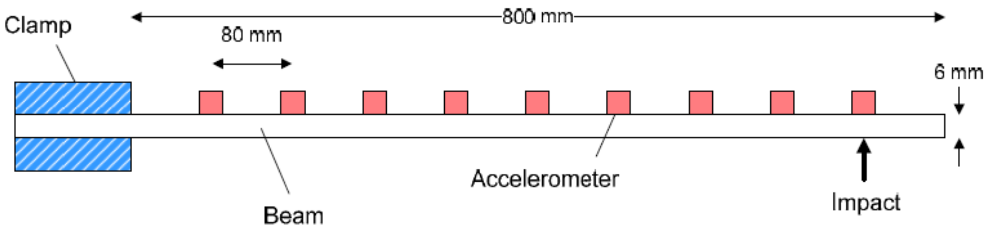
Problème:

Nous allons faire l'analyse des résultats expérimentaux d'une poutre encastrée libre. Nous disposons de 9 FRFS (correspondant aux rapports fréquentiels entre le déplacement et la force d'excitation ie marteau d'impact). Nous disposons du signal d'excitation et des fonctions de cohérence.



Comment retrouver les paramètres modaux (fréquences, taux d'amortissement, déformées modales) ?
Utiliser la méthode RFP décrite dans le paragraphe suivant. (en anglais)

Identification of Modal Parameters

The identification process consists of estimating the modal parameters from Frequency Response Function (FRF) measurements [27]. An FRF represents the dynamic characteristics of the structure between the response degree of freedom (DOF) and the excitation degree of freedom. The equations of motion for a vibrating structure are commonly derived by applying Newton's second law

$$[M]x''(t) + [C]x'(t) + [K]x(t) = f(t) \qquad (1)$$

The excitation forces and responses are functions of time *(t)*, and *[M], [C]* and *[K]* are the mass, damping and stiffness constants respectively. The equivalent frequency domain form of the dynamic model can be represented in terms of discrete Fourier transforms, as

$$H(j\omega) = \frac{X(j\omega)}{F(j\omega)} \qquad (2)$$

This equation is a definition of the FRF matrix. Each element of this matrix is an FRF measurement between two DOFs of the test structure. For a single DOF, the FRF merely becomes

$$H(j\omega) = \frac{1}{(M(j\omega)^2 + C(j\omega) + K)} \qquad (3)$$

Since a single DOF system has only one mode, its FRF can also be written,

$$H(j\omega) = \frac{1}{M((j\omega)^2 + 2\sigma(j\omega) + \sigma^2 + \omega^2)} \qquad (4)$$

Each term of the FRF matrix can be represented in terms of pole location and a mode shape. The numerators are constants and only the denominators are functions of frequency. The numerators are called residues.

$$H(j\omega) = \frac{r_k}{(j\omega - \lambda_k)} + \frac{r_k^*}{(j\omega - \lambda_k^*)} \qquad (5)$$

where,

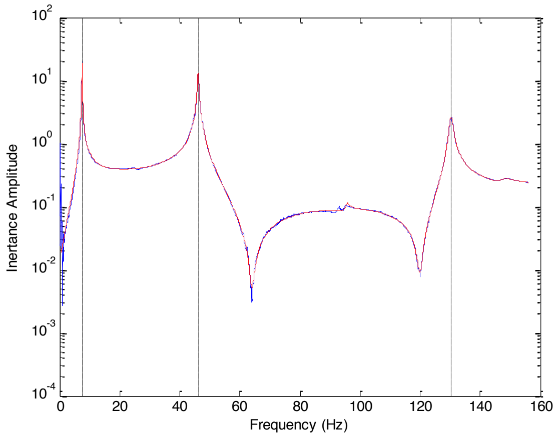
r_k = the (*n by n*) residue matrix for the *kth* mode

λ_k = pole value for mode *k* = $-\xi_k\omega_k + j\omega_k\sqrt{1-\xi_k^2}$ (6)

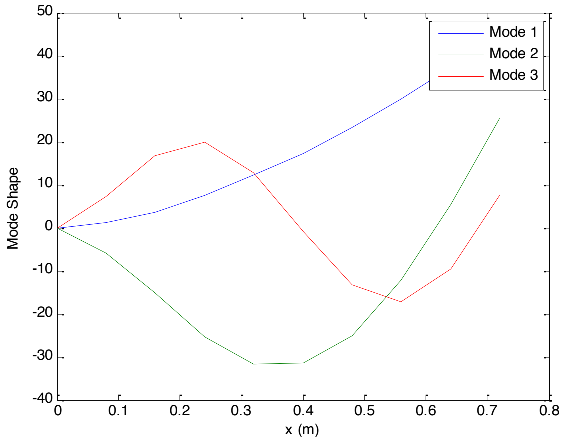
* designates complex conjugates

where, ω_k = undamped natural frequency and ξ_k = damping ratio of mode k

Classical parameter estimation (or curve fitting) is the process of numerically applying Equation (5) to one or more FRF measurements also known as Rational Fraction Polynomial (RFP) method. The result is an estimate of the residue and pole location for each mode in the frequency band of the measurements. Natural frequencies and damping values for a mode can be calculated by solving Equation (6).



Inertance Amplitude
Frequency (Hz)



Mode 1
Mode 2
Mode 3
Mode Shape
x (m)