Assignment 1
Kawasaki Z650

Single-DOF vibration model – Modelling approach

(10 points)

MECA0155 – Dynamics of mechanical systems

Academic year 2024-2025

Objective

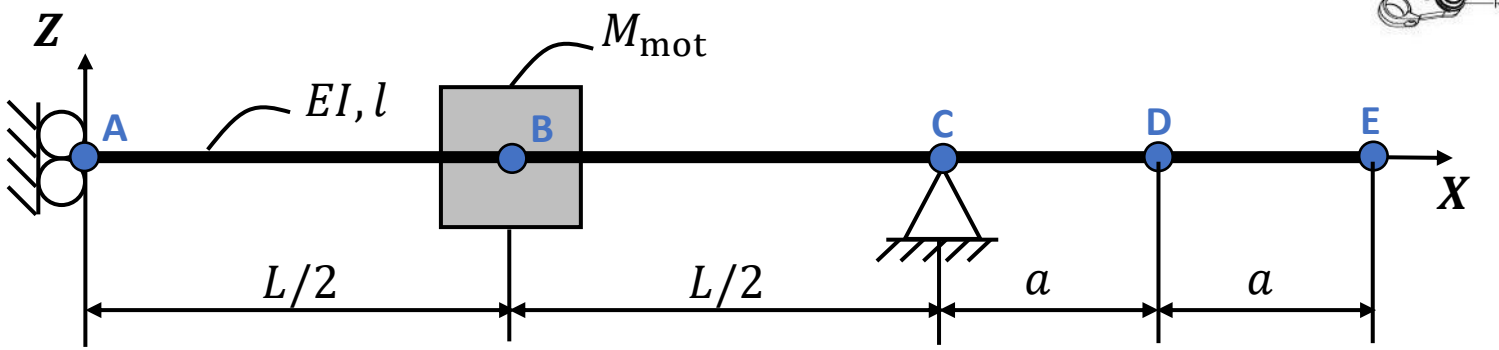
Calculation of the first natural frequency of the motorcycle frame in bending

The aim of the assignment is to

- build an equivalent 1-DOF model of a motorcycle frame in bending;
- determine the equivalent stiffness and the equivalent mass of the model;
- compute an estimation of the natural frequency.

Simplified model of the motorcycle frame (SDOF model)

- The picture on the right represents the bare frame
- The picture below represents a **simplified model of the motorcycle frame** in bending
  - The frame is represented by a flexible **massless beam**
  - The fork is modeled as a slide support. No inclination is considered.
  - The connection of the swingarm is modeled as a pin
  - The beam supports an equivalent mass representing the engine and the auxiliaries at mid-distance between the fork and the pin



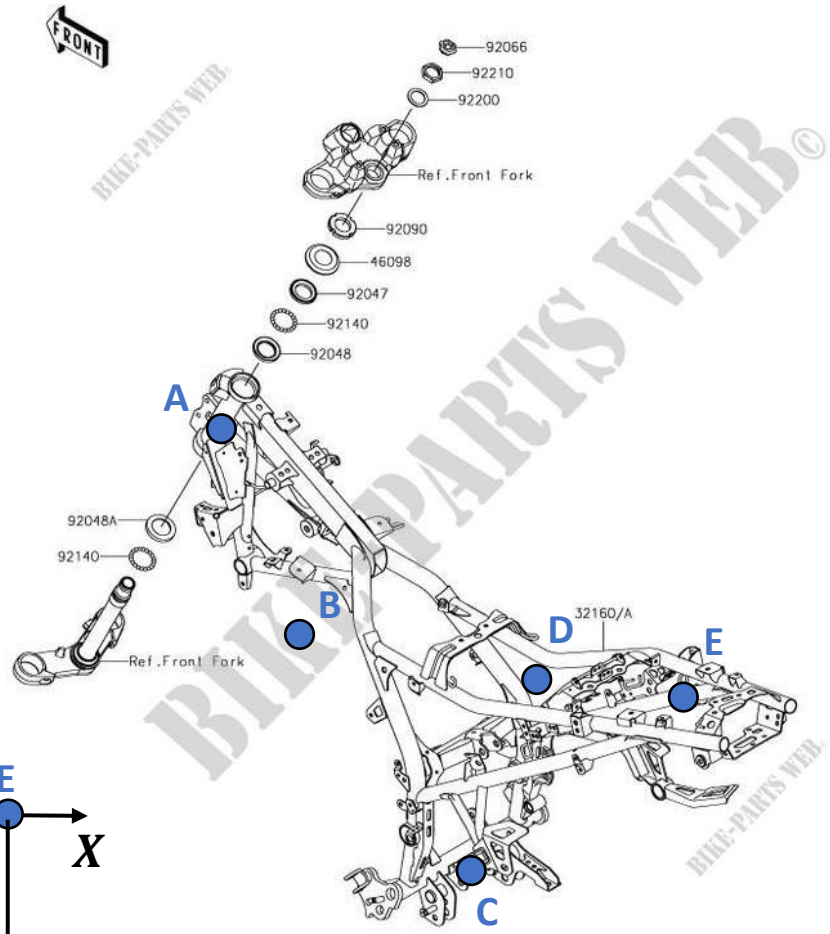


Figure 1 – SDOF model with $l = L + \mathbf{2}a$, $a = L/\mathbf{4}$. Use $a = 0.2$ m.

SDOF model of the motorcycle frame

Suggested procedure – Bending case

The following procedure is known as the Rayleigh's method.

- From the fundamental equation $\frac{d^2z}{dx^2} = -\frac{M(x)}{EI}$, develop analytically the expression of the static deflection of the model as in Figure 1 considering a single load P located at the free end.
- Plot the deflected beam considering $P = 1000$ N.
- Write the general expression of the potential energy of the model. Develop the expression of the equivalent stiffness and compute it.
  - Use the deflection at the fork, $z(0) = z_0$, as the generalized coordinate.
- Write the general expression of the kinetic energy of the model.
  - In that general expression, include the terms related to the beam even if we consider a massless beam. Do not develop this expression.
  - From the general expression, identify the equivalent mass of the model and compute it.
  - Use the deflection at the fork, $z(0) = z_0$, as the generalized coordinate.
- Compute the natural frequency of this SDOF model.
- The effect of vibrations on humans in the frequency range from 0.1 to 100 Hz can cause particularly adverse effects due to the characteristic natural frequencies for organs and body parts. What can you conclude about the model?

Specific guidelines for assignment 1

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 11, 2024 at 18:00