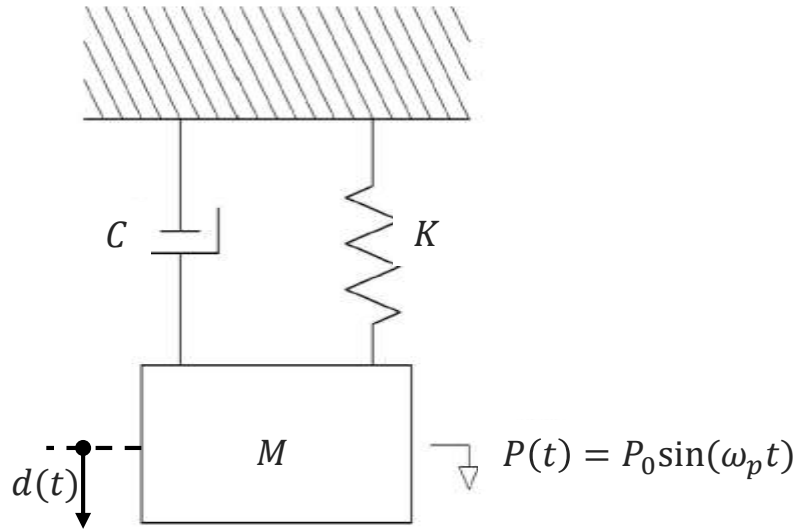




SVIKT OCH VIBRATIONER

Vad behöver du kunna?

Something about dynamics



$$Ma + Cv + Kd = P(t)$$

$$\omega = \sqrt{\frac{K}{M}} ; f = \frac{\omega}{2\pi}$$

$$\xi = \frac{C}{2M\omega}$$

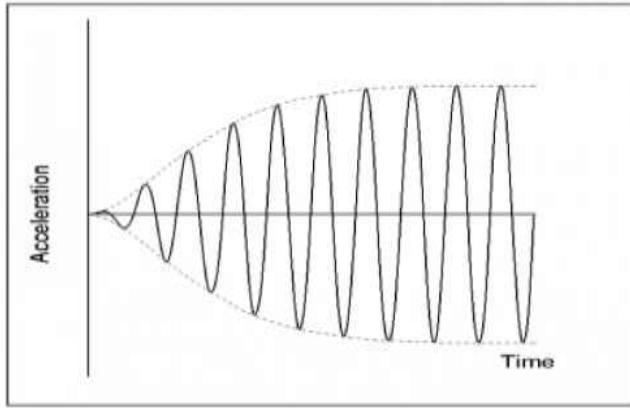
$$\omega_d = \omega\sqrt{1 - \xi^2}$$

$$r = \frac{\omega_p}{\omega}$$

$$d(t) = \underbrace{Xe^{-\xi\omega_d t} \sin(\omega_d t + \varphi)}_{\text{transient}} + \underbrace{\frac{P_0}{M\omega^2} \frac{1}{\sqrt{(1 - r^2)^2 + (2\xi r)^2}} \sin(\omega_p t - \psi)}_{\text{stationary}}$$

What do you need to know?

Something about dynamics

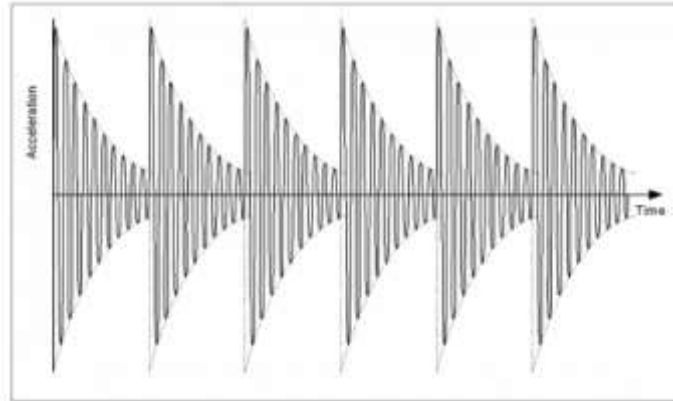


Stationary response – for resonance $f = f_p$

OBS: at resonance the maximum value of the acceleration is:

$$a_{max} = \frac{P_0}{2\xi M} \Rightarrow \left\{ \begin{array}{l} \triangleright \text{increase } \xi \\ \triangleright \text{increase } M \\ \triangleright K \text{ changes } f \end{array} \right.$$

Transient response $\rightarrow f \gg f_p$



What do you need to know?

