Universitas Pembangunan Jaya

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Mata Kuliah : Statika
Kode : CVL – 104
SKS : 3 SKS

Konsep Keseimbangan & Pemodelan Struktur

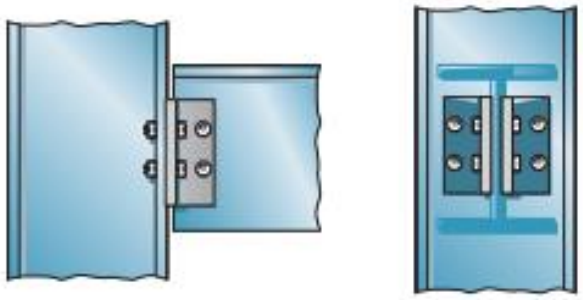
Pertemuan – 3 & 4

- TIU :
  - Mahasiswa dapat menghitung reaksi perletakan pada struktur statis tertentu
- TIK :
  - Mahasiswa dapat menjelaskan Konsep Keseimbangan
  - Mahasiswa dapat menjelaskan model fisik struktur sederhana

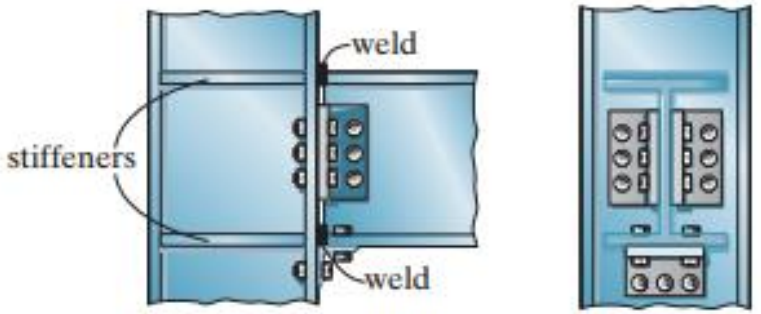
- Sub Pokok Bahasan :
  - Kriteria Keseimbangan
  - Free Body Diagram
  - Keseimbangan dalam dua dan tiga dimensi
  - Jenis Tumpuan dan Sifatnya
  - Struktur Balok Sederhana

Support Connections

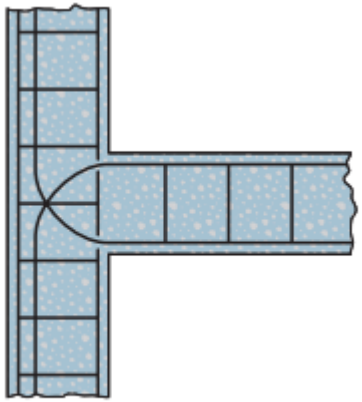
- Structural members are joined together in various ways depending on the intent of the designer.
- The three types of joints most often specified are the **pin connection**, the **roller support**, and **the fixed joint**.



typical "pin-supported" connection (metal)
(a)

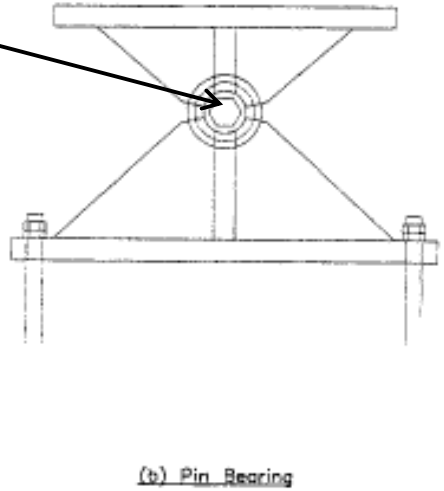


typical "fixed-supported" connection (metal)
(b)



typical "fixed-supported" connection (concrete)

