Assignment 2
Kawasaki Z650

Single-DOF vibration model
Numerical approach: pothole

(10 points)

MECA0155 – Dynamics of mechanical systems

Academic year 2024-2025

Objective

Modal identification of the Single-DOF vibration model of the motorbike frame

From the given results of a numerical simulation, the aim of the assignment is to

- plot a time response resulting from a pothole impact;
- plot the Bode and Nyquist diagrams;
- identify the modal parameters (natural frequency and modal damping) of the 1-DOF system.

The modal parameters will be identified for the first bending mode of the motorbike frame in the vertical direction.

Simplified model of the motorcycle frame (SDOF model)

- The model simulates a constant speed motion
  - The frame is represented as a beam whose characteristics are listed in the general presentation of the project
  - Two concentrated masses are located at points B and D
    - B: represents the engine and the auxiliaries, located at mid-distance between the fork (A) and the swingarm (C) and at 250 mm below the frame
    - D: represents the driver, assumed to be on the frame
  - The frame is supported by the fork and the swingarm
    - Both are modeled as linear and rotational springs with adequate stiffness

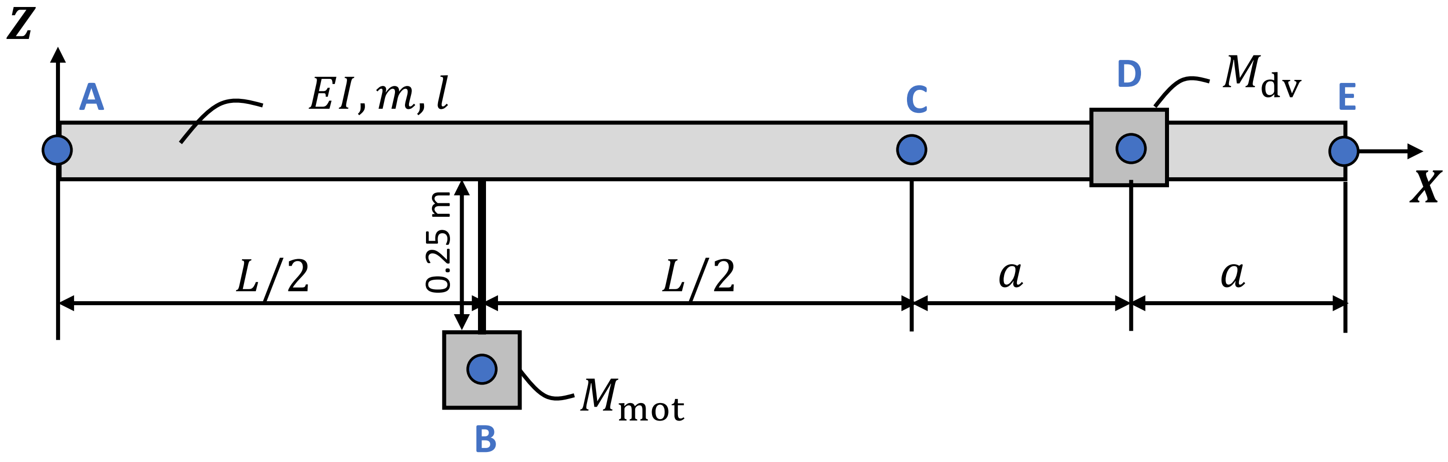
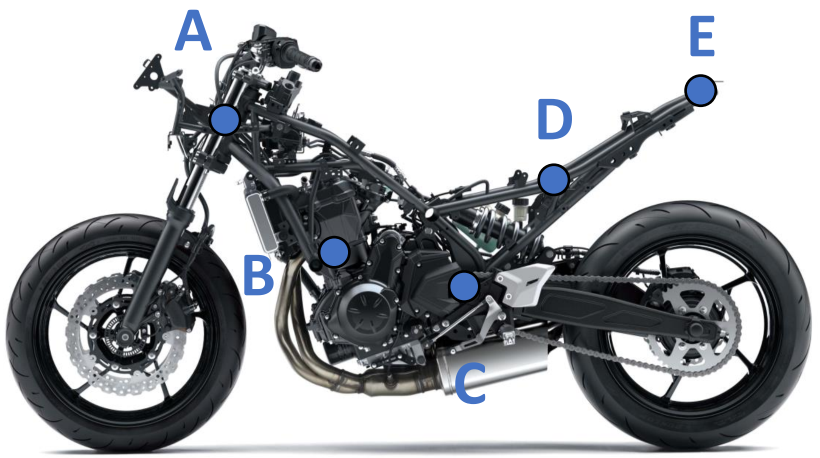


Figure 1 – SDOF model with $l = L + 2a$, $a = \frac{L}{4} = 0.2$ m.



