

1 Conventional Kolsky-bar (Hopkinson Bar)

A conventional Kolsky-bar is an apparatus in experimental mechanics for the study of properties of materials undergoing high strain rates.

A conventional Kolsky-bar device, schematically shown in Figure 1, consists of a striker, an incident bar, and a transmission bar. The specimen is sandwiched between the incident bar and the transmission bar. The impact of the striker on the end of the incident bar generates elastic waves in both the striker and the incident bar. The elastic wave in the incident bar is called incident wave. It travels through the incident bar to the specimen. Because of the mismatch of mechanical impedances between the bars and the specimen, part of the incident wave is reflected back into the incident bar as a reflected wave and the rest of the incident wave transmits through the specimen into the transmission bar as a transmitted wave. The three wave signals are sensed by the strain gages mounted in the middle of the incident and the transmission bar.

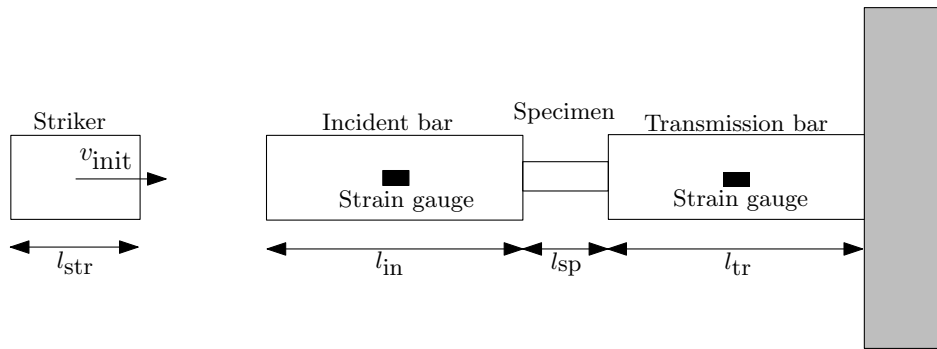


Figure 1: Conventional Kolsky-bar

In the given case, the same material is used for the striker, the incident bar, and the transmission bar. They are described by a cross section A , a Young's Modulus E , a density ρ , and a mechanical impedance Z . During the experiment, the material stays always in its elastic domain. The strain gages measure the longitudinal deformation of the incident wave $\varepsilon_i(t)$, of the reflected wave $\varepsilon_r(t)$, and of the transmitted wave $\varepsilon_t(t)$.

The material of the specimen is characterized by a Young's Modulus E_{sp} , a density ρ_{sp} , a mechanical impedance Z_{sp} , and cross section A_{sp} .

Question 1

Using the shock polar as well as the x-t diagram, determine the time of loss of contact between the striker and the incident bar (the time at which there is no force at the contact interface) as well as the state of stress in the incident bar.

Question 2

There exists a condition ensuring that the measured signal of the incident wave in the incident bar is not overcovered by the signal of the reflected wave. What is this condition? Illustrate the signal measured by the strain gage on the incident bar with respect to time (for $Z_{sp} < Z$).

Question 3

Considering equilibrium of the specimen, determine stress $\sigma_{sp}(t)$, strain rate $\dot{\varepsilon}_{sp}(t)$ and strain $\varepsilon_{sp}(t)$ knowing the measured strain $\varepsilon_i(t)$, $\varepsilon_r(t)$, and $\varepsilon_t(t)$.