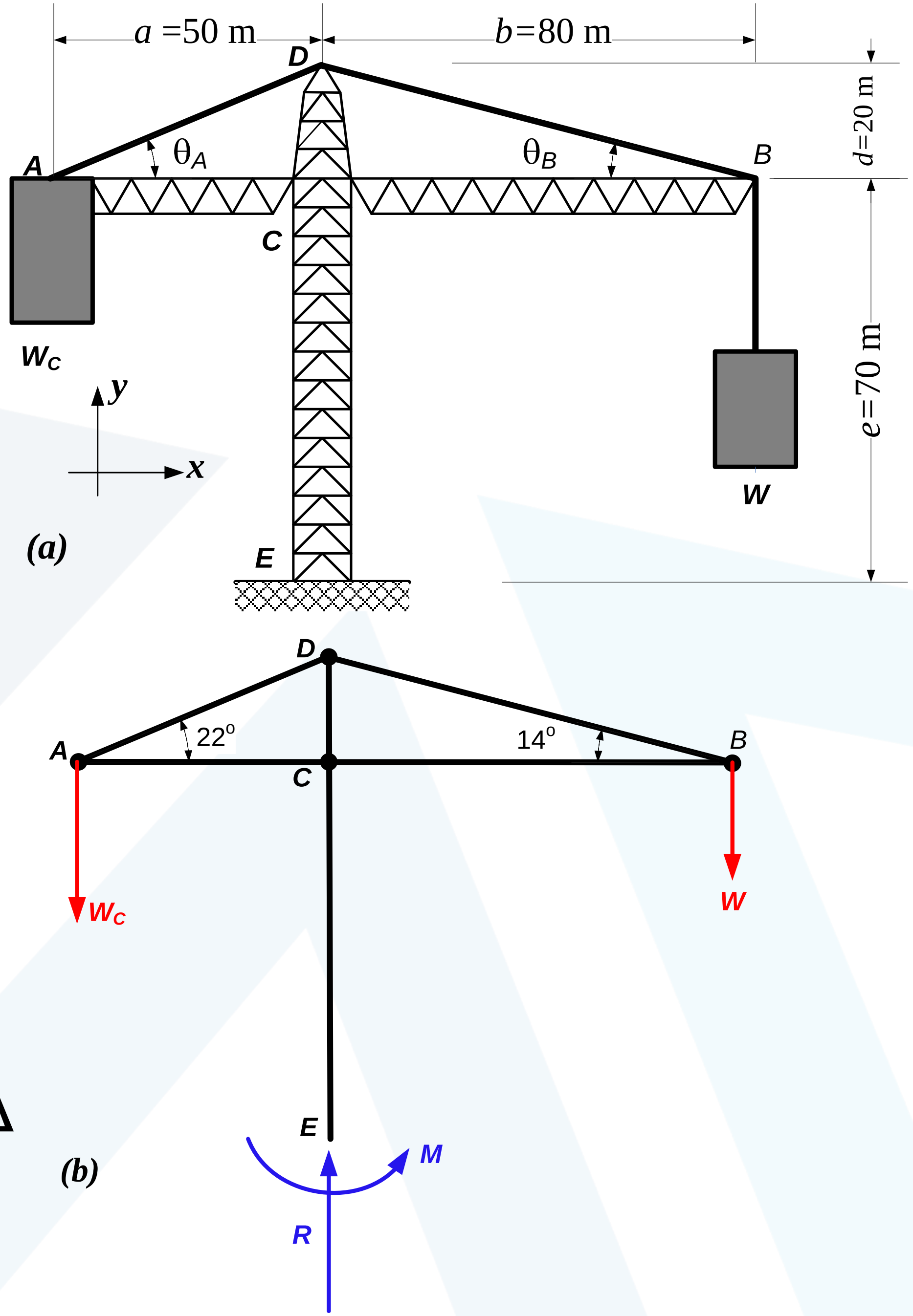
Ex. 2. Tower Crane

The tower crane shown in (*Figure a*) consists of tower ***DCE*** fixed at the ground, and two jibs ***AC*** and ***CB***. The jibs are supported by tie bars ***AD*** and ***DB***, and are assumed to be attached to the tower by pinned connections.

The counterweight W_C weighs 1750 kN and the crane has a lifting capacity of $W_{max} = 1200$ kN. Neglect the weight of the crane itself. Determine:



(a) the reactions at the base of the tower when the crane is lifting its capacity.

(b) the axial forces in tie bars ***AD*** and ***DB***, and jibs ***AC*** and ***CB***, and

(c) If the factor of safety against yielding is 2.0, determine the minimum cross-sectional area of tie bar *DB*.

(d) Using the area calculated in Part (c), determine the change in length Δ of *DB*.

The modulus of resilience U_R of a material is the strain energy density that it can store without undergoing plastic deformation (i.e., the maximum elastic strain energy).

a) Determine the resilience of the steel, aluminum, nickel, and titanium alloys listed below.

b) For the same size structure, which material can absorb the most energy without plastically deforming?

Alloy	E (GPa)	S_y (MPa)
Steel	200	250
Aluminum	70	240
Nickel	210	600
Titanium	115	800

Structural steel has yield strength S_y = 250 MPa and modulus E = 200 GPa. A steel bar with a volume of 0.002 m^3 is loaded slowly in tension.

Determine

(a) the modulus of resilience of the steel and

(b) the total energy (N·m) required to yield the component.