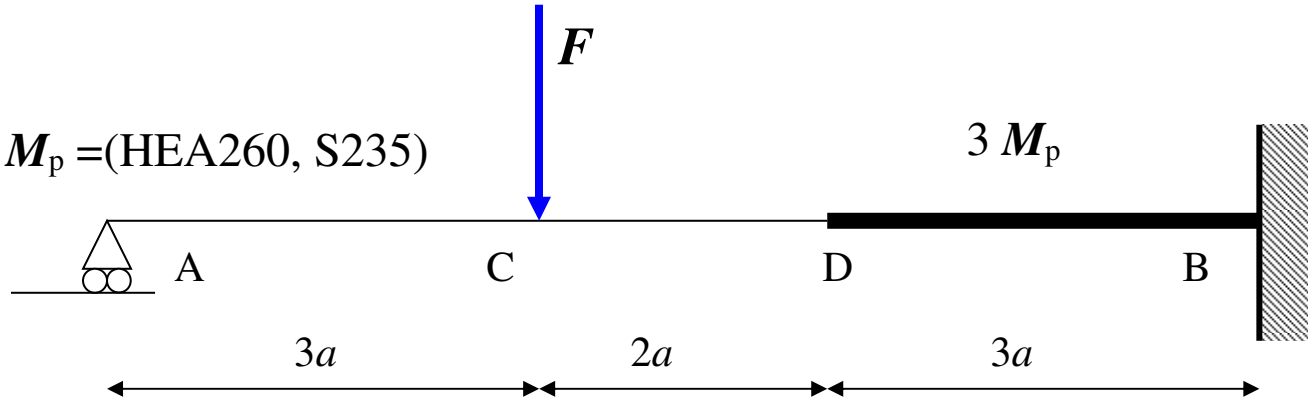
EXAMPLE



FIND THE LIMIT LOAD or COLLAPSE LOAD $\boldsymbol{F_p}$?

Given:

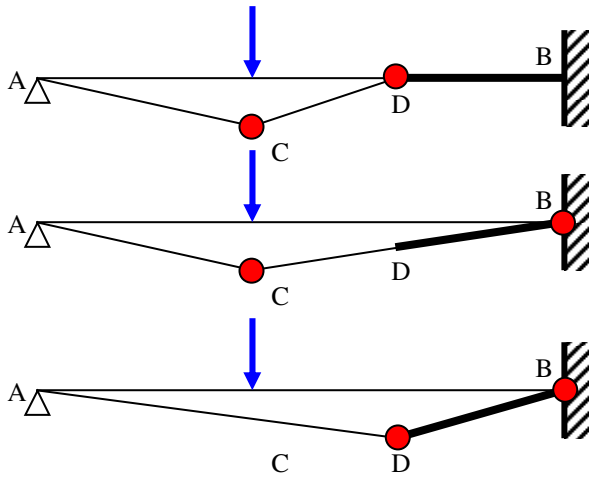
$a = 1.0\ \text{m}$

$$M_p = W_p \times f_y = 919.8\times10^3 \times 235\times10^{-6} = 216\ \text{kNm}$$

Tables for Steel sections e.g. “Staalprofielen uit de serie (Over) Spannend Staal”, Bouwen met Staal

ANALYSIS

- Simply static indeterminate structure, 2 plastic hinges required
- Three possible positions for hinges (C, D en B)
- Three possible mechanisms (3 over 2 = 3)
- hinges at CD, CB and DB