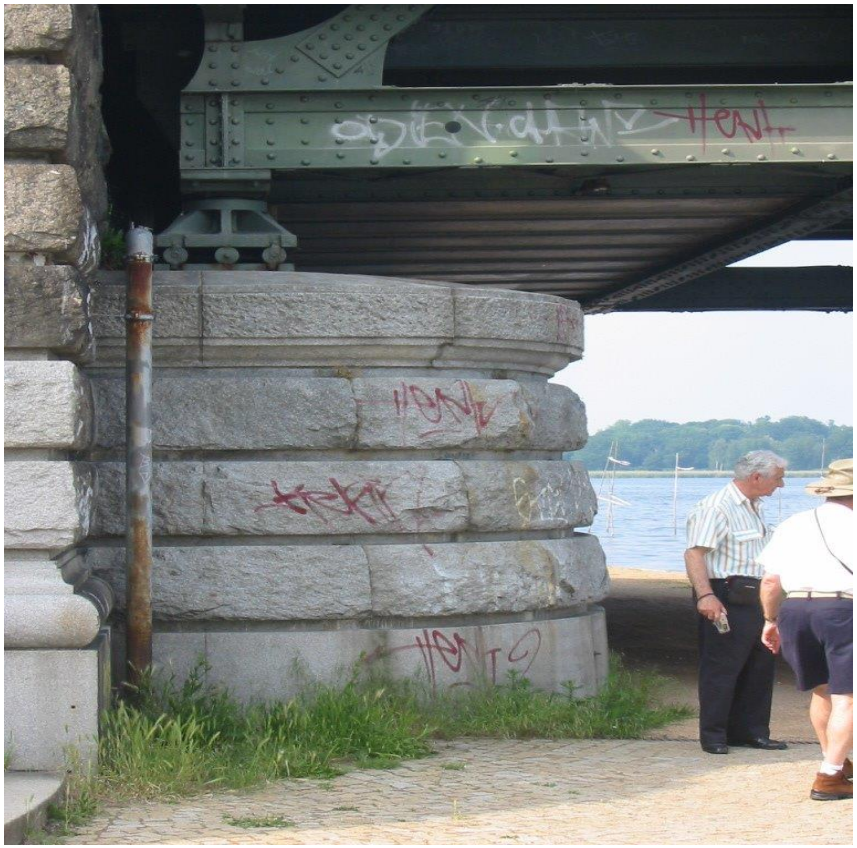
Pin Bearing



- **Rotational Movement is allowed**
- **Lateral and Translational Movements are Restricted**

