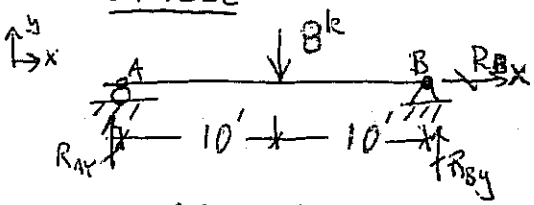
CLASS 2: STABILITY AND DETERMINCY

A. **STABILITY**: SUFFICIENT RESTRAINT IS PROVIDED TO PREVENT A STRUCTURE, OR ANY PORTION OF THE STRUCTURE, FROM MOVING AS A RIGID BODY.

-IN OTHER WORDS- EQUILIBRIUM MUST BE SATISFIED.

STABLE



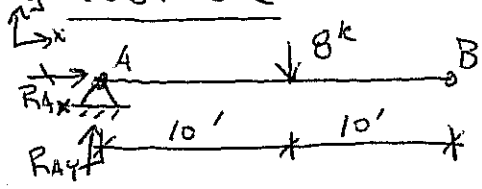
$\Sigma F_x = 0] \quad R_{Bx} = 0$

$\Sigma F_y = 0] \quad R_{Ay} + R_{By} - 8 = 0$

$\oplus \Sigma M_A = 0] \quad -(8)10 + R_{By}(20) = 0$

OK

UNSTABLE



$\Sigma F_x = 0] \quad R_{Ax} = 0$

$\Sigma F_y = 0] \quad R_{Ay} - 8 = 0$

$\circlearrowleft \Sigma M_A = 0] \quad 8(10) = 0$

No!

SINGLE RIGID STRUCTURE (Text Table 3.2a)

Case 1: Supports supply < 3 restraints. ($R<3$)

Reactions

Never Stable

Case 2: Supports Supply 3 restraints. ($R=3$)

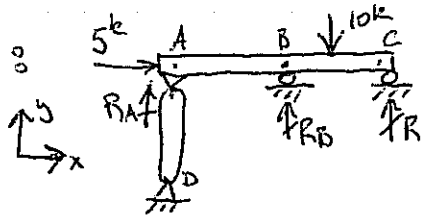
Stable unless:

a.) Restraints form a parallel force system.

b.) Restraints form a concurrent force system.

PARALLEL FORCE SYSTEM: A PARALLEL FORCE SYSTEM IS DEFINED BY ALL REACTIONS APPLIED TO BODY IN SAME DIRECTION

EXAMPLE:



$\Sigma F_y = 0] \quad R_A + R_B + R_C = 10$

$\Sigma F_x = 0] \quad 5 \neq 0$

No!

Unstable

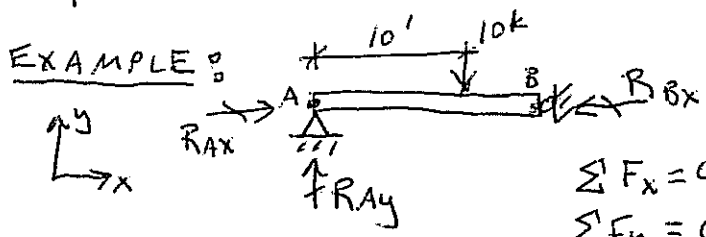
$R_A \parallel R_B \parallel R_C$

-NOTE: ONCE BEAM ABC MOVES FAR ENOUGH, LINK AD WILL CHANGE ANGLE & PROVIDE HORIZ. RESTRAINT.
-STILL UNSTABLE!-

CONCURRENT FORCE SYSTEM: A concurrent force system is one such that all reactions are oriented so that their lines of action pass through a single point.

TRANSMISSIBILITY

EXAMPLE:



$\Sigma F_x = 0] \; R_{Ax} + R_{Bx} = 0$

$\Sigma F_y = 0] \; R_{Ay} = 10^k$

$\circlearrowleft + \Sigma M_A = 0] \; 10(10) = 0$ ← No!

UNSTABLE!

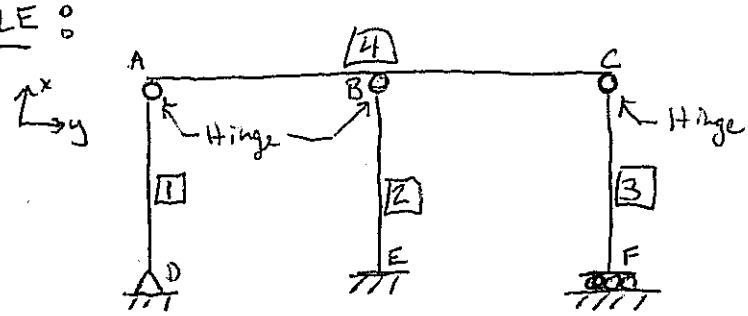
Case 3: Supports supply >3 restraints ($R > 3$)

— Stable unless restraints form parallel or concurrent support system.

