The Spring Model vs. The Beam Model: our observations

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The Spring Model

\[
\frac{d^2 y(t)}{dt^2} + C \frac{dy(t)}{dt} + Ky(t) = 0
\]

**Parameters**

the restoring force \( K = \frac{k}{m} \)  
the damping constant \( C = \frac{c}{m} \)
fminsearch returns $C=0.7877$ and $K=1532.6$. 

Two-parameter model estimation

- experimental data
- model displacement

Residuals

- time (s)
To damp more slowly, we decreased the value of $C$

Data and model are in phase, so leave $K$ at value returned by fminsearch

$C = 0.52$

$K = 1532.6$
Best value of C (for fitting beginning and end of model) that we could find

C = 0.3
K = 1532.6

Model does not reflect the rate of damping of the actual data! Need a new model?
The Beam Model

\[ f(t, x) = \rho \frac{\partial^2 w}{\partial t^2} + \gamma \frac{\partial w}{\partial t} - \frac{\partial^2 M}{\partial x^2} \]

\[ w(t, 0) = \frac{\partial w}{\partial x}(t, 0) = 0 \]

\[ M(t, l) = \frac{\partial M}{\partial x}(t, l) = 0 \]

\[ w(0, x) = w_0(x), \quad \frac{\partial w}{\partial t}(0, x) = w_1(x) \]

where

\[ M(t, x) = -YI(x) \frac{\partial^2 w}{\partial x^2} - cI(x) \frac{\partial^3 w}{\partial x^2 \partial t} \]
Beam Model with Default Values

- Issue with FREQUENCY!
- Play with Young’s Modulus and the Density.
Changing Young’s Modulus (Y)

\[ Y = 0.24 \]
Changing the Density (Rho)

Rho = 0.081
Changing Y and Rho Together

Y = 0.24  Rho = 0.081
Residual vs. Time Graph

Residual for Fourth Simulation (Changing Rho & Y)
Conclusions