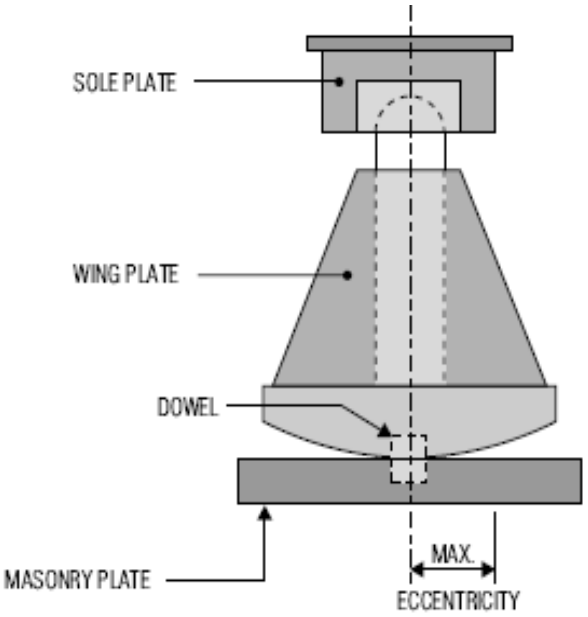
Roller Type Bearings

Single Roller Bearing



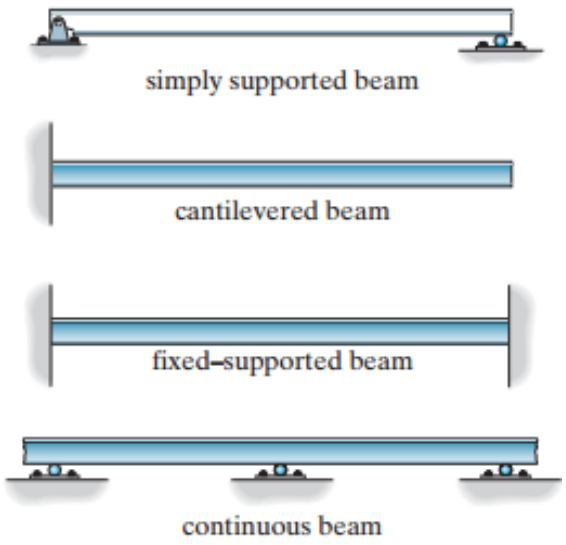
Multiple Roller Bearing

Rocker Type Bearing

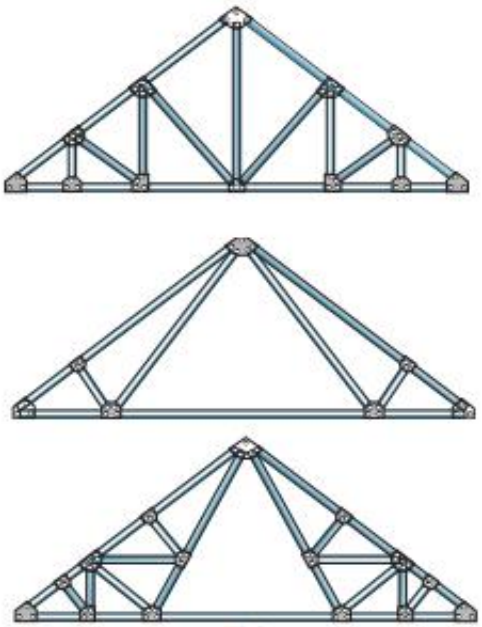


- A rocker bearing is a type of expansion bearing that comes in a great variety.
- It typically consists of a pin at the top that facilitates rotations, and a curved surface at the bottom that accommodates the translational movements
- Rocker and pin bearings are primarily used in steel bridges.