Dynamical problems

A. BRIDGES

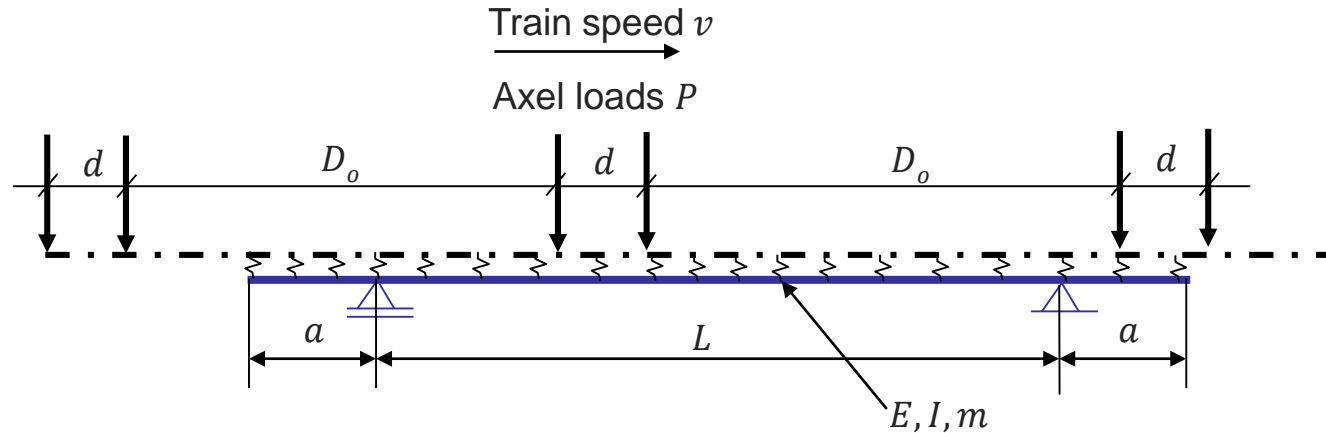
- **Pedestrian bridges** – Dynamic (resonant) effects from a group of people which are: walking, running, jumping
- **Railway bridges** – Response to high speed train passage (resonant effects)
- **Road bridges with a pedestrian lane**
 - Walking, running, jumping (resonant effects)
 - Vibrations from traffic (not necessarily resonant effects)

B. BUILDINGS

- **Floor response** – comfort conditions (resonant effects)
- **Vibration from traffic around the building** – comfort conditions (not necessarily resonant effects)

