Influence lines (Einflusslinien) [P. Marti, Theory of Structures, Chapter 12]

Overview

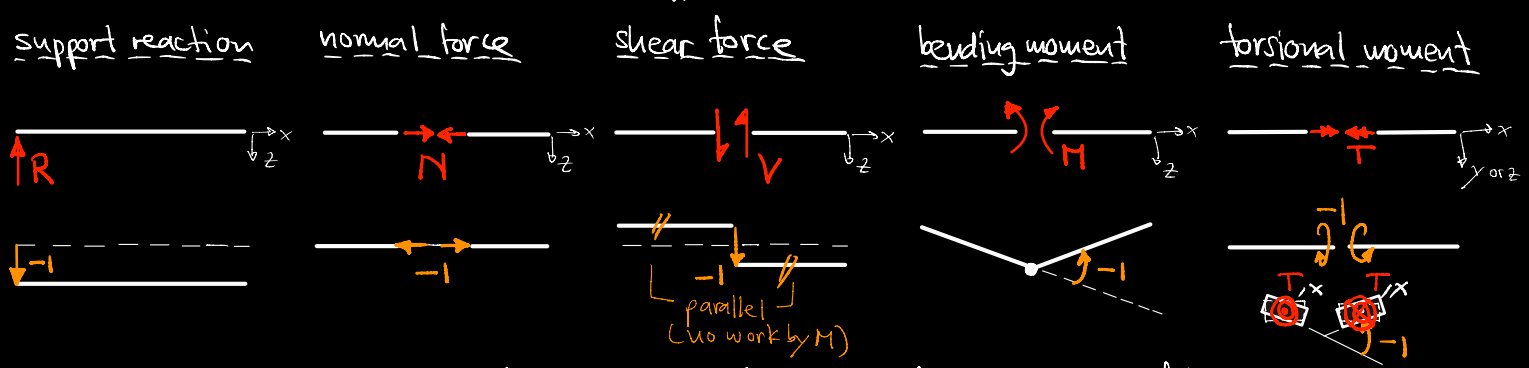
Influence lines show how loads applied along a structure affect certain state variables at a specific location. IL are particularly useful in bridge design to determine the governing position/arrangement of movable (free) loads.

IL of stress resultants (bending and torsional moments, shear and normal forces) can be determined by equilibrium or kinematically, using the Method of Land, based on the principle of virtual deformations.

The Method of Land can be applied to statically determinate as well as statically indeterminate systems, yielding straight and curved segments of the IL. This powerful, intuitive tool is illustated below.

Determining influence lines using the method of Land

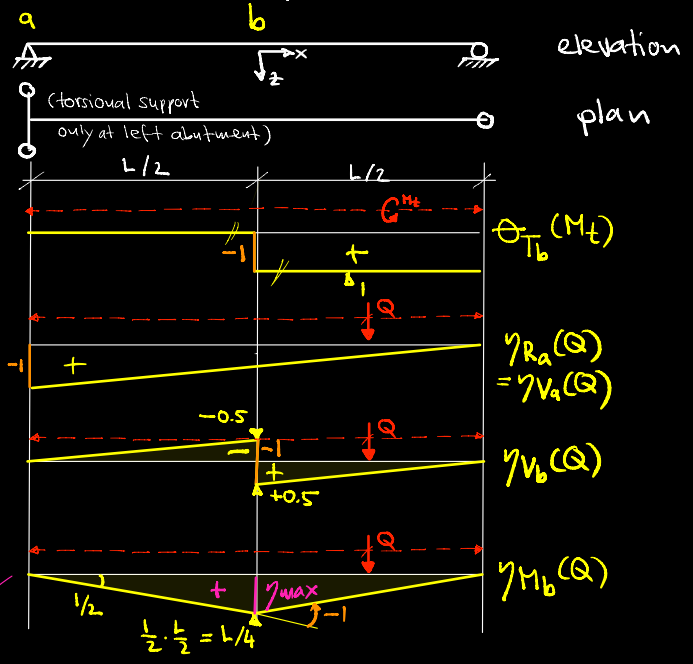
1. Release the constraint (introduce a 'hinge') corresponding to the stress resultant of interest at the location for which the influence line shall be determined.
2. Introduce a negative unit displacement opposite to the stress resultant of interest



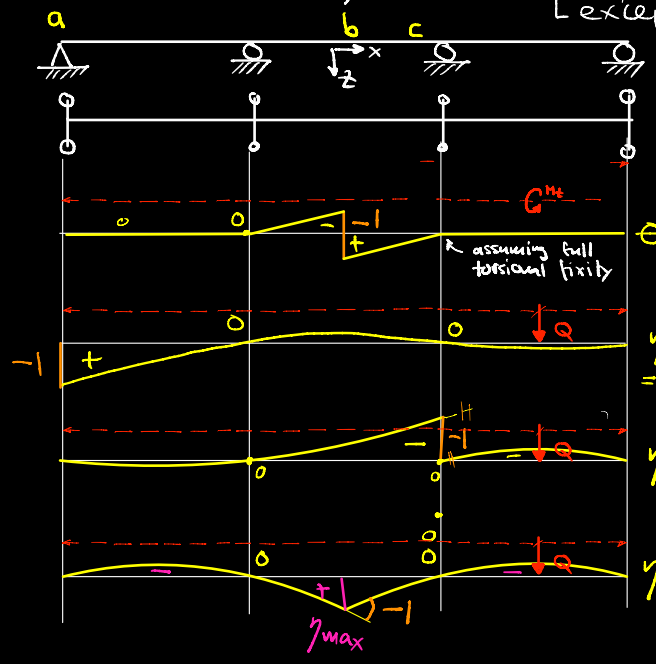
3. The influence line for the stress resultant of interest, at the location of the unit displacement, is defined by the resulting deformation in direction of the applied load causing the stress resultant.

Examples (η = vertical displacement → IL for vertical load Q; Θ = rotation x → IL for torques)

(stat. determinate system → IL straight)



(stat. indeterminate system → IL curved, qualitative) Except T



Based on the IL, the governing load arrangement can be found, e.g. for the max. bending moment in b (IL shown at bottom, $\eta_{M_b}(Q)$), considering rail traffic LM1: