

CLASS 1: REVIEW OF STATICS

TEXT: CHAPTER 3

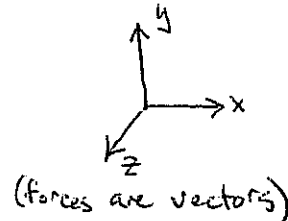
A, STATICS: STUDY OF FORCE SYSTEMS ACTING ON RIGID BODIES AT REST.

1. STATIC EQUILIBRIUM:

- FORCES AND MOMENTS ACTING ON A BODY ARE BALANCED

2. EQUATIONS OF EQUILIBRIUM

3D: $\rightarrow \sum F_x = 0$ $+ \curvearrowright \sum M_x = 0$
 $\uparrow \sum F_y = 0$ $\odot \sum M_y = 0$
 $\swarrow \sum F_z = 0$ $\oplus \sum M_z = 0$



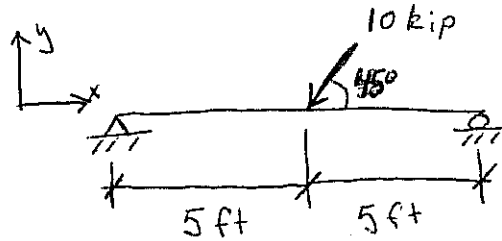
6 EQNS,

2D: $\rightarrow \sum F_x = 0$
 $\uparrow \sum F_y = 0$
 $+ \curvearrowright \sum M = 0$



3 EQNS.

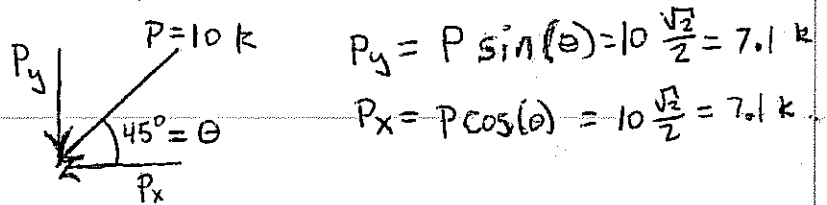
3. EXAMPLE



1 kip = 1000 lb

$\sum F_x = ?$
 $\sum F_y = ?$
 $\sum M = ?$

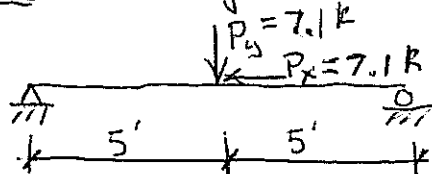
NOTE: INCLINED FORCE (w/ respect to coordinate system):
 FIND COMPONENT FORCES



$P_y = P \sin(\theta) = 10 \frac{\sqrt{2}}{2} = 7.1 \text{ k}$

$P_x = P \cos(\theta) = 10 \frac{\sqrt{2}}{2} = 7.1 \text{ k}$

→ Replace the original load by the components:



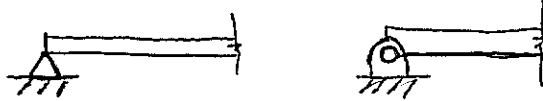
→ Can we sum forces yet? What is missing?

REACTIONS

B. REACTIONS AND SUPPORTS

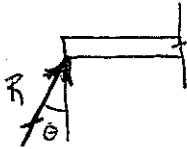
1. TYPES OF SUPPORTS (TEXT: TABLE 3.1)

a.) PIN SUPPORT

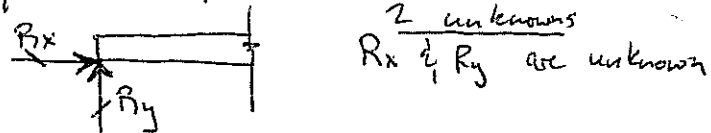


Prevents: Horizontal translation
Vertical translation

Allows: Rotation

Reactions:  $\frac{2 \text{ unknowns}}$
 $R \text{ \& } \theta \text{ are unknown}$

equivalent representation

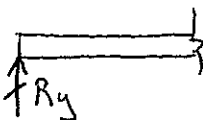


b.) ROLLER SUPPORT

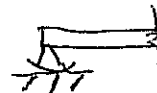


Prevents: Vertical translation

Allows: Rotation
Horizontal translation

Reactions:  $\frac{1 \text{ unknown}}$
 $R_y \text{ is unknown}$

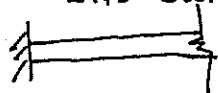
SEE ALSO: ROCKER SUPPORT



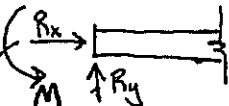
SEE ALSO: ELASTOMERIC PAD



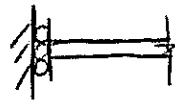
c.) FIXED END SUPPORT



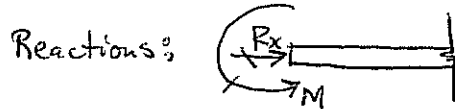
Prevents: Vertical Translation
Horizontal Translation
ROTATION