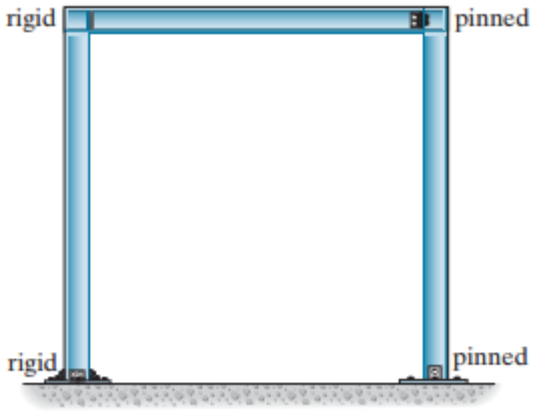
- Classification of Structures



BEAM

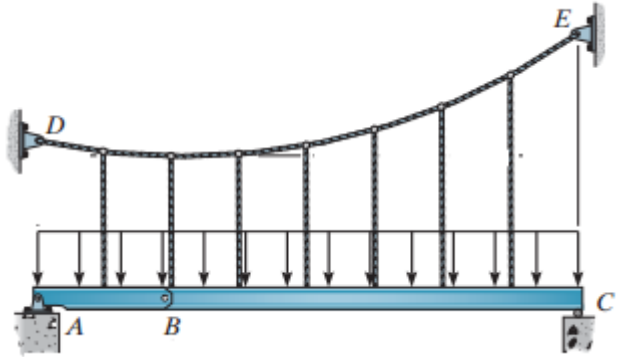


2D TRUSS



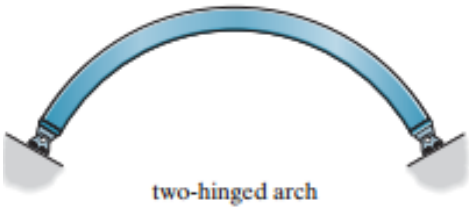
2D FRAME

- Classification of Structures



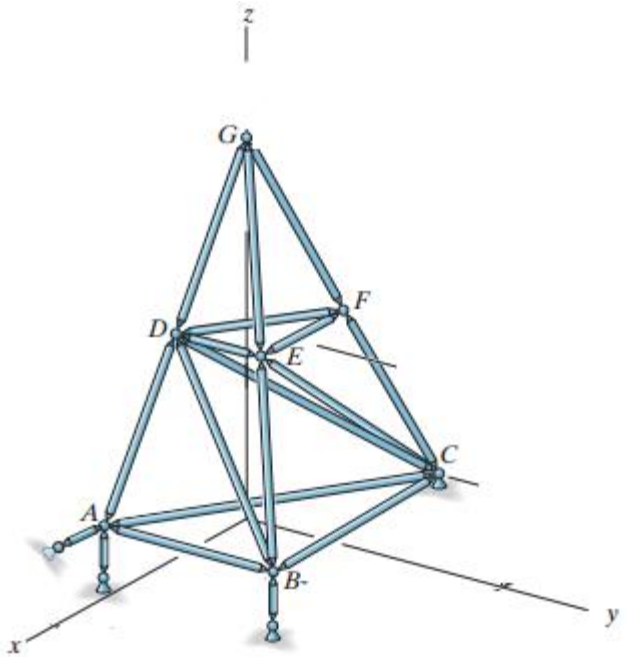
CABLE

fixed arch
(a)



two-hinged arch
(b)

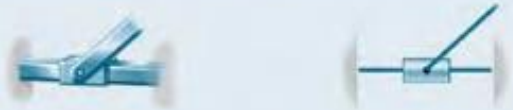
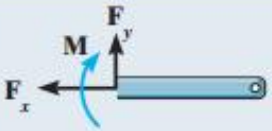
ARCH



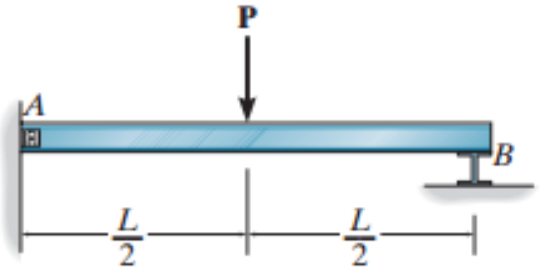
3D TRUSS

TABLE 2–1 Supports for Coplanar Structures

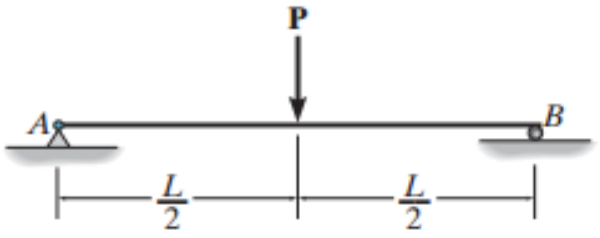
Type of Connection	Idealized Symbol	Reaction	Number of Unknowns
(1)  light cable  weightless link			One unknown. The reaction is a force that acts in the direction of the cable or link.
(2)  rollers   rocker	  		One unknown. The reaction is a force that acts perpendicular to the surface at the point of contact.

(4) smooth pin-connected collar			One unknown. The reaction is a force that acts perpendicular to the surface at the point of contact.
(5) smooth pin or hinge			Two unknowns. The reactions are two force components.
(6) slider			Two unknowns. The reactions are a force and a moment.
fixed-connected collar			
(7) fixed support			Three unknowns. The reactions are the moment and the two force components.

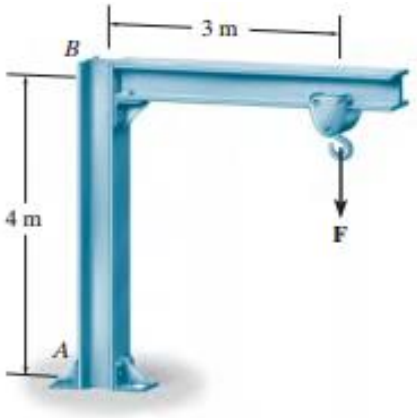
Idealized Structure



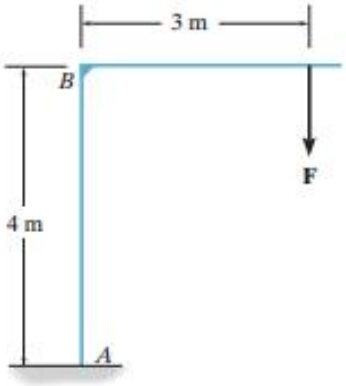
actual beam
(a)



idealized beam
(b)

