Electronic Supplementary Material

Reduced-order modeling and vibration transfer analysis of a fluid-delivering branch pipeline that consider fluid–solid interactions

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The coefficient matrices of the branch point are

$$\boldsymbol{\Xi}_1=\begin{bmatrix} A_{f1} & 0 & -A_{f1} & 0 & \\ 0 & 1 & 0 & 0 & \mathbf{0}_{4\times 10} \\ 0 & 0 & 1 & 0 & \\ 0 & A_{f1} & 0 & 1 & \\ & \mathbf{0}_{10\times 4} & & & \boldsymbol{I}_{10\times 10} \end{bmatrix},\ \boldsymbol{\Xi}_2=\begin{bmatrix} \tilde{\boldsymbol{A}} & \mathbf{0}_{6\times 4} & \mathbf{0}_{6\times 4} \\ \mathbf{0}_{4\times 6} & I_{4\times 4} & \mathbf{0}_{6\times 4} \\ \mathbf{0}_{4\times 6} & \mathbf{0}_{4\times 4} & \tilde{\boldsymbol{B}} \end{bmatrix},\ \boldsymbol{\Xi}_N=\begin{bmatrix} \hat{\boldsymbol{A}} & \mathbf{0}_{6\times 4} & \mathbf{0}_{6\times 4} \\ \mathbf{0}_{4\times 6} & \hat{\boldsymbol{C}} & \mathbf{0}_{6\times 4} \\ \mathbf{0}_{4\times 6} & \mathbf{0}_{4\times 4} & \hat{\boldsymbol{B}} \end{bmatrix} \tag{1}$$

where matrices $\tilde{\boldsymbol{A}}$, $\tilde{\boldsymbol{B}}$, $\hat{\boldsymbol{A}}$, $\hat{\boldsymbol{B}}$, and $\hat{\boldsymbol{C}}$ can be expressed as

$$\tilde{\boldsymbol{A}}=\begin{bmatrix} A_{f2} & 0 & -A_{f2} & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & -\cos\alpha_2 & 0 & \sin\alpha_2 & 0 \\ 0 & -A_{f2}\cos\alpha_2 & 0 & -\cos\alpha_2 & 0 & \sin\alpha_2 \\ 0 & 0 & -\sin\alpha_2 & 0 & -\cos\alpha_2 & 0 \\ 0 & -A_{f2}\sin\alpha_2 & 0 & -\sin\alpha_2 & 0 & -\cos\alpha_2 \end{bmatrix} \tag{2}$$

$$\tilde{\boldsymbol{B}}=\begin{bmatrix} -\cos\alpha_2 & 0 & -\sin\alpha_2 & 0 \\ 0 & -\cos\alpha_2 & 0 & -\sin\alpha_2 \\ \sin\alpha_2 & 0 & -\cos\alpha_2 & 0 \\ 0 & \sin\alpha_2 & 0 & -\cos\alpha_2 \end{bmatrix} \tag{3}$$

$$\hat{\boldsymbol{A}}=\begin{bmatrix} A_{fN} & 0 & -A_{fN} & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & -A_{fN}\cos\alpha_N & 0 & -\cos\alpha_N & 0 & \sin\alpha_N \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & -A_{fN}\sin\alpha_N & 0 & -\sin\alpha_N & 0 & -\cos\alpha_N \end{bmatrix} \tag{4}$$

$$\hat{\boldsymbol{B}}=\begin{bmatrix} 0 & 0 & 0 & 0 \\ 0 & -\cos\alpha_N & 0 & -\sin\alpha_N \\ 0 & 0 & 0 & 0 \\ 0 & \sin\alpha_N & 0 & -\cos\alpha_N \end{bmatrix} \tag{5}$$

$$\hat{\boldsymbol{C}}=\begin{bmatrix} 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix} \tag{6}$$