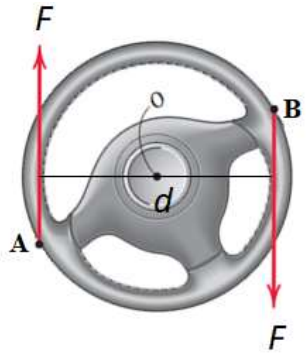
## 1.4 Moment of a Couples

Couple is defined as two non-collinear parallel forces that have the same magnitude, but opposite directions. The magnitude of the couple is given by:

$$\boldsymbol{M_{couple} = F \cdot d}$$

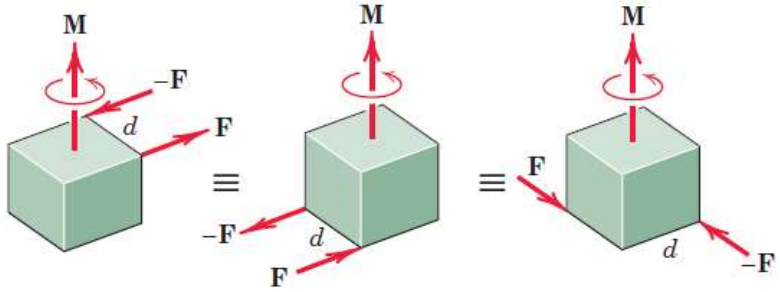



where:

$\boldsymbol{M_{couple}}$**:** The moment of a couple (N.m, kN.m, N.mm).

$\boldsymbol{F}$**:** Applied force (N, kN).

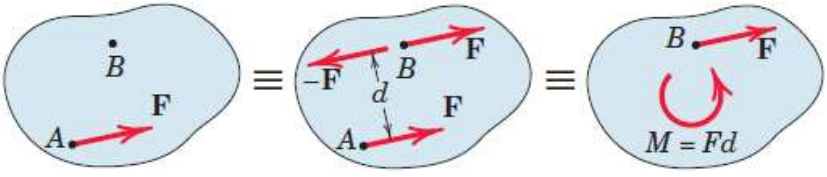
$\boldsymbol{d}$**:** The perpendicular distance between the forces (m, mm, cm).



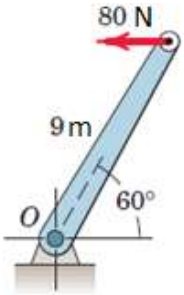

**Force – Couple Systems**

According to the principle of transmissibility, the force can be moved to any point along its line of action, as it produces the same effect on the body. However, if we want to move the force to a point not lying on its line of action, it must generate a couple such that it produces the same effect as the force. This is known as *force-couple system*.

The replacement of a force into a force and a couple is explain in Figure below, where the given force **F** acting at point *A* is replaced by an equal force **F** at point *B* and the counterclockwise couple $M = Fd$.



**Example No. 1:** Replace the horizontal 80 N force acting on the lever by an equivalent system consisting of a force at *O* and a couple.

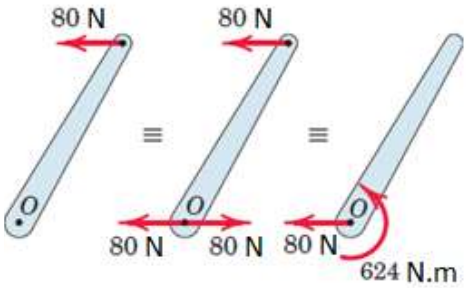



**Solution:**

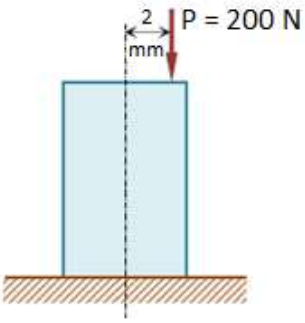
$M_o = F \cdot d$

$M_o = 80 \times (9 \ \sin 60)$

$M_o = 624 \ N.m$ ↺

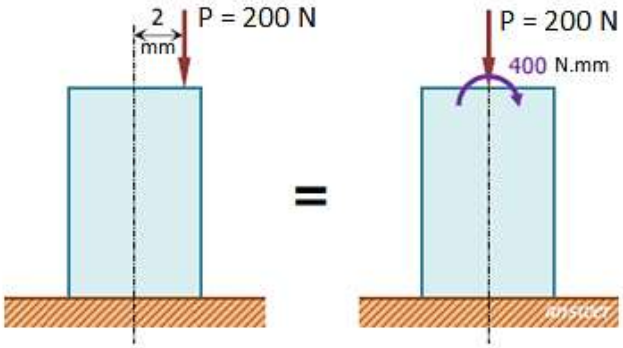



**Example No. 2:** For the compression member shown in the figure, replace the force P = 200 N by an equivalent axial load and a couple.