High speed trains on bridges

Acceleration of the deck is the main concern – **this is a resonance problem**

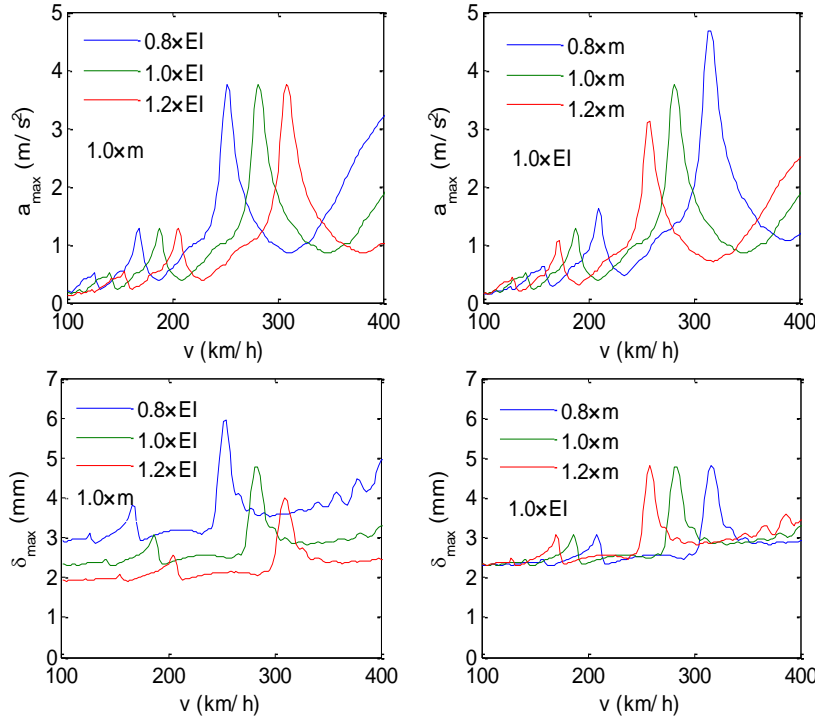


Load frequency: $f_L = \frac{v}{D_0 + d}$

f_L (or a multiple of that i.e. $j f_L$) coincides with one of the frequencies of the bridge

Resonance – effects of stiffness and mass

Response to high speed trains



Accelerations

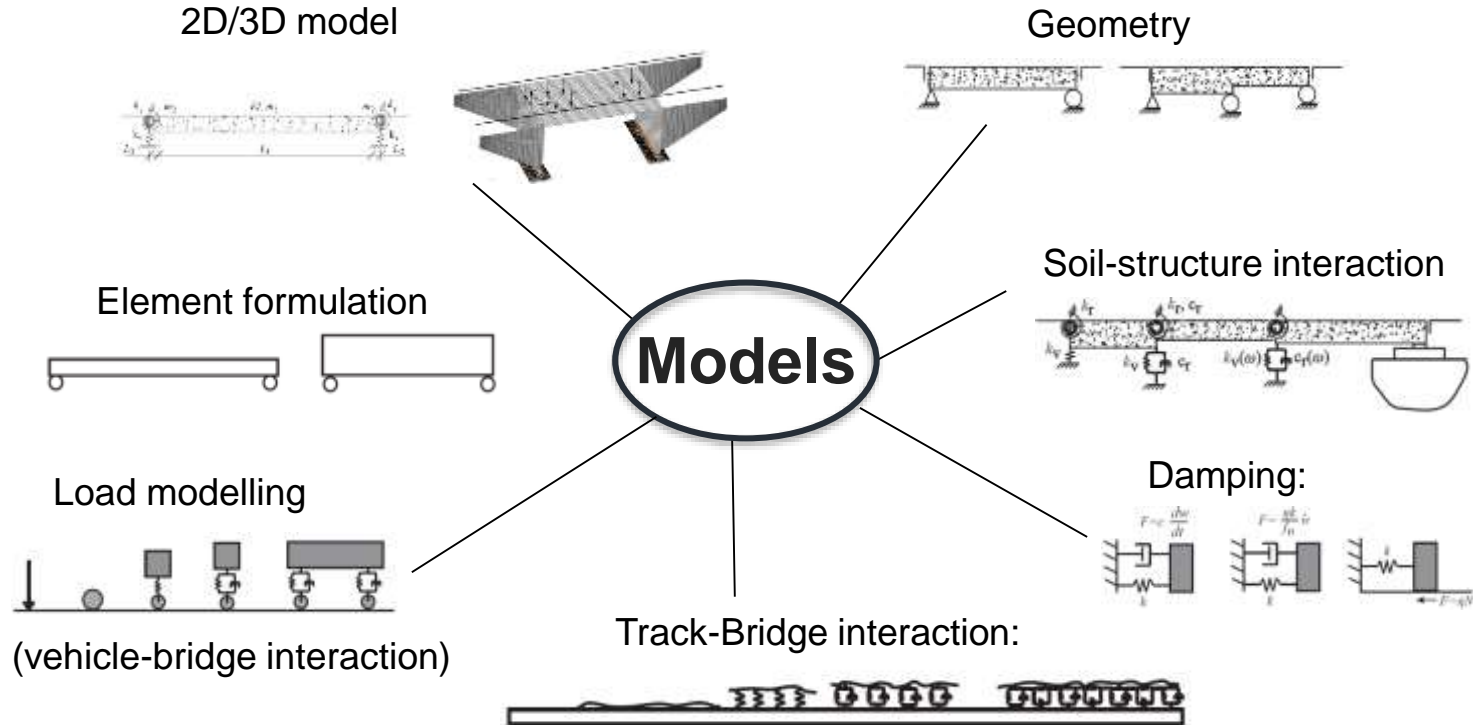
- K changes the resonance frequency but does not affect the amplitudes at resonance
- M changes both

