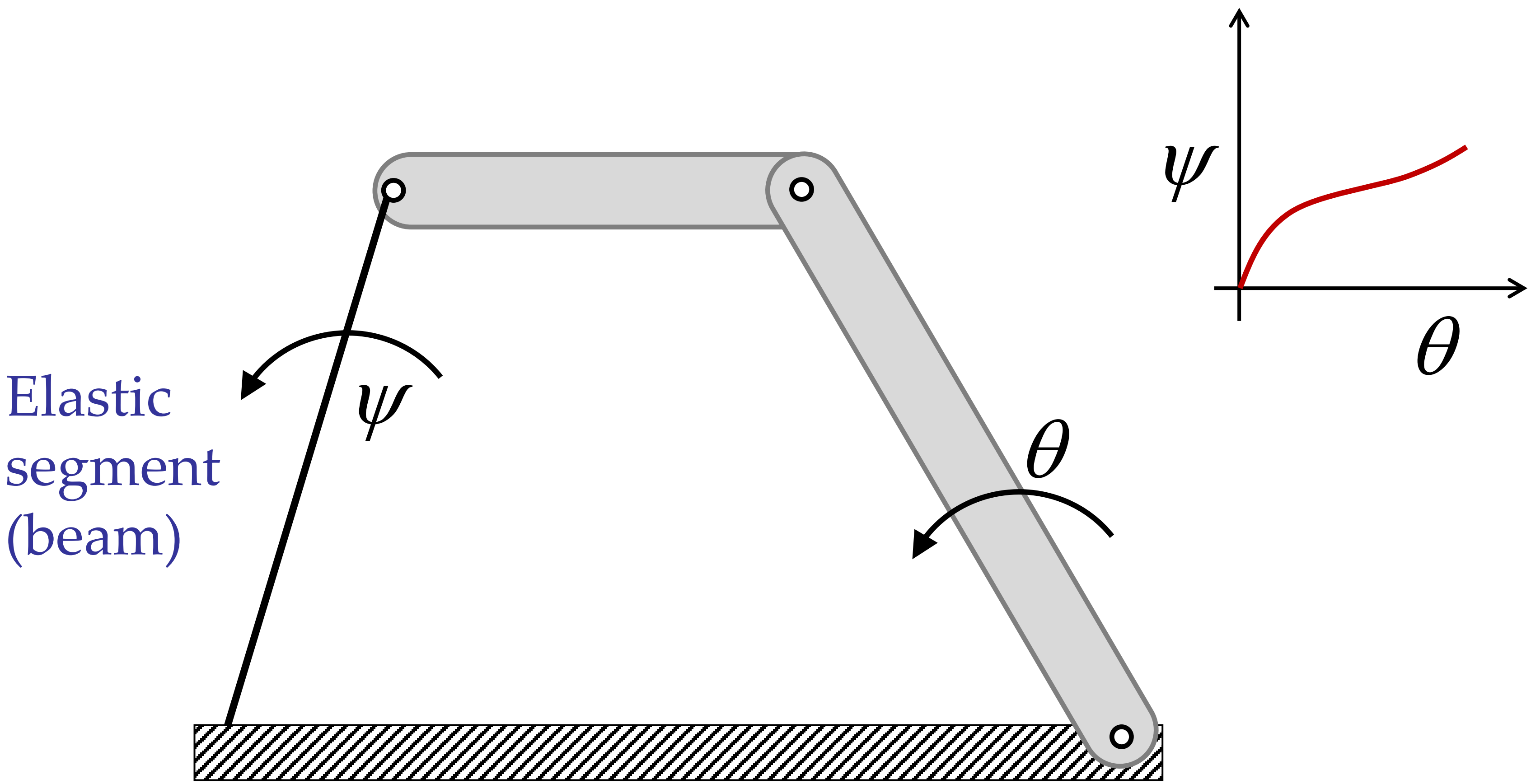


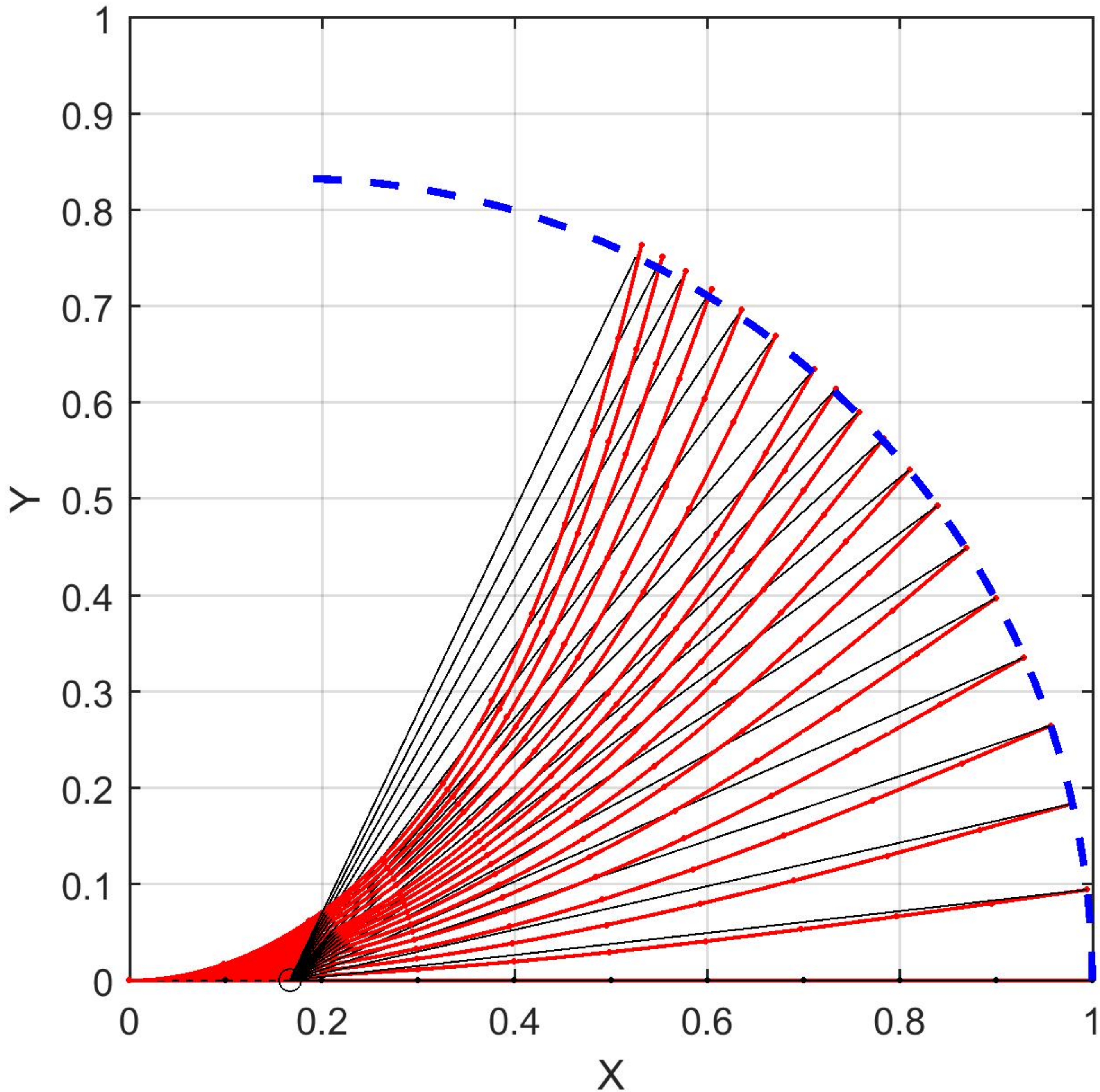
Burns, R. H. and Crossley, F. R. E., "Kinetostatic Synthesis of Flexible Link Mechanisms," Trans. ASME, 68-MECH-36, 1968.

Burns and Crossley, 1968

The locus can be approximated with a circular arc for a very large range of bending of a cantilever.