Reactions:  $\frac{3 \text{ unknowns}}$
 $R_x, R_y, \text{ \& } M \text{ are unknown}$

d.) GUIDE SUPPORT



Prevents: Horizontal Translation
Rotation
Allows: Vertical Translation



2 unknowns
Rx & M are unknown

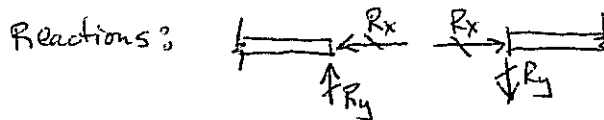
ALSO SEE: SLOT SUPPORT

2.) OTHER ELEMENTS

a.) INTERNAL HINGE



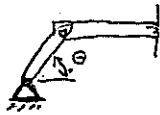
Prevents: Relative Horizontal & Vertical Displacement
Allows: Absolute Horizontal & Vertical Displacement
Rotation



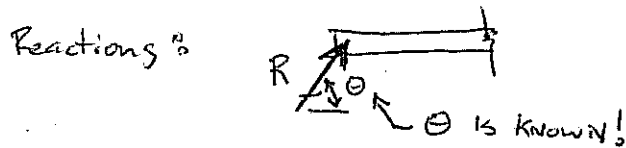
2 unknowns
Rx & Ry are unknown

NOTE: EQUAL & OPPOSITE

b.) LINK ELEMENT



Prevents: Translation in direction of link
Allows: Translation perpendicular to link
Rotation



1 unknown
R is unknown

★

C: FREE BODY DIAGRAMS: (FBD)

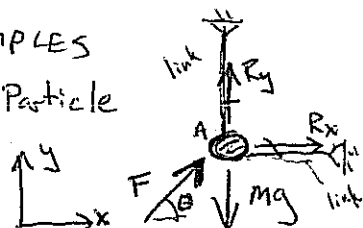
1. SIMPLIFIED SKETCH OF STRUCTURE (ALL OR IN PART) SHOWING DIMENSIONS, ALL EXTERNAL FORCES, REACTIONS, AND IN CASES OF PARTIAL STRUCTURE, INTERNAL FORCES AS WELL

2. ELEMENTS OF A FBD

- a.) sketch of structure
- b.) external forces
- c.) internal forces
- d.) reactions
- e.) dimensions
- f.) coordinate system

3. EXAMPLES

a.) Particle



what about ΣM ?

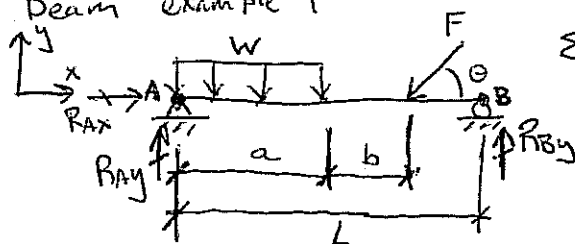
Can we solve for R_x & R_y ?
2 eqns., 2 unknowns

SUM OF FORCES

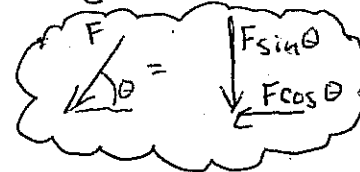
$$\Sigma F_x = 0 \Rightarrow F \sin \theta + R_x = 0$$

$$\Sigma F_y = 0 \Rightarrow F \cos \theta - mg + R_y = 0$$

b.) Beam example 1



$$\Sigma F_x = 0 \Rightarrow -F \cos \theta + R_{ax} = 0$$



$$\Sigma F_y = 0 \Rightarrow R_{ay} + R_{by} - wa - F \sin \theta = 0$$

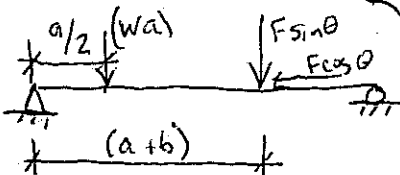
$$+\circlearrowleft \Sigma M_A = 0 \Rightarrow -wa \left(\frac{a}{2}\right) + F \sin \theta (a+b) + R_{by} (L) = 0$$

Note \rightarrow ?

Can we solve for $R_{ax}, R_{ay},$ & R_{by} ?

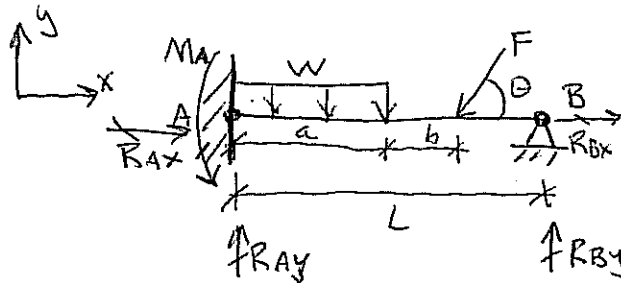
3 eqns., 3 unknowns

DISTRIBUTED LOAD



FIND RESULTANT

c.) Beam example 2



SUM OF FORCES

$$\sum F_x = 0 \Rightarrow -F \cos \theta + R_{Ax} + R_{Bx} = 0$$

$$\sum F_y = 0 \Rightarrow R_{Ay} + R_{By} - F \sin \theta - wa = 0$$

$$\sum M_A = 0 \Rightarrow -wa \left(\frac{a}{2}\right) - F \sin \theta (a+b) + R_{By} (L) + M_A = 0$$

Can we solve for R_{Ax} , R_{Ay} , M_A , R_{Bx} , and R_{By} ?

3 eqns., 5 unknowns

Indeterminate from equations of static equilibrium.

We will address statically indeterminate structures later in this ~~class~~ course.