Displacements

- K changes both the resonance frequency and the amplitudes at resonance
- M changes only the resonance frequency

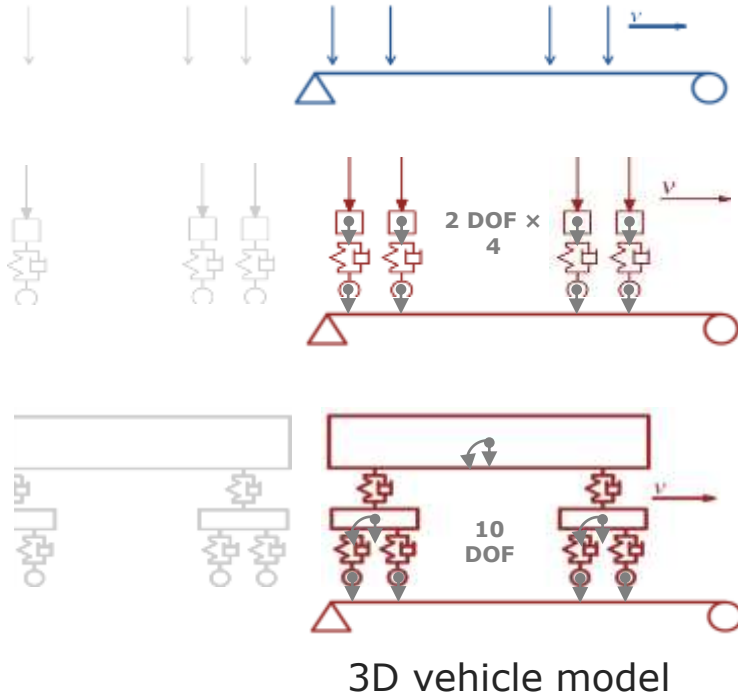
Remember the theory!

Reliable prediction models



What do you need to know?

Load models



Moving load model

- **Design calculations** (when no specific vehicle data is known).
- When only interested in the bridge response for cases where TBI is not important (away from resonance, long spans, very short spans)

Vehicle model

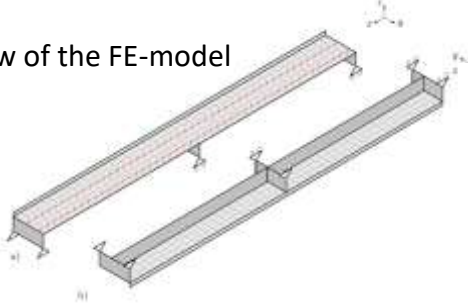
- **When TBI is important for the bridge response – at resonance for certain spans in the range 10-30 m.**
- To study the effect of track irregularities.
- To evaluate the vehicle response (passenger comfort, running stability).

NOTE: TBI=train bridge interaction

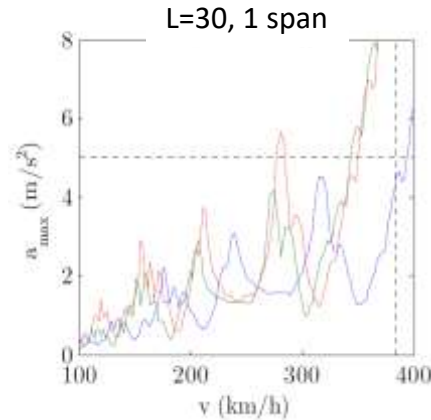
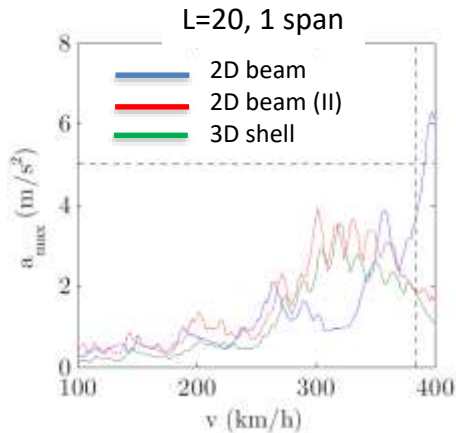
What do you need to know?