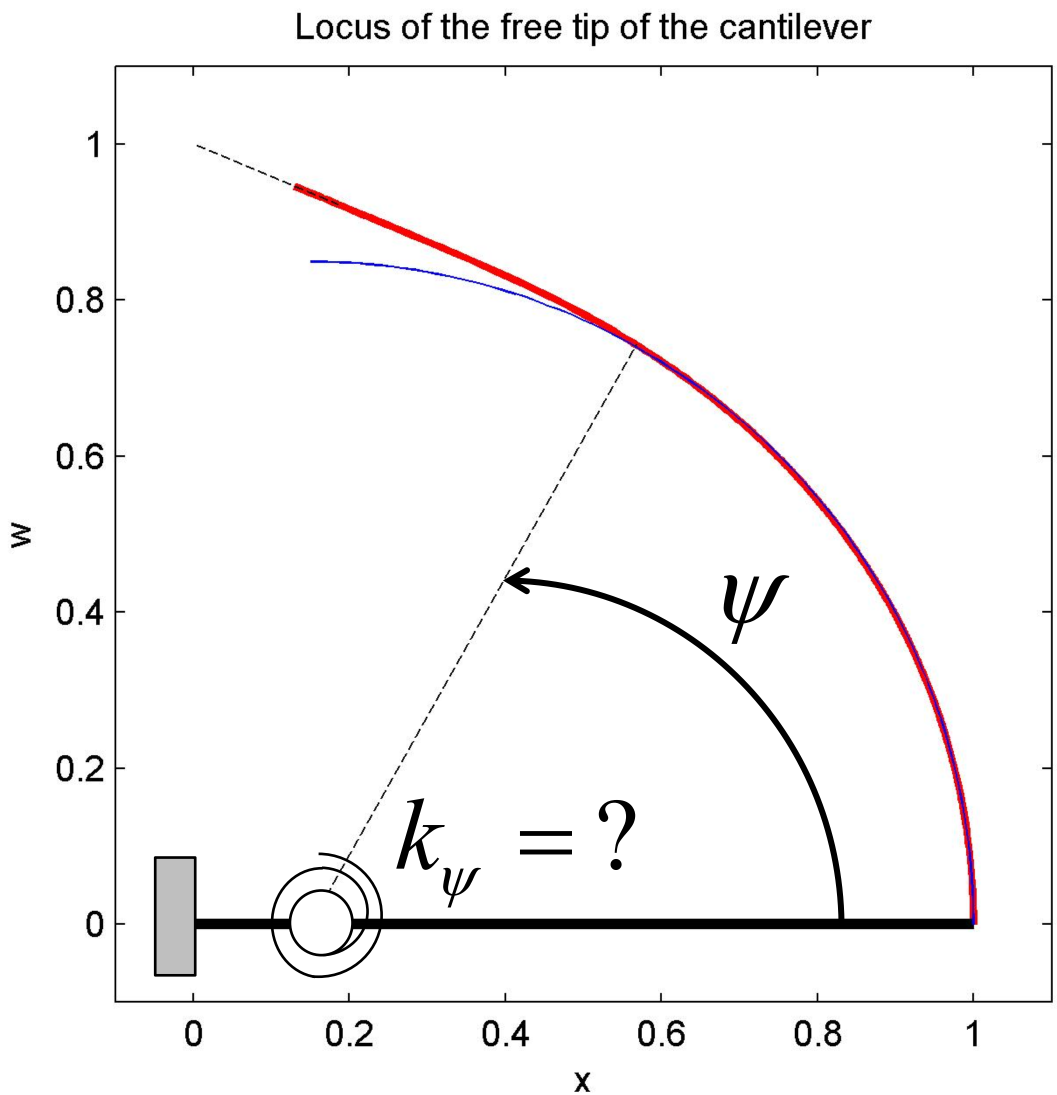
Now, can we solve this problem for "function generation"?





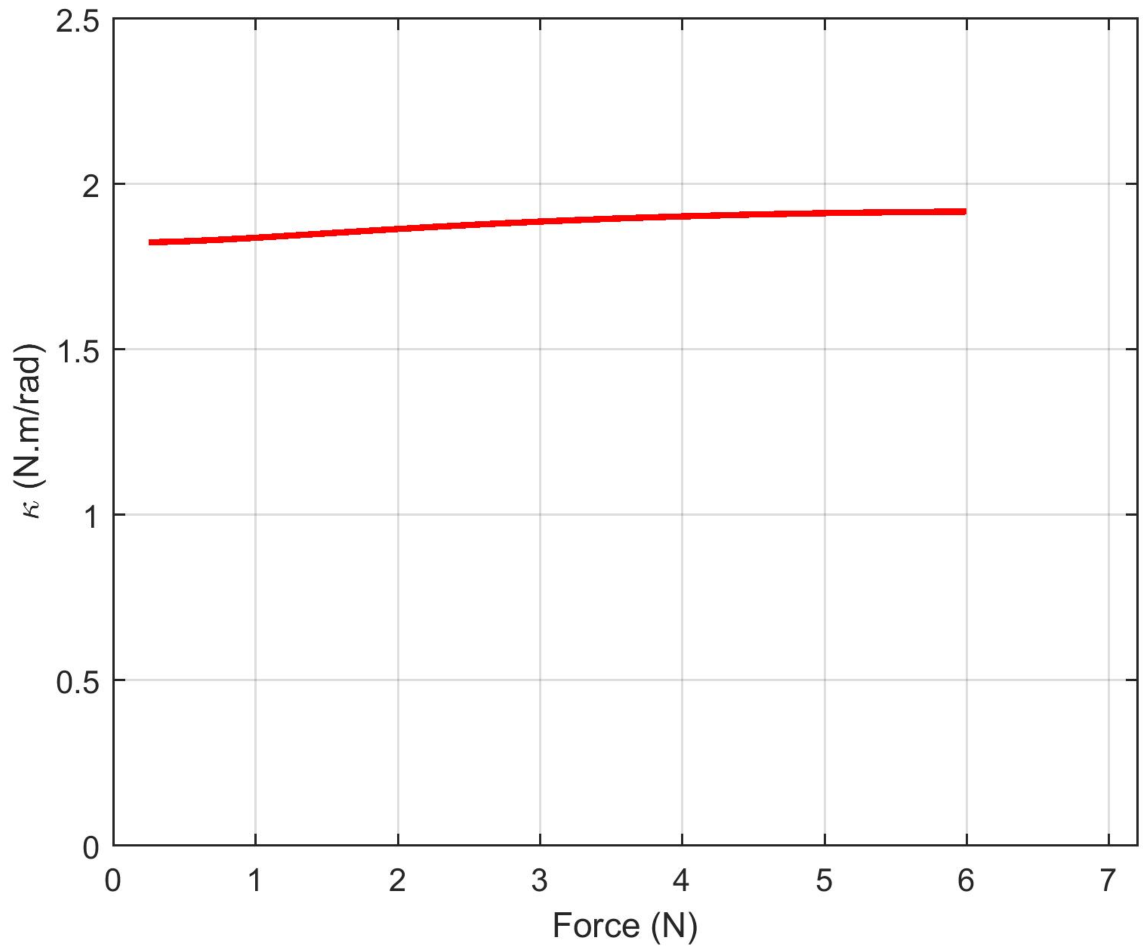
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
Y
0
0.2
0.4
0.6
0.8
1
X

