# MATLAB Toolbox for WBM

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# Example: Jointed EB-Beam

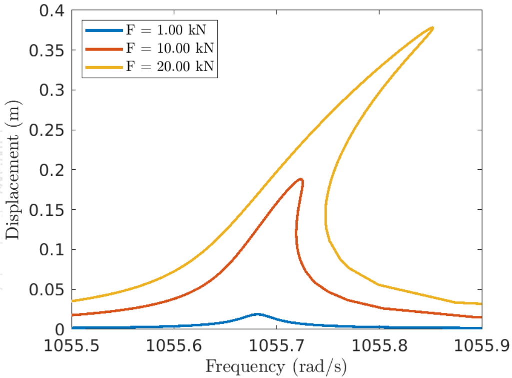



Figure: Forced Response

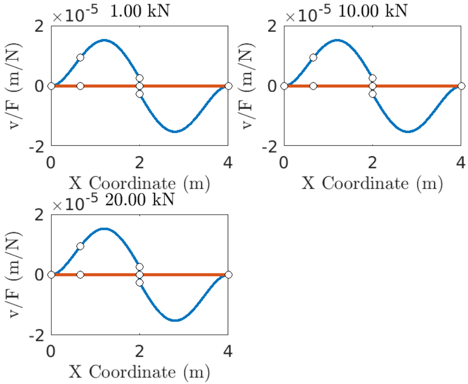



Figure: Deflection Shape

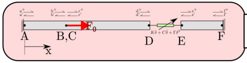
# Toolbox Plan I

**Dispersion Relationships**

$$k_1^+ = k_1^+(\omega)$$
$$k_1^- = k_1^-(\omega)$$
$$k_2^+ = k_2^+(\omega)$$
$$k_2^- = k_2^-(\omega)$$
$$\vdots$$

**Propagation Relationships**

$$\begin{bmatrix} b_1^+ \\ b_1^- \\ b_2^+ \\ b_2^- \\ \vdots \end{bmatrix} = \begin{bmatrix} e^{k_1^+ x_B} & 0 & 0 & 0 & \dots \\ 0 & e^{k_1^- x_B} & 0 & 0 & \dots \\ 0 & 0 & e^{k_2^+ x_B} & 0 & \dots \\ 0 & 0 & 0 & e^{k_2^- x_B} & \dots \\ \vdots & \vdots & \vdots & \vdots & \ddots \end{bmatrix} \begin{bmatrix} a_1^+ \\ a_1^- \\ a_2^+ \\ a_2^- \\ \vdots \end{bmatrix}$$




**Vector of Points**
X = {0, 0.1, 0.2, ...}

**Excitation Properties**

**Point Nonlinearities**

**Residue Vector**

# Toolbox Plan II

- Allows user to input arbitrary dispersion relationships for the different "pieces" in the model.
- Have implemented an **efficient symbolic differentiation** for all the expressions, making the Jacobian evaluations reliably fast, while ensuring the user doesn't need to type these in.
- Have validated the code for the bar examples in our paper as well as a jointed Euler-Bernoulli Beam example.
- **Muli-Harmonic**, allows for PWE-type harmonic balance (& stability), EPMC, etc.

# Toolbox Plan III

**Need to do:**

- Only binary joints are implemented. Higher order joints can be implemented, but has to be done.
- Schur complement based decomposition to make the nonlinear solves much more efficient.
- Implementing constitutive relationships for 3D frame joints (direction cosines are available for each "piece").
- Curved members?