2D versus 3D

view of the FE-model



Modified 2D model – beam II



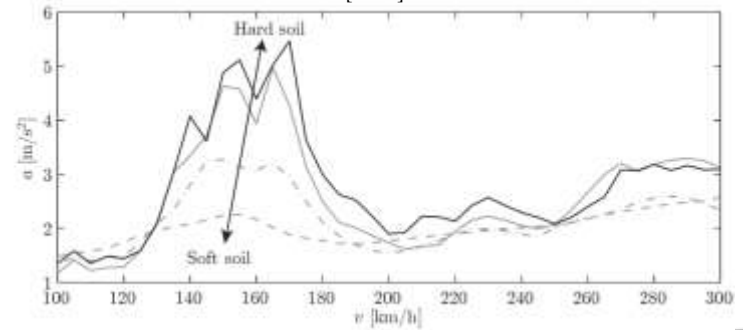
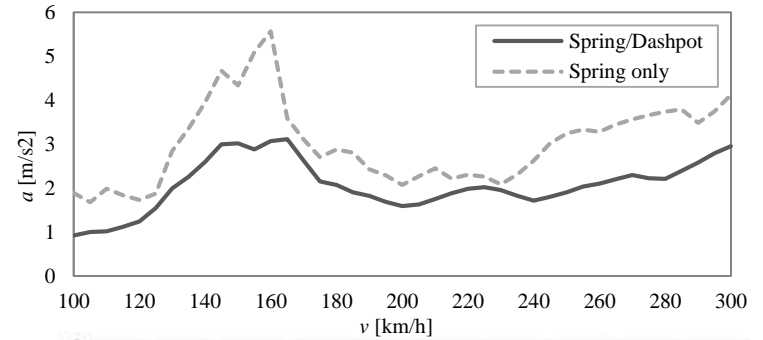
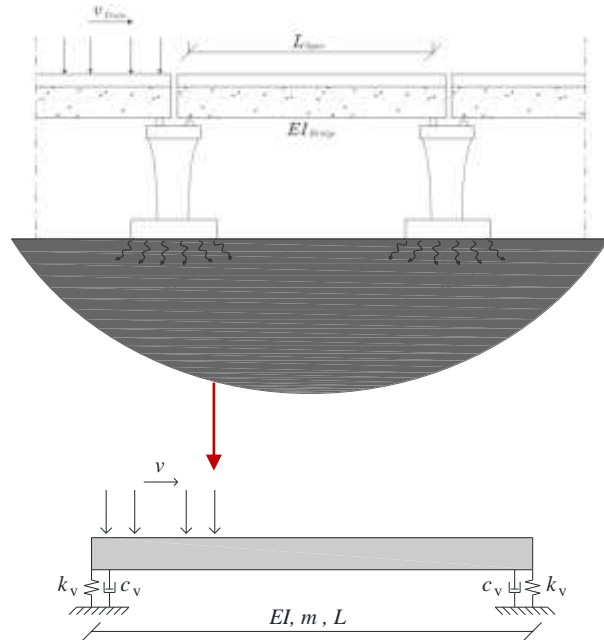
2D models can be used providing that:

- Shear-lag and the eccentricity of supports considered when estimating the first natural frequency for bending n_0
- If the first torsional mode $n_T < 1.2n_0$ a full 3D analysis is required
- In the case a 3D model shows several closely spaced bending modes with similar shape, a full 3D dynamic analysis should be performed

What do you need to know?

Influence of soil-structure interaction

This has been confirmed experimentally



What do you need to know?

Svikt och vibrationer

Tack för er uppmärksamhet