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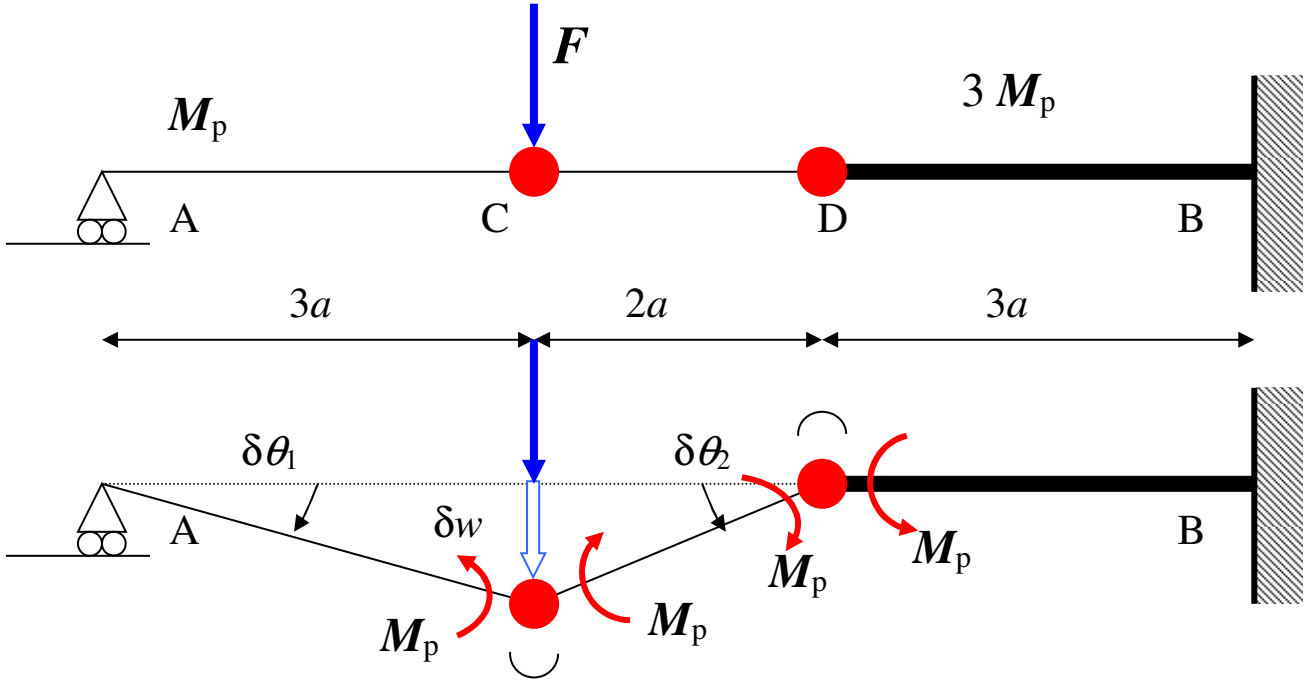
SOLUTION MECHANISM 1 : plastic hinges at C and D



Virtual work:

$$\delta A = 0$$

$$\delta A = -M_p \delta\theta_1 - M_p \delta\theta_2 - M_p \delta\theta_2 + F\delta w = 0$$

$$F_p = \frac{4M_p}{3a} = 287 \text{ kN}$$

$$\delta\theta_1 = \frac{\delta w}{3a} \qquad \delta\theta_2 = \frac{\delta w}{2a}$$