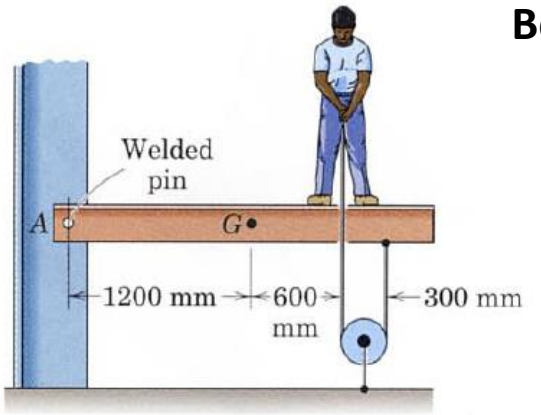


actual structure
(a)

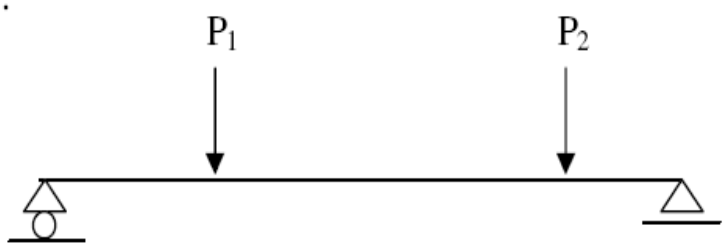


idealized structure
(b)

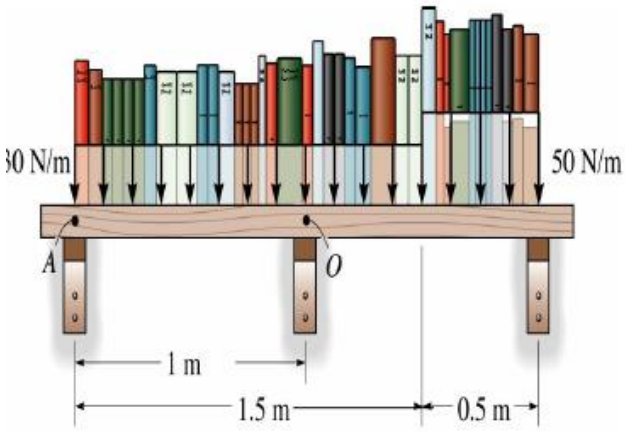
Loading

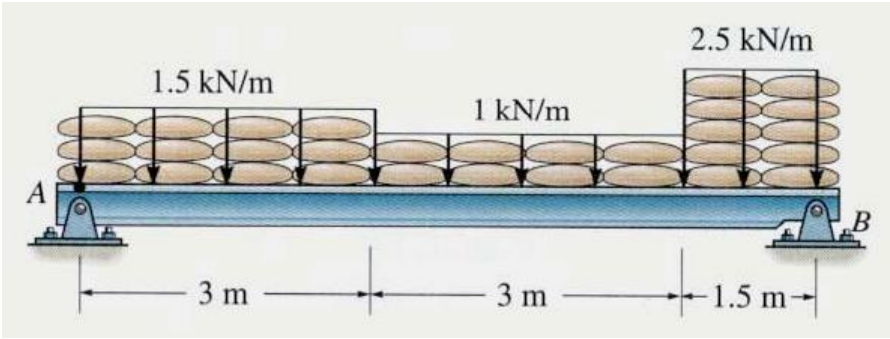


Beban terpusat



Beban terdistribusi

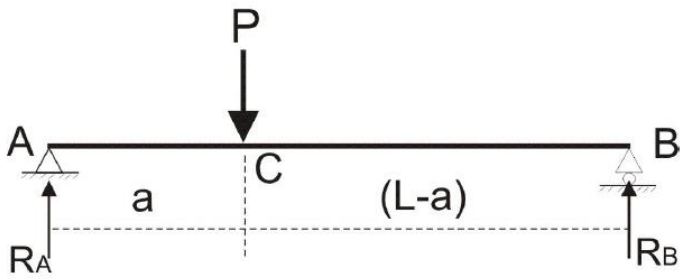


