UPPER BOUND, LOWER BOUND, AND UNIQUENESS THEOREMS IN PLASTIC ANALYSIS

CE 130 — Structural Design and Optimization
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Assumptions:

- All external loads increase in proportion to one another.
- The behavior is elastic-plastic.
- The deformations are small.

I. Lower Bound Theorem [P] (Static Theorem)

An external load computed on the basis of an assumed *distribution of internal forces*, in which

- the forces are bounded by limit values, and
- the forces are in equilibrium,

is less than or equal to the true collapse load.

II. Upper Bound Theorem [D] (Kinematic Theorem)

An external load computed on the basis of an assumed *mechanism*, in which

- the forces are in equilibrium,

is always greater than or equal to the true collapse load.

III. Uniqueness Theorem

An external load computed on the basis of an assumed *mechanism*, in which

- the forces are bounded by limit values, and
- the forces are in equilibrium,

is equal to the true collapse load.