Simplified model of the motorcycle frame

- The structure is excited by an impact simulating a pothole at the fork (A) in the vertical direction Z
- The response is measured at point A in the same direction
- For the time response, note that the time pulse signal has a duration of 0.02s (corresponding to a 20 cm long pothole at 36 km/h).

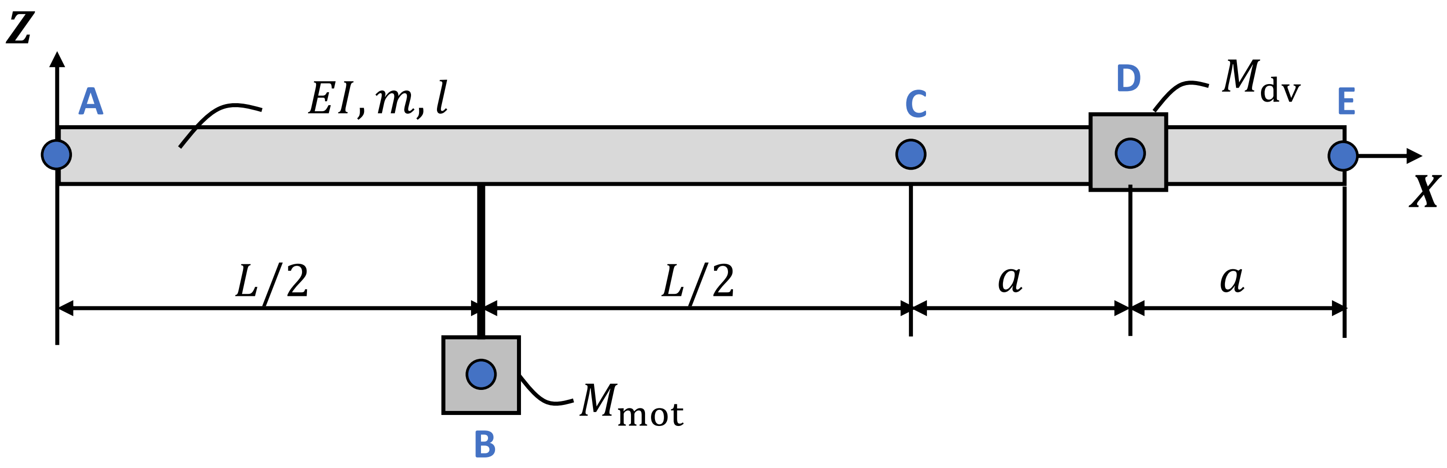


Figure 1 – SDOF model with $l = L + 2a$, $a = L/4$. Use $a = 0.2$ m.

Data available on eCampus

- The time response to the pothole impact is obtained by a numerical simulation. The time response is given in the file *P2024_irf_acc.txt*, in which two columns of data are given:

Time [s]	**Acceleration [m/s²]**
…	…

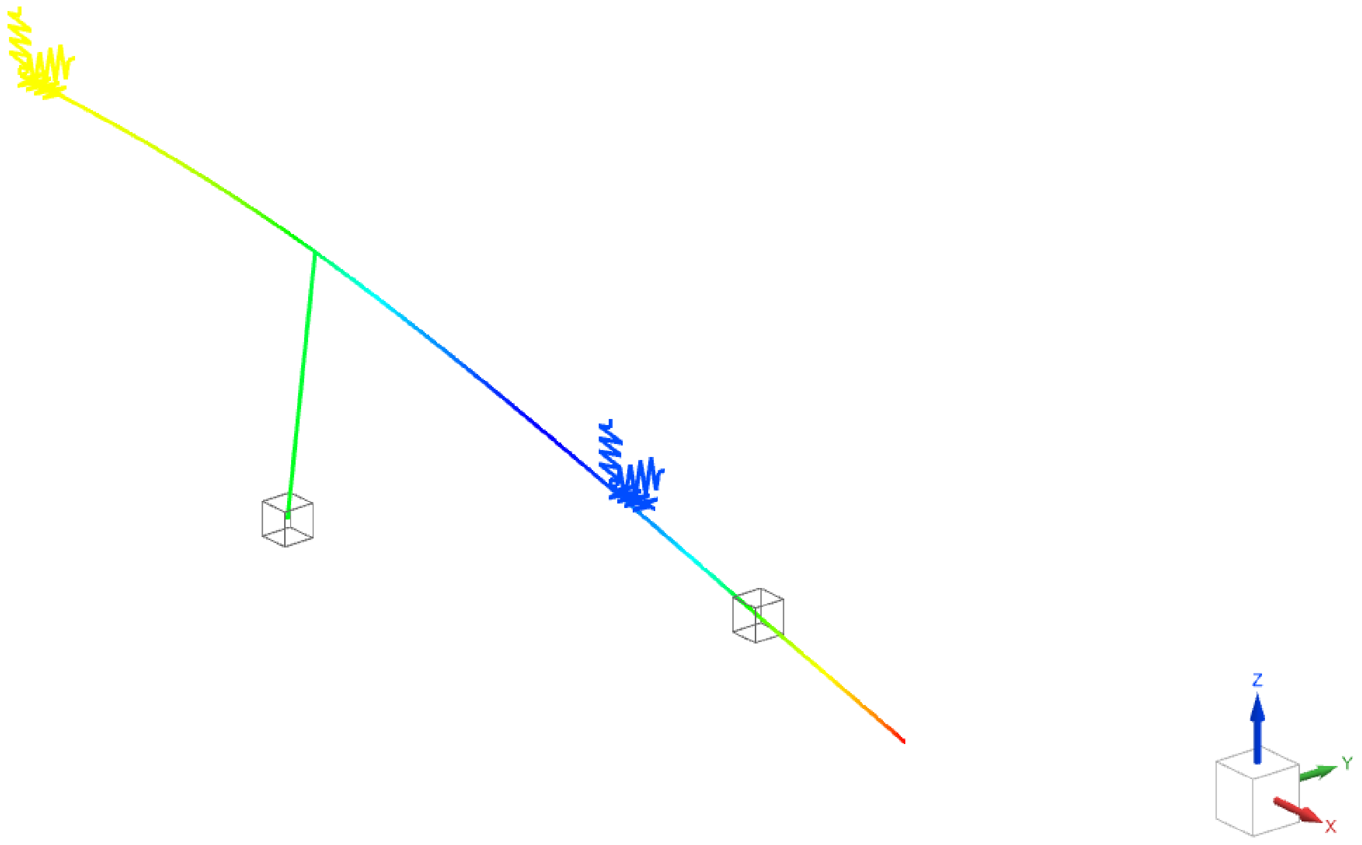
- The frequency response function (FRF) is measured in the frequency range [0 – 150] Hz. The FRF is given in the file *P2024_frf_acc.txt* in which three columns of data are present:

Frequency [Hz]	$\boldsymbol{Re(FRF)}$ **[m/s²/N]**	$\boldsymbol{Im(FRF)}$ **[m/s²/N]**
…	…	…

Project statement

- Plot the time response at point A.
  - Estimate the damped natural frequency in bending from the time data.
  - Estimate the associated damping ratio using the logarithmic decrement method.
    - Note that the time response is obtained from a time pulse signal whose duration is 0.02s.
    - What about the low damping hypothesis?
- Plot the Bode diagram and estimate the natural frequency.
  - Evaluate the quality factor and the damping ratio using the half-power method.
- Plot the Nyquist diagram and evaluate the damping ratio based on the equivalent mass of the motorbike frame system of 87.5 kg.
  - Note that this equivalent mass is estimated from the FE model of the frame system and is different from the equivalent mass found in assignment n°1 where some additional assumptions were made.
- Compare the identification methods using the time data and the frequency data with respect to their ease of use and their accuracy.

Mode 1: Bending in XZ-plane (87.49 Hz)



Specific guidelines for assignment 2

1) The length of the report will not exceed 5 pages including figures.
2) Prefer the dedicated forum on eCampus to ask questions
3) The deadline for the submission of the report (on eCampus platform) is fixed to

October 25, 2024 at 18:00