Today:

Virtual Work continued

Book: Chapter 11.1-11.3 + hand-out

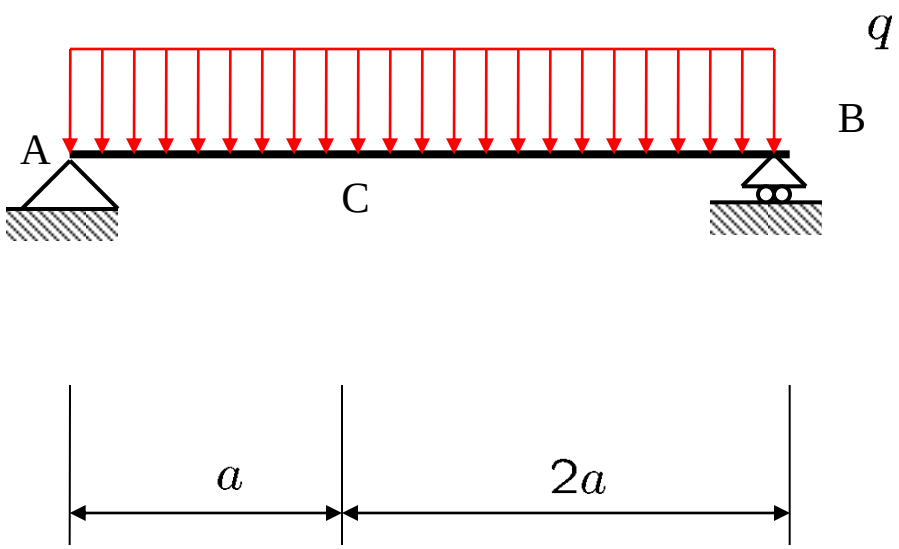
The principle of virtual work (body in two dimensions)

A particle is in equilibrium when for any variational displacement and/or rotation, the virtual work is equal to zero.

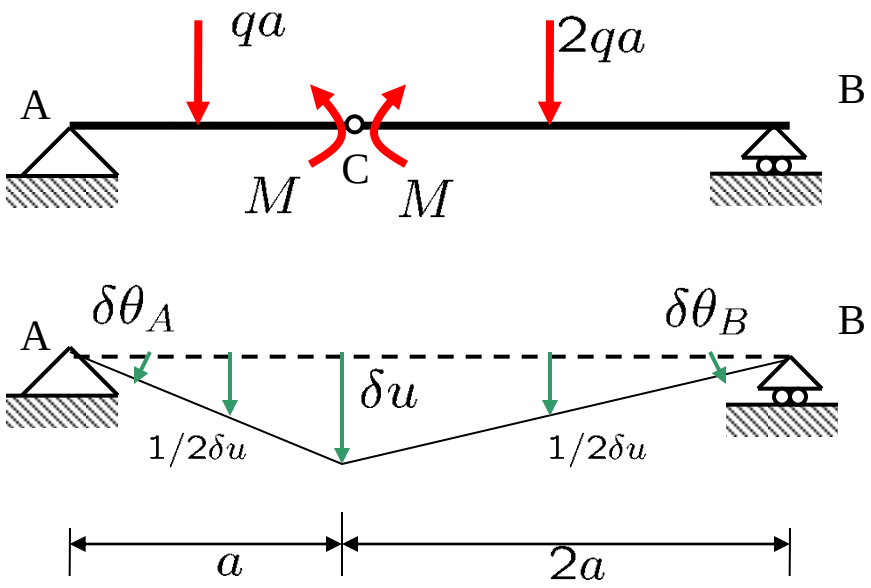
$$\delta W = \sum \delta u_{x_i} F_{x_i} + \sum \delta u_{y_i} F_{y_i} + \sum \delta \theta_i M_i = 0$$

The principle of virtual work

- Calculation of (reaction) forces without dismembering the structure or calculation all the other reaction forces
- Using the knowledge on the kinematic behaviour of the structure



