[M]*x'-[M]*x'=0 添加，成方程组
y={x';x}

then, [A]*y'+[B]*y=0

OME=C*OMEmax
OMEmax=2*fmax

Dynamics of Mechanical Systems

Railway arc bridge

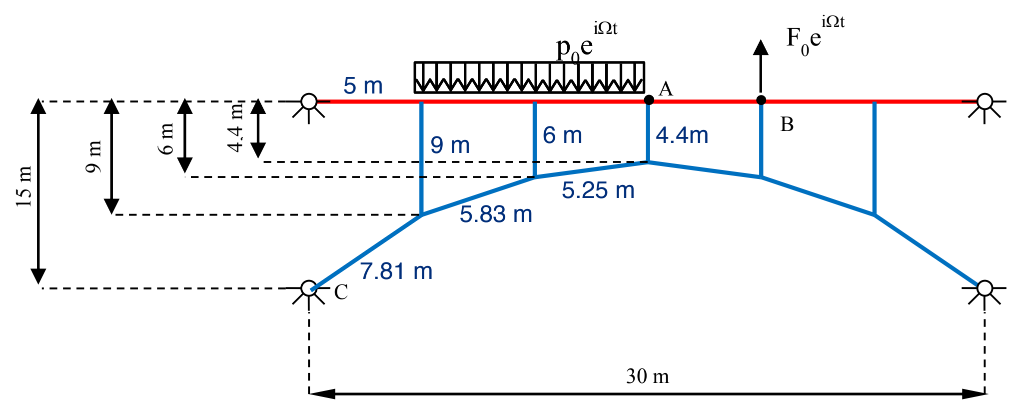

Fig.1

Consider the railway bridge shown in Fig.1. All beams are made of steel ($E=2.06e11$ N/m^2, $\rho=7800$ kg/m^3). Beams in blue have IPE240 cross section ($A=3.912e\text{-}3$ m^2, $J=3.892e\text{-}5$ m^4) and beams in red have IPE400 cross section ($A=8.446e\text{-}3$ m^2, $I=2.313e\text{-}4$ m^4). Damping is defined according to the "proportional damping" assumption: $[C]=\alpha[M]+\beta[K]$, with $\alpha=0.8$ s^{-1} and $\beta=3.0e\text{-}5$ s.

1. Define a FE model of the structure suitable for analysing its dynamic response in the **0-25 Hz** frequency range (***using a safety coefficient 2***). Plot the undeformed structure.
2. Compute the structure's natural frequencies and modes of vibration. Plot the first **four** mode shapes with the indication of the associated natural frequencies.
3. Compute the natural frequencies of the damped structure.
4. Compute the structure frequency response functions between an input force applied at position B in vertical direction and the output **vertical acceleration** evaluated at points A and B. Assume the input force to vary in the 0-25 Hz frequency range and set the frequency resolution to 0.01 Hz. Plot the Bode diagrams (in linear scales).
5. Compute the structure frequency response functions which relate the input represented by a distributed load (consider **p_0 = 1 N/m**) applied on a portion of the deck (as shown in the figure) to the output **vertical acceleration** in A and **vertical constrain force** in C. Assume the distributed load to vary in the 0-25 Hz frequency range and set the frequency resolution to 0.01 Hz. Plot the Bode diagrams (in linear scales).
6. Compute the same FRF as point 5 developing a model in modal coordinates limited to the first three modes. Plot the Bode diagrams superimposed (with two different colours) to those of point 4.
7. Define a change in the structure to reduce **by 30% at least** the maximum amplitude of the FRF of the vertical acceleration of point B for a unit force applied at B (see point 4.) **without increasing the total mass of the system by more than 5%**. The following modifications are not allowed: any change in the length of the span or vertical distance between points A and C; any change of material properties; use of additional constraints. If the section of one or more beam is changed, unified beam sections such as IPE, HPE etc. shall be used.

Have with you at the oral exam **a printed copy** of the following:

1) all plots mentioned above
2) the .inp input file of the system (and of the modified system at point 7, if needed)
3) any .m script used to answer points 3, 5, 6 (7 if needed)