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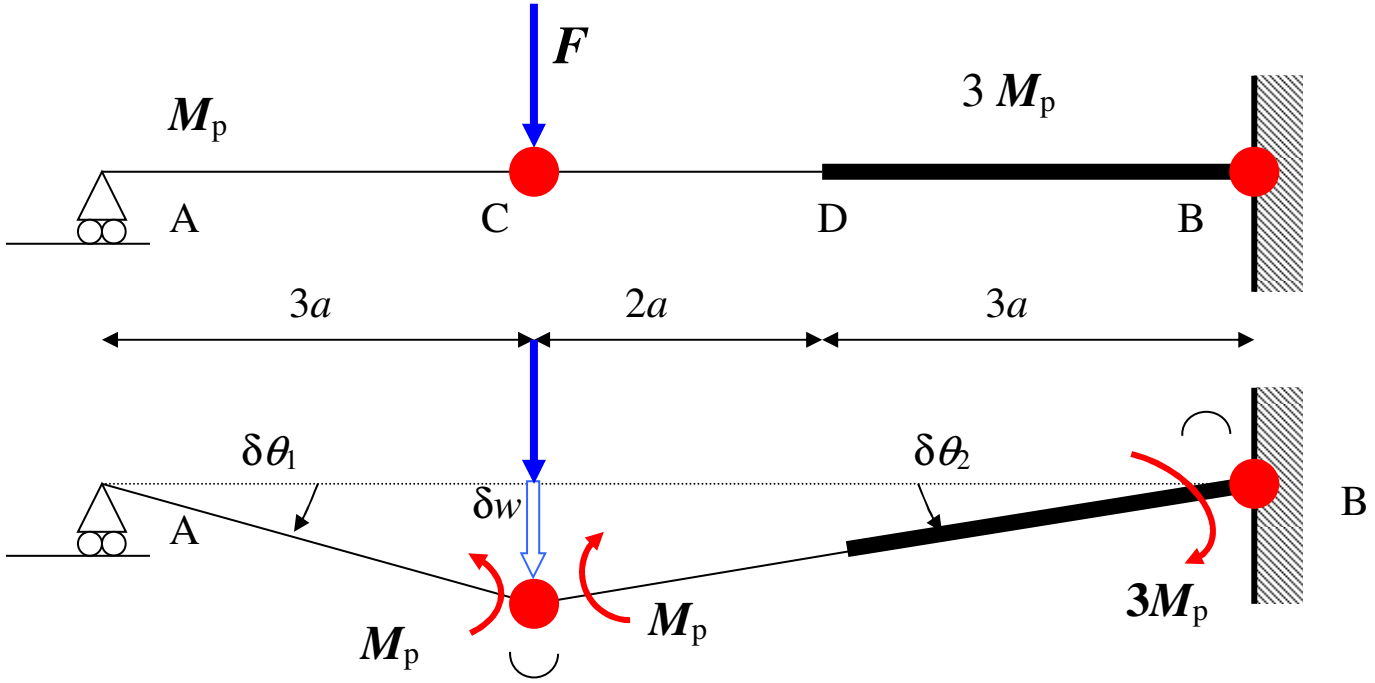
SOLUTION MECHANISM 2 : plastic hinges at C and B



Virtual work :

$$\delta A = 0$$

$$\delta A = -M_p \delta\theta_1 - M_p \delta\theta_2 - 3M_p \delta\theta_2 + F\delta w = 0$$

$$F_p = \frac{17 M_p}{15a} = 244 \text{ kN}$$

$$\delta\theta_1 = \frac{\delta w}{3a} \qquad \delta\theta_2 = \frac{\delta w}{5a}$$

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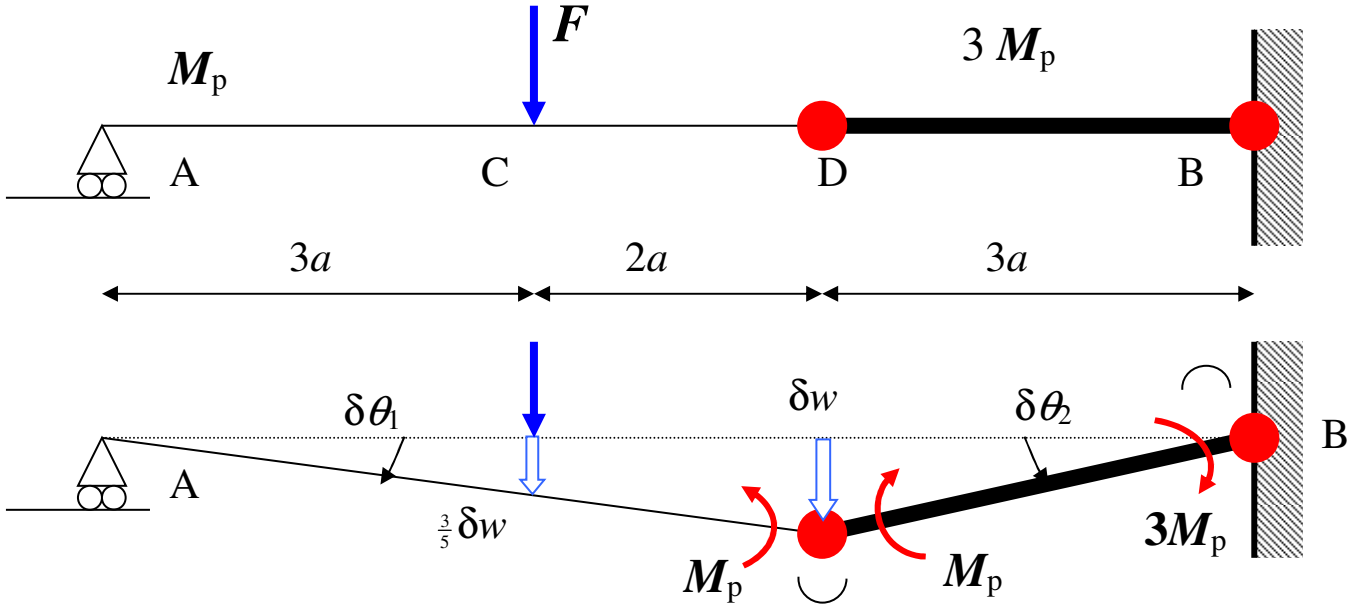
SOLUTION MECHANISM 3 : plastic hinges at D and B