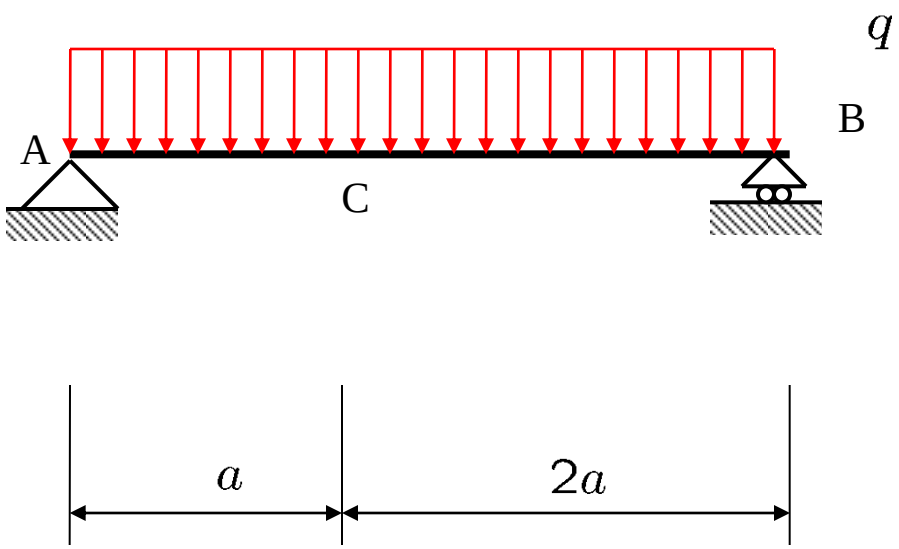
Calculate the internal moment in C



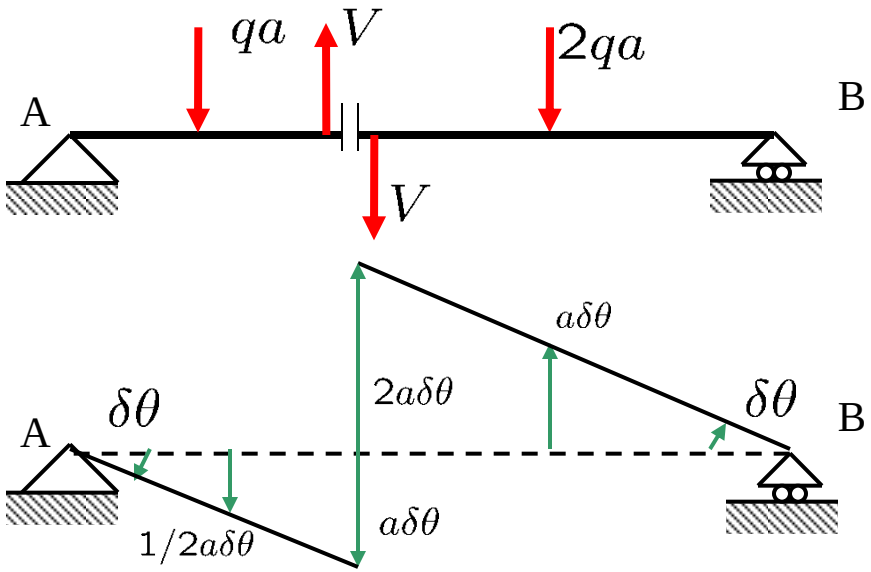
Calculate the internal moment in C

Internal moment

- **Hinge**: only different rotation angles on either side of the cut.
- Reaction moments *M*



