mon/wed/fri, 12:50-2:05pm, 370-370

statics of the leaning problem

\[ F_Y = 0 : \quad B_V - W = 0 \]
\[ B_V = W \]

\[ M_B = 0 : \quad A d_2 - W d_1/2 = 0 \]
\[ A = W d_1/2d_2 \]

\[ F_X = 0 : \quad A - B_H = 0 \]
\[ B_H = W d_1/2d_2 \]

the flatter the leaning angle
the larger the horizontal force

5. equations of equilibrium

\[ F_Y = 0 : \quad A_V - w_0d_1 = 0 \]
\[ A_V = w_0d_1 \]

\[ M_A = 0 : \quad Bd_2 - w_0d_1^2/2 = 0 \]
\[ B = w_0d_1^2/2d_2 \]

\[ F_X = 0 : \quad A - B = 0 \]
\[ A_H = w_0d_1^2/2d_2 \]

the flatter the leaning angle
the larger the horizontal force
5. equations of equilibrium

- The flatter the leaning angle, the larger the horizontal force
- In a way, this is a couple moment problem: \( A_V \) and \( W \) @moment arm \( d_1/2 \) vs \( B \) and \( A_H \) @moment arm \( d_2 \)

6. structural analysis

- To show how to determine the forces in the members of a truss using the methods of joints
- To analyze the forces acting on the members of frames and machines composed of pin-connected members

6.1 simple trusses

- Roof trusses
- Bridge trusses
6.1 simple trusses

**design assumptions**

- **all loadings** are applied at the joints, weight is typically much smaller than external loads and thus neglected
- **all members** are joined together by smooth pins, this implies that each member acts as a **two-force member**

**simple truss**

- **three members** pin-connected at their ends form a **rigid triangle**
- attaching **two more members** to form a new triangle forms a larger truss
- a truss that is constructed by expanding a basic triangle is called a ‘**simple truss**’

6.1 simple trusses

**example 6.1**

6.2 method of joints

**example 6.3**

6.2 method of joints
identify zero-force members!

- if only two members for a truss joint, and there are no other forces acting on it, the two members must be zero force members!

\[ \sum F_x = 0; F_{AB} = 0 \]
\[ \sum F_y = 0; F_{AF} = 0 \]

6.3 zero-force members

example 6.9

EXAMPLE 6.9

For the frame shown in Fig. 6-21a, draw the free-body diagram of (a) each member, (b) the pin at B, and (c) the two members connected together.

6.6 frames and machines

example 6.9

SOLUTION

Part (a): By inspection, members BA and BC are not two-force members. Instead, as shown on the free-body diagrams, Fig. 6-21b, BC is subjected to a force from the pins at B and C and the external force P. Likewise, AB is subjected to a force from the pins at A and B and the external couple moment M. The pin forces are represented by their x and y components.

Part (b): The pin at B is subjected to only two forces, i.e., the force of member BC and the force of member AB. For equilibrium these forces or their respective components must be equal but opposite, Fig. 6-21c. Realize that Newton's third law is applied between the pin and its connected members, i.e., the effect of the pin on the two members, Fig. 6-21b, and the equal but opposite effect of the two members on the pin, Fig. 6-21c.

Part (c): The free-body diagram of both members connected together, yet removed from the supporting pins at A and C, is shown in Fig. 6-21d. The force components \( R_b \) and \( R_c \) are not shown on this diagram since they are internal forces (Fig. 6-21b) and therefore cancel out. Also, to be consistent when later applying the equilibrium equations, the unknown force components at A and C must act in the same sense as those shown in Fig. 6-21b.
for the frame shown below, draw a free body diagram of each member, the pin, and the two members together. calculate all forces! assume pin-type supports at the hands and feet.
example 6.11

**EXAMPLE 6.11**

For the frame shown in Fig. 6-23a, draw the free-body diagrams of (a) the entire frame including the pulleys and cords, (b) the frame without the pulleys and cords, and (c) each of the pulleys.

**SOLUTION**

**Part (a).** When the entire frame including the pulleys and cords is considered, the interactions at the points where the pulleys and cords are connected to the frame become pairs of internal forces which cancel each other and therefore are not shown on the free-body diagram, Fig. 6-23b.

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6.6 frames and machines

example: structure with 3 subsystems

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6.6 frames and machines