Virtual work:

$$\delta A = 0$$

$$\delta A = -M_p \delta\theta_1 - M_p \delta\theta_2 - 3M_p \delta\theta_2 + F\,\tfrac{3}{5}\delta w = 0$$

$$F_p = \frac{23M_p}{9a} = 552 \text{ kN}$$

$$\delta\theta_1 = \frac{\delta w}{5a} \qquad \delta\theta_2 = \frac{\delta w}{3a}$$

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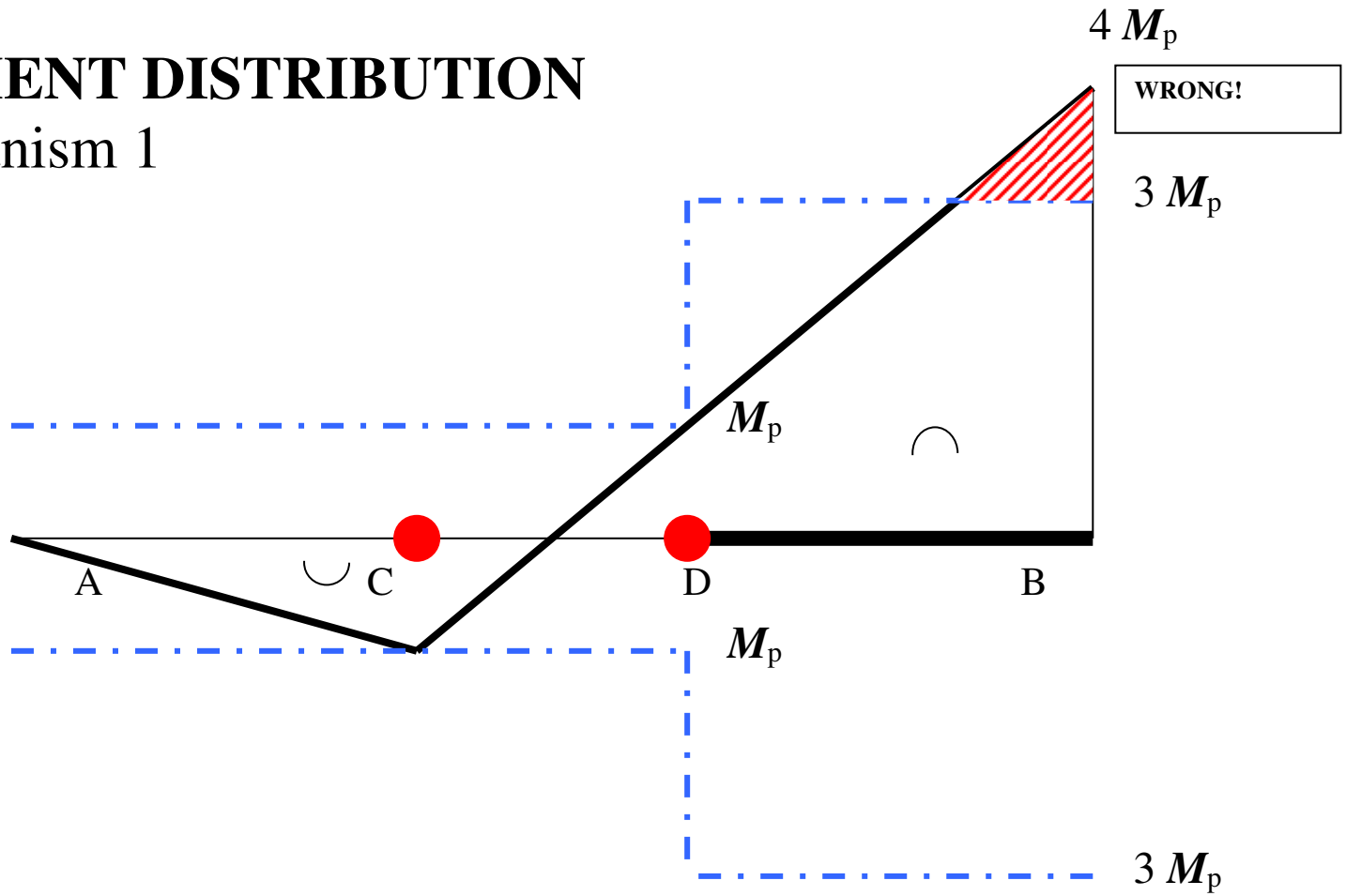
MOMENT DISTRIBUTION