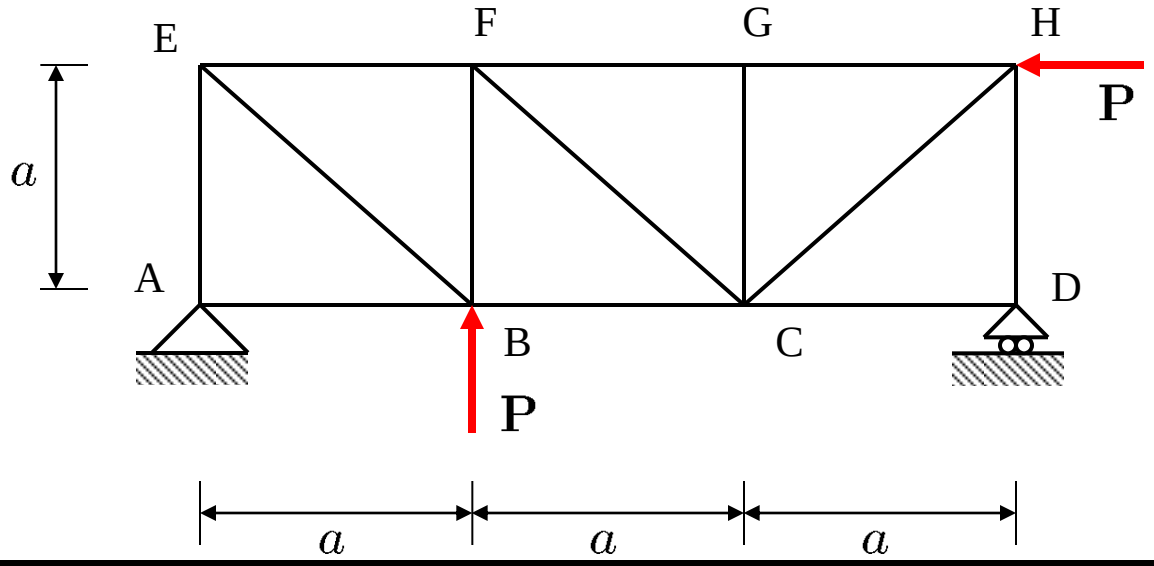
Calculate the shear force in C



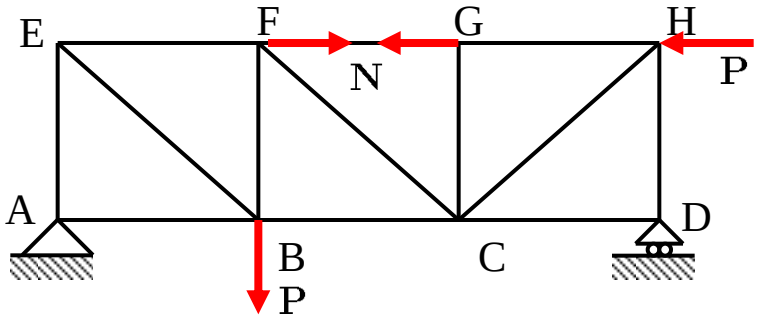
Calculate the shear force in C

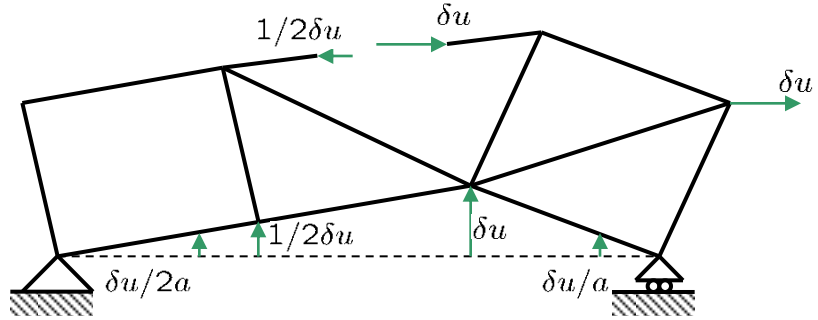
Shear force

- **Shear hinge**: only different displacements perpendicular to the member on either side of the cut.
- Reaction forces *V*



Calculate the normal force in member FG of this truss structure.

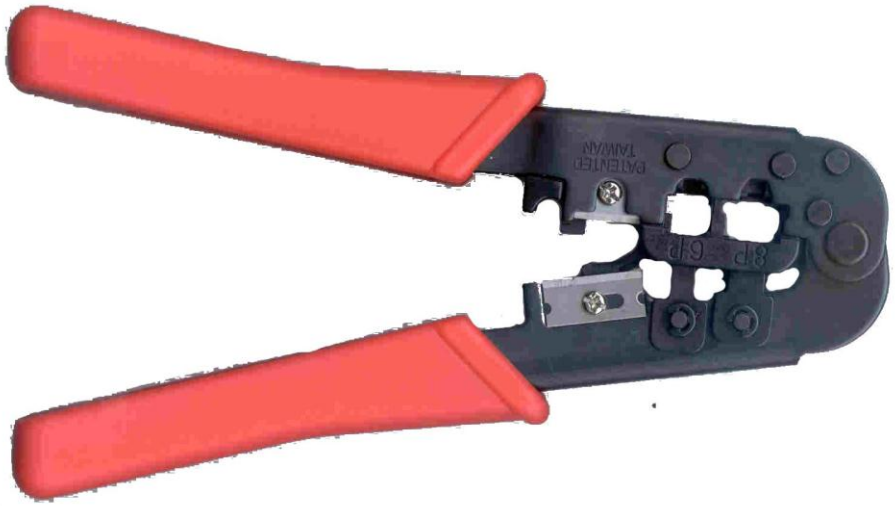




Calculate the normal force in member FG of this truss structure.

Normal force

- **Telescope hinge**: only different displacements parallel to the member on either side of the cut
- Reaction forces *N*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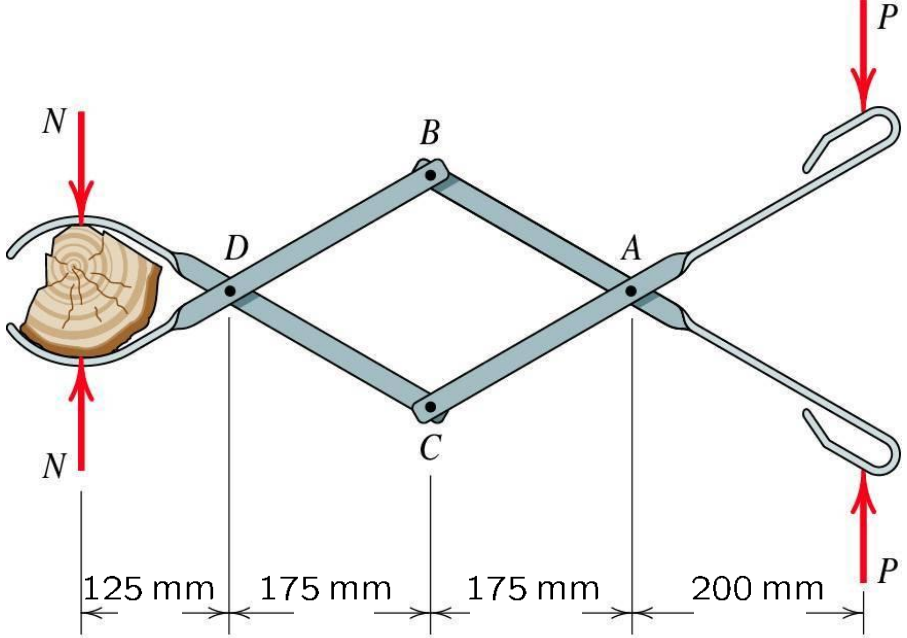
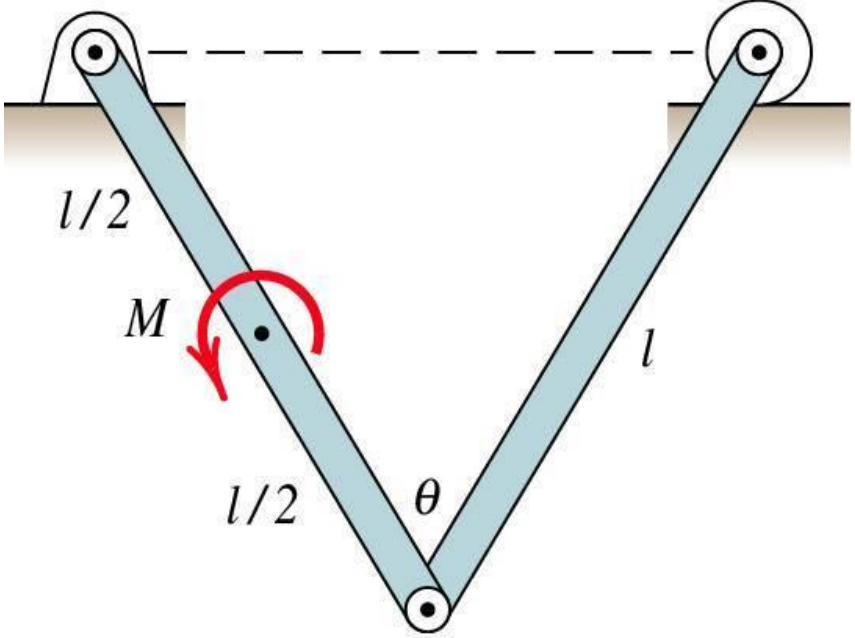


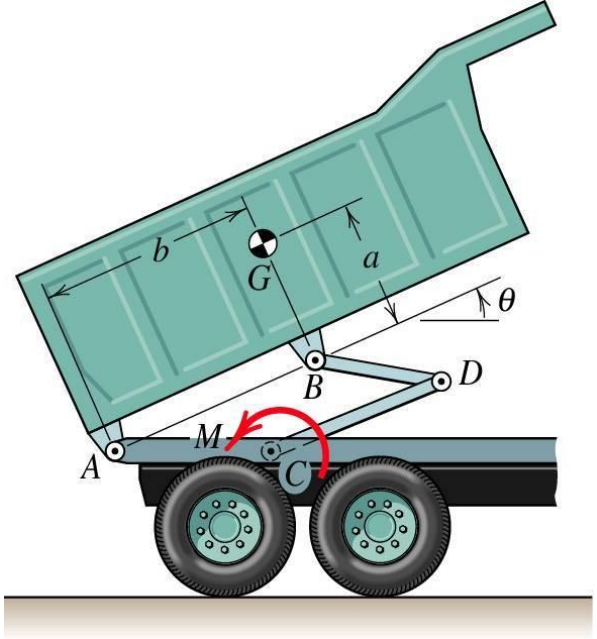
Determine the force N exerted on the log by each jaw of the fireplace tongs shown

Source: R.C. Hibbeler, "Engineering Mechanics – Statics"



Determine the couple M required to maintain equilibrium at an angle θ. Each of the two uniform bars has mass m and length l.