What about the rotation spring constant?

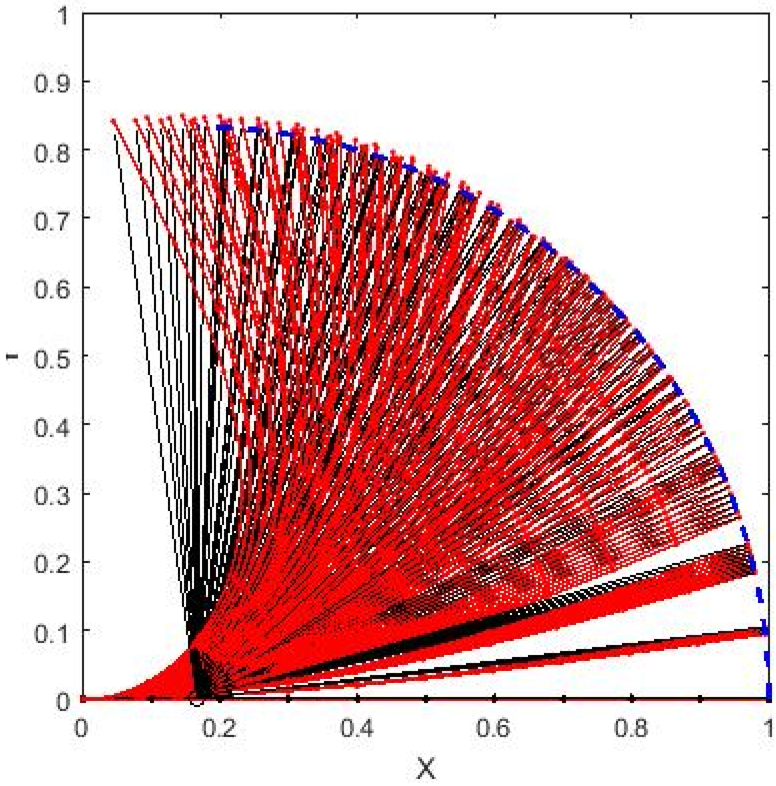


Rotation spring constant *is almost constant.*

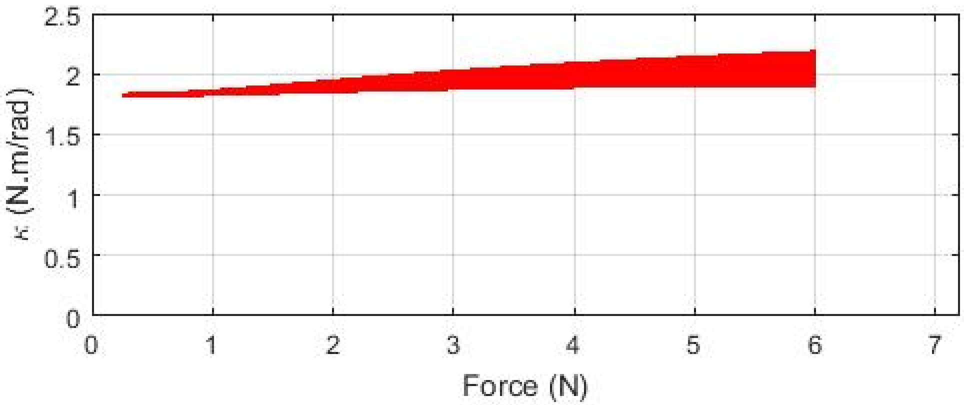