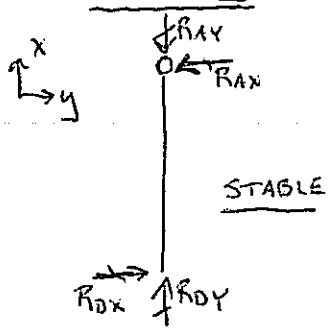
INTERCONNECTED RIGID STRUCTURES (TEXT TABLE 3.2b)

APPLY STABILITY RULES TO ALL PORTIONS OF THE TOTAL STRUCTURE

EXAMPLE:

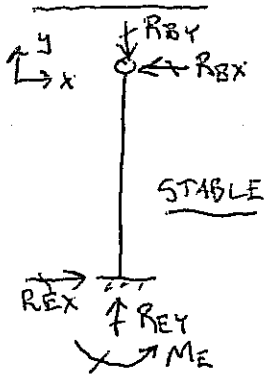


MEMBER 1



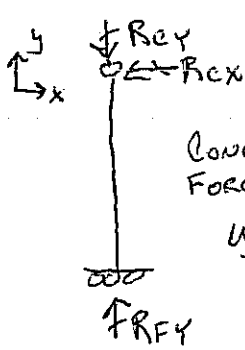
STABLE

MEMBER 2



STABLE

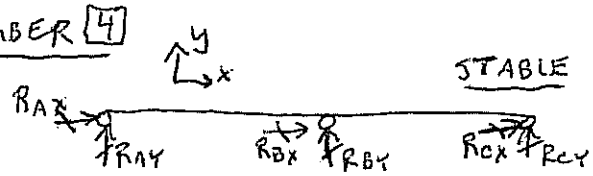
MEMBER 3



CONCURRENT FORCE SYSTEM

UNSTABLE!

MEMBER 4



STABLE

IF ONE PORTION OF THE STRUCTURE IS UNSTABLE, ENTIRE STRUCTURE IS UNSTABLE

B. DETERMINACY:

1.) SINGLE RIGID BODY (Text Table 3.2a)

STRUCTURE IS DETERMINATE IF AND ONLY IF THE REACTIONS CAN BE DETERMINED FROM THE EQUATIONS OF EQUILIBRIUM.

CASE 1: $R < 3$ ← Why 3? (EQNS OF EQUILIBRIUM)
UNSTABLE - DETERMINACY NOT AN ISSUE

CASE 2: $R = 3$
IF STABLE, THEN DETERMINANT

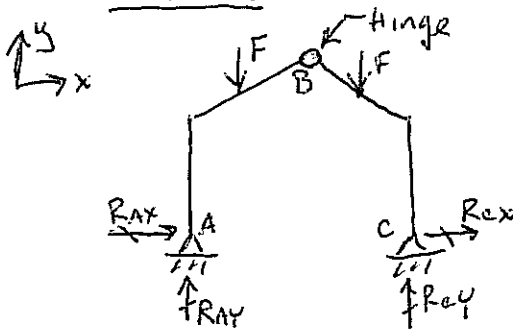
CASE 3: $R > 3$
IF STABLE, INDETERMINANT
DEGREE OF INDETERMINACY = $R - 3$ Degrees

2.) INTER CONNECTED RIGID STRUCTURES (TEXT TABLE 3.2b)

a.) INTERNAL RELEASES CAN INTRODUCE ADDITIONAL CONDITIONS THAT CAN BE EXPLOITED TO DETERMINE REACTIONS.

b.) Equations that summarize these conditions are referred to as EQUATIONS OF CONDITION

EXAMPLE



4 REACTIONS ($R = 4$)
1 CONDITION ($C = 1$)
3 EQNS. OF EQUILIBRIUM

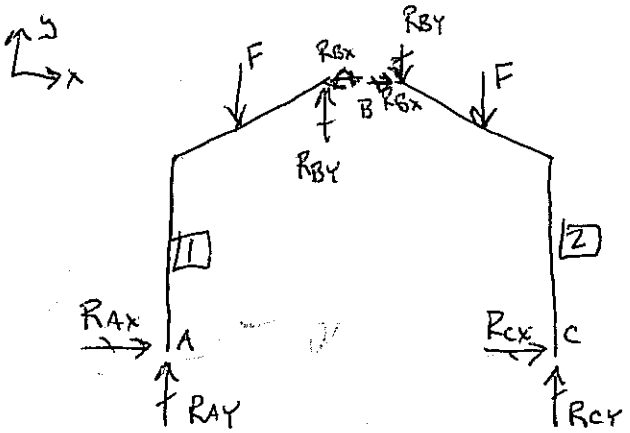
4 unknown reactions, 4 equations
structure is determinate

EQUATIONS OF EQUILIBRIUM

$\Sigma F_x = 0$
$\Sigma F_y = 0$
$\Sigma M_A = 0$ or $\Sigma M_C = 0$
$\Sigma M_B = 0$

Note: Must Cut Structure. See Alt. View (Next Page).

EXAMPLE (ALTERNATE VIEW)



→ 2 CONNECTED STRUCTURES

- REACTIONS AT B EQUAL AND OPPOSITE.
- REACTIONS AT PINS A & C ARE UNIQUE

SIX TOTAL UNKNOWNS

PART 1: 3 EQNS. OF EQUILIBRIUM
PART 2: 3 EQNS. OF EQUILIBRIUM
} SIX TOTAL EQUATIONS

DETERMINATE

CASE 1: $R < 3 + C$

UNSTABLE - DETERMINACY NOT AN ISSUE

CASE 2: $R = 3 + C$

IF STABLE, THEN DETERMINANT

CASE 3: $R > 3 + C$

IF STABLE, THEN INDETERMINANT

DEGREE OF INDETERMINACE = $R - (3 + C)$