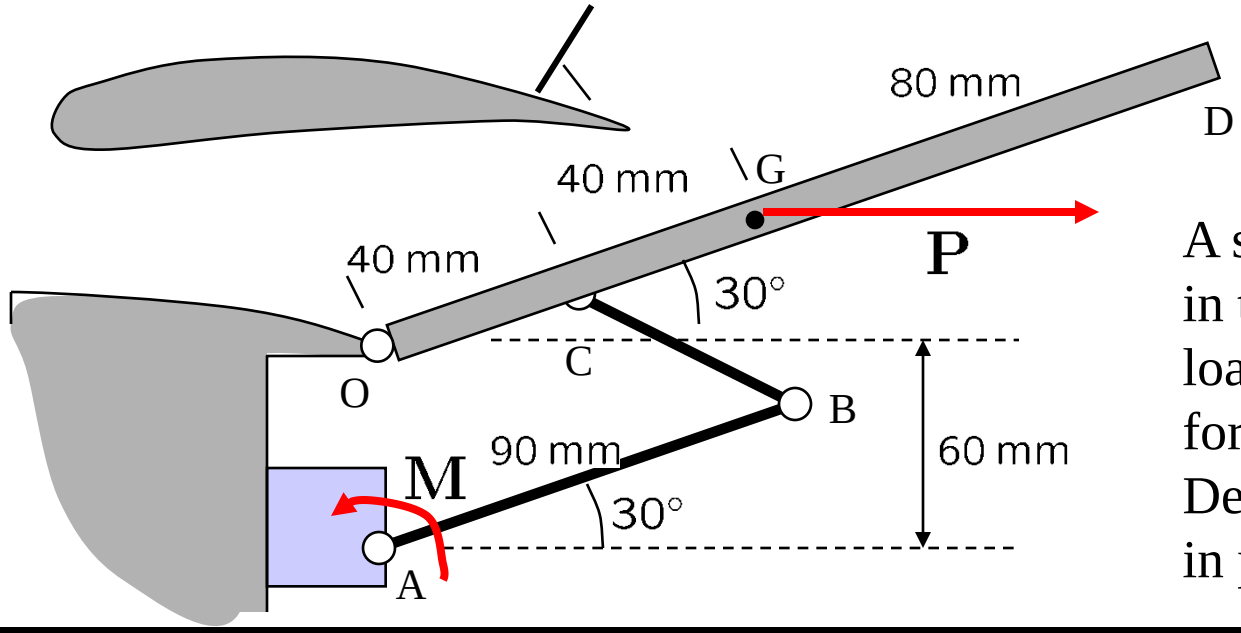
Source: R.C. Hibbeler, "Engineering Mechanics – Statics"



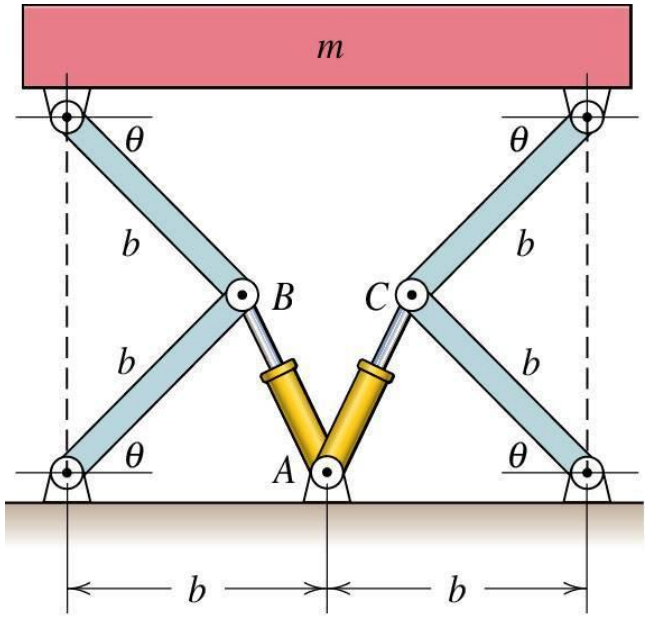
Determine the torque *M* on the activating lever of the dump truck necessary to balance the load of mass *m* with centre of mass at G when the dump angle is θ. The polygon ABDC is a parallelogram.

Source: R.C. Hibbeler,

"Engineering Mechanics – Statics"



A spoiler flap is held open in the position shown. It is loaded by an aerodynamic force **P**=800 N in point G. Determine the moment M in point A.



The height of the platform with mass m is determined by the hydraulic pistons AB and AC which rotate about point A. Determine the compressive force P in each of the two pistons for a specific angle θ.

Source: R.C. Hibbeler,

"Engineering Mechanics – Statics"