Another
"Eureka!"
moment



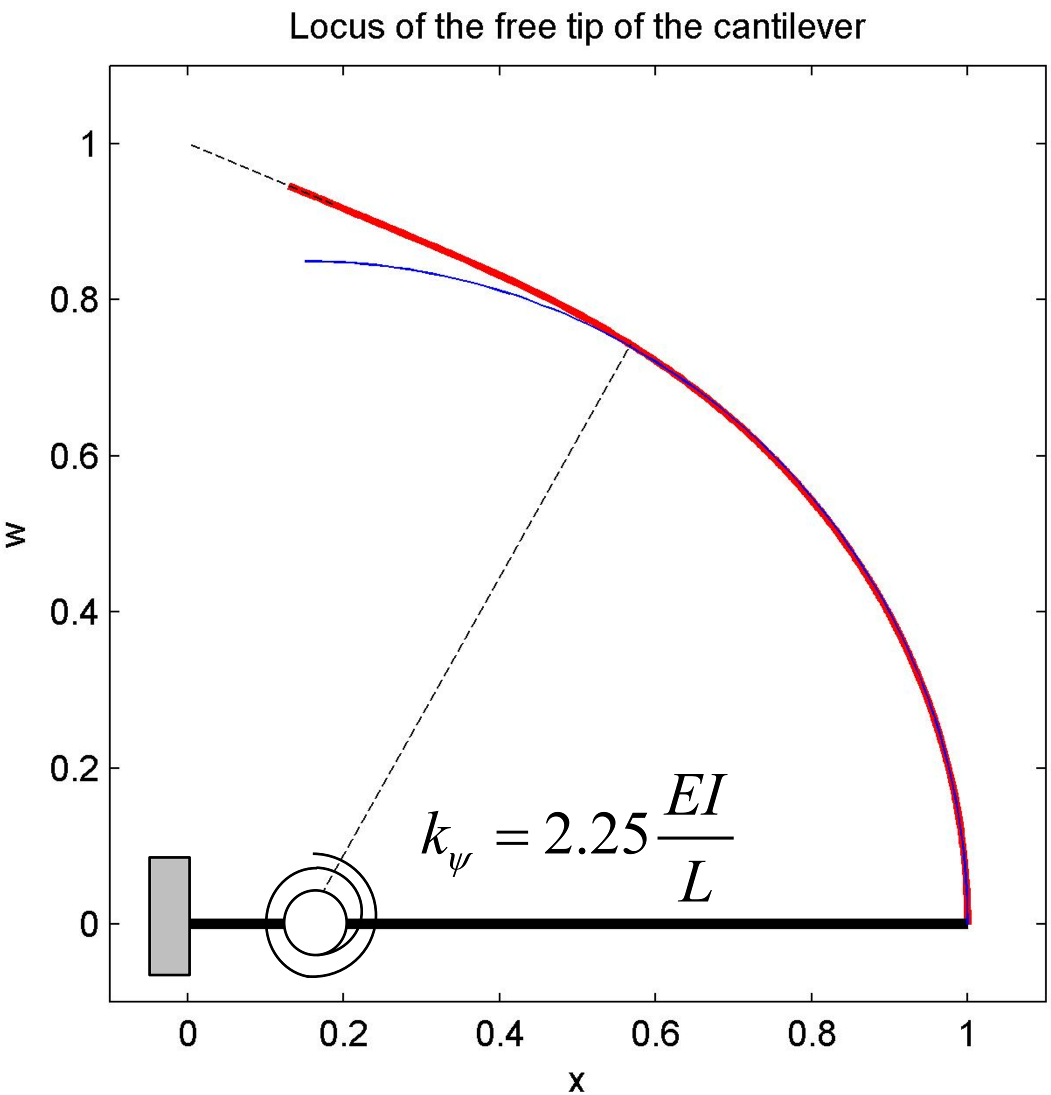
Inclined loads



n = -1 to 0



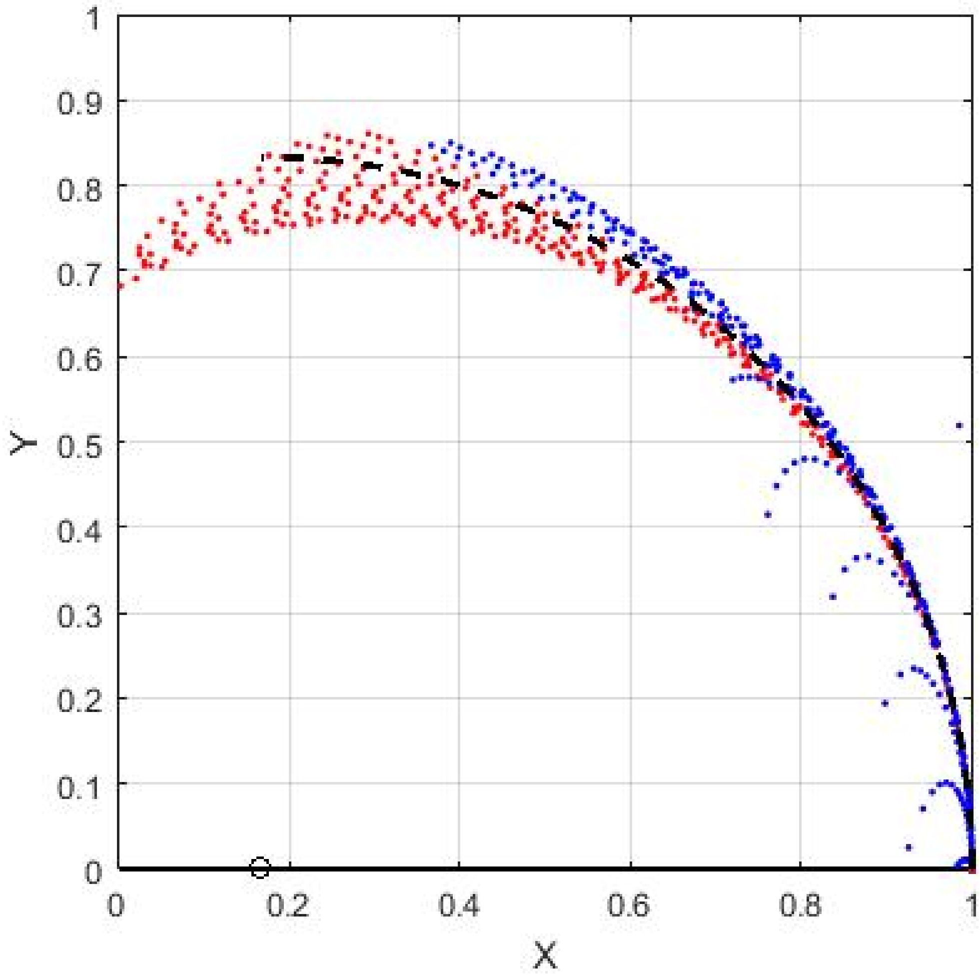
Elastostatic approximation