**Solution:**

$M_{couple} = F \cdot d = 200 \times 2 = 400 \ N.mm$ ↺

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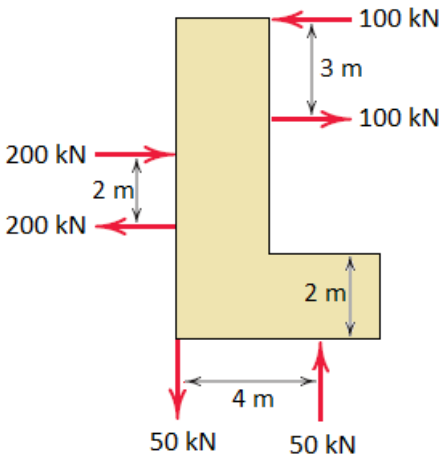
**Example No. 3:** Determine the resultant moment of the three couples acting on the plate.

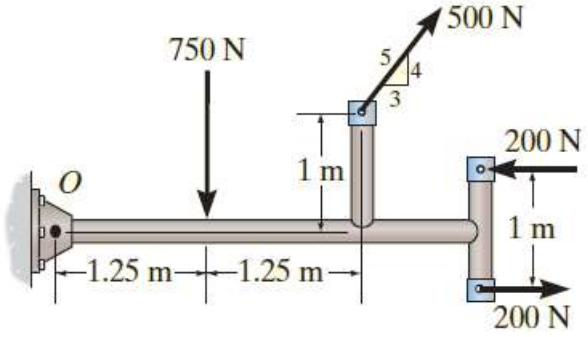



**Solution:**

$$\oplus M = \sum F \cdot d = 200 \times 2 - 100 \times 3 - 50 \times 4$$

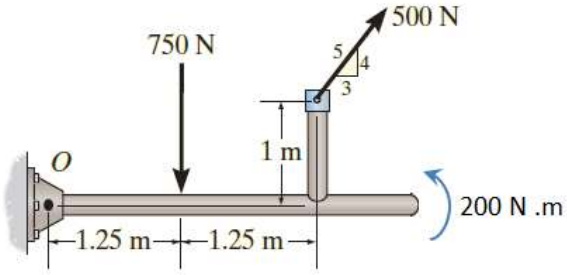
$$\therefore M = -100\ kN.m = 100\ kN.m \circlearrowright$$

**Example No. 4:** Determine the resultant moment with respect to point O.




**Solution:**

$$M_{couple} = F \cdot d = 200 \times 1 = 200\ N.m \circlearrowleft$$



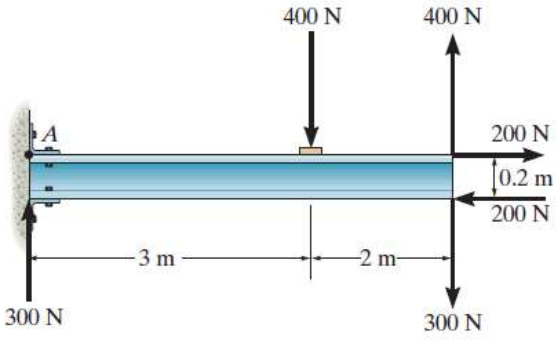

$$\oplus M_o = \sum F \cdot d$$

$$M_o = 750 \times 1.25 + 500 \times \frac{3}{5} \times 1 - 500 \times \frac{4}{5} \times 2.5 - 200$$

$$M_o = 37.5\ N.m \circlearrowright$$

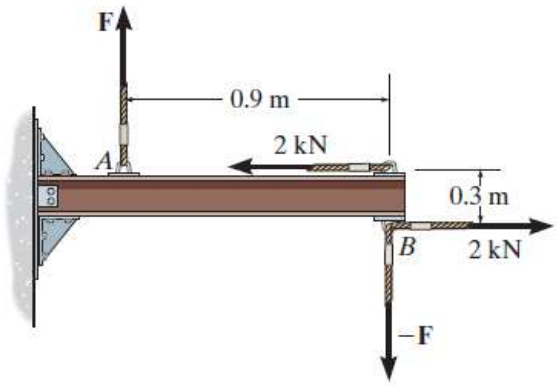
## Problems:

**1.** Determine the resultant moment acting on the beam.



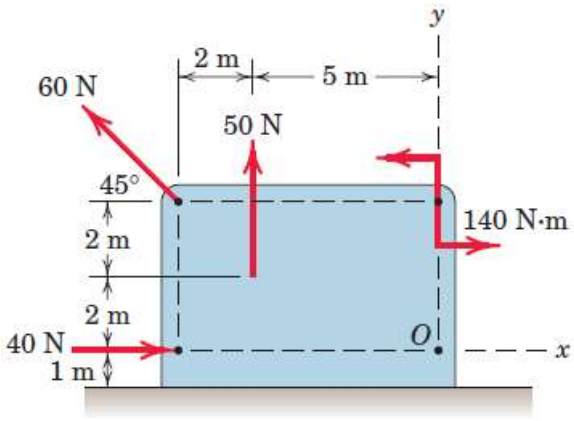

**Answer**: $M_{couple} = 740\ N.m$ ↺

**2.** Determine the magnitude of F so that the resultant moment acting on the beam is 1.5 kN.m clockwise.




**Answer**: $F = 2.333\ kN$

**3.** Determine the resultant moment of the three forces and one couple which act on the plate shown about point O.




**Answer**: $M_O = 237.279\ N.m$ ↺