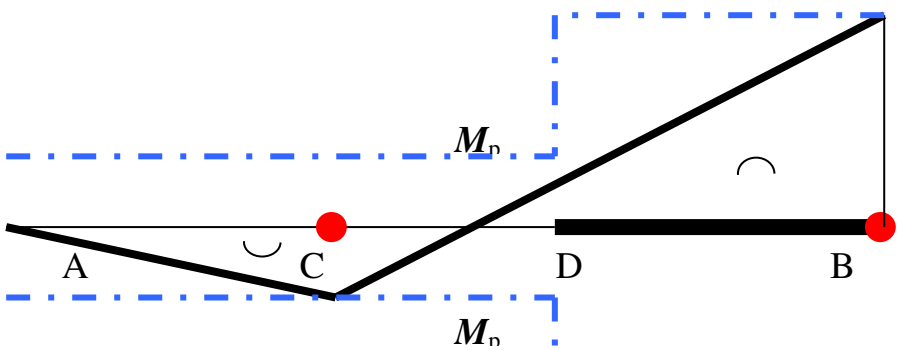
mechanism 1



Blue dashed lines are the *moment boundaries* based on the given strength.

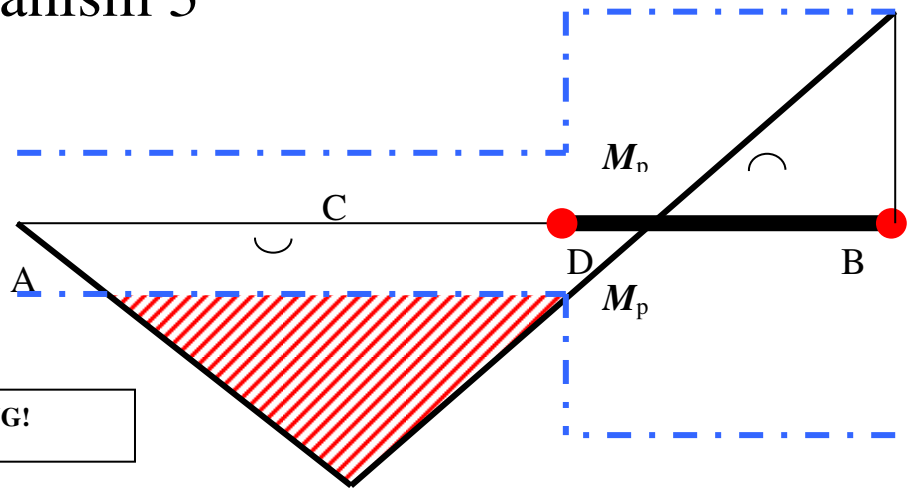
MOMENT DISTRIBUTION

mechanism 2



collapse mechanism
(lowest possible collapse load of all possible mechanisms)

mechanism 3



WRONG!

3.67 M_p