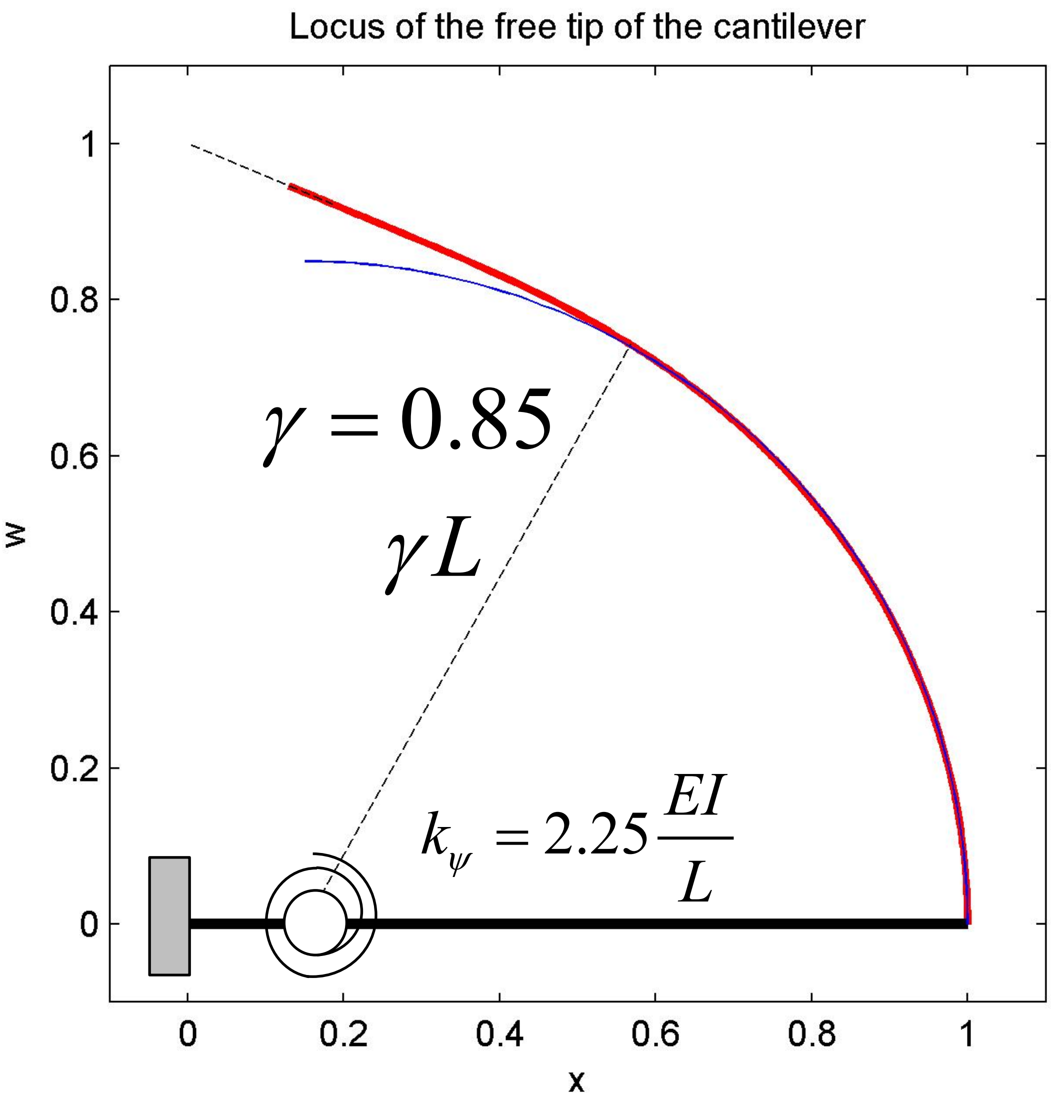
Howell and Midha, 1995

The rotational stiffness at the joint remains constant for a large range, too!

The reality of kinematic approximation



