Model Input

English units

Mass entered in lbm, converted to consistent units: $m = W/386$ [lbf sec^2/in]

Stiffness k [lbf/in], length [in], force [lbf], acceleration [in/sec^2]

$1\,G = 386$ in/sec^2

Metric units

Mass m [kg], stiffness k [N/m], length [m], force [N]

$1\,G = 9.81$ m/sec^2

Spring-mass chain

$[M] = \text{diag}(m_1, \ldots, m_n)$, spring k_i joins mass $i-1$ and mass i (mass 0 = ground)

$[K] = \sum_i k_i \{e_i - e_{i-1}\}\{e_i - e_{i-1}\}^T$ (free-free: k_1 omitted)

Rigid-body check

Rigid-body mass $m_{rb} = \{r\}^T[M]\{r\}$ equals the total mass for $\{r\} = \{1\}$

Free model: $\|[K]\{r\}\| \,/\, (\|K\|\,\|r\|) \approx 0$; zero-frequency modes: $\lambda_i \leq 10^{-8}\lambda_{max}$