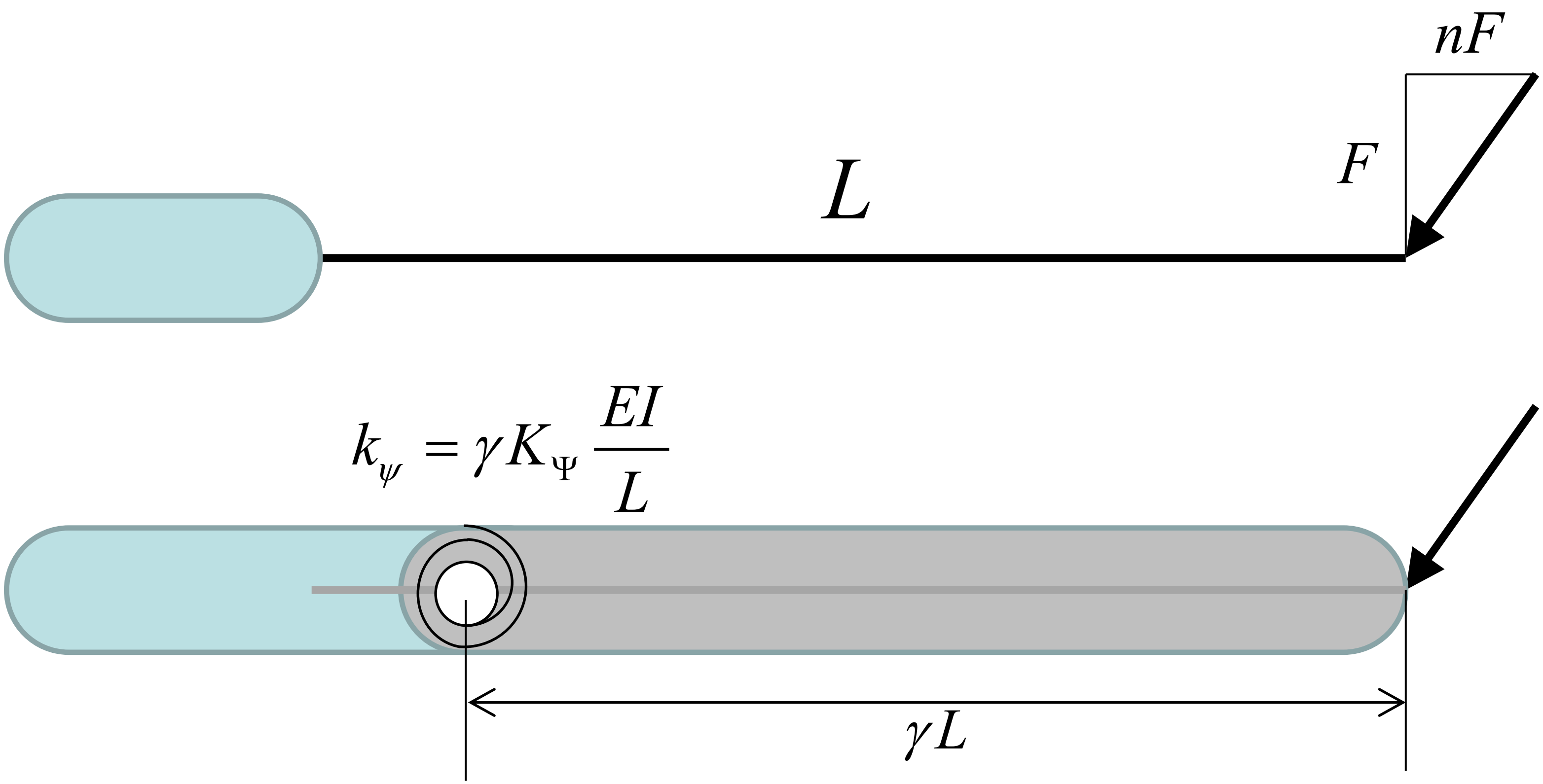
Pseudo rigid-body model



Howell and Midha, 1995

The rotational stiffness at the joint remains constant for a large range, too!

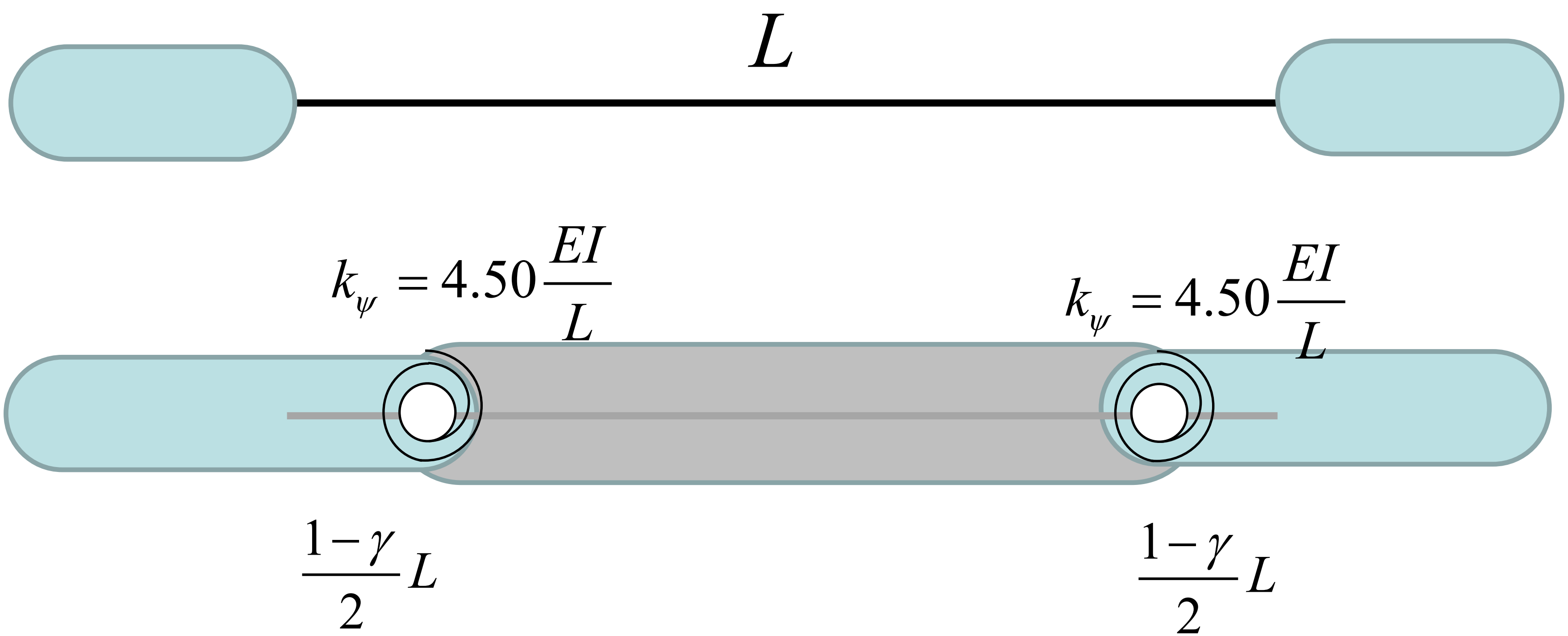
Transverse plus axial force



$$\gamma = \begin{cases} 0.84 - 0.007n + \cdots & 0.5 < n < 10 \\ 0.85 - 0.02n + \cdots & -1.83 < n \le 0.5 \\ 0.91 + 0.01n + \cdots & -5 < n \le 1.83 \end{cases} \qquad K_\Psi = \begin{cases} 3.02 + 0.12n \\ 1.97 - 2.62n + \cdots \\ 2.65 - 0.05n + \cdots \end{cases}$$

Different ranges of n

PRB for a fixed-fixed beam



Further reading

- Burns, R. H. and Crossley, F. R. E., “Kinetostatic Synthesis of Flexible Link Mechanisms,” Trans. ASME, 68-MECH-36, 1968.
- Burns, R. H. and Crossley, F. R. E., “Structural Permuations of Flexible Link Mechanisms,” Trans. ASME, 66-MECH-5, 1966.
- Burns, R. H., “The Kinetostatic Synthesis and Analysis of Flexible Link Mechanisms,” Dr. Eng. Dissertation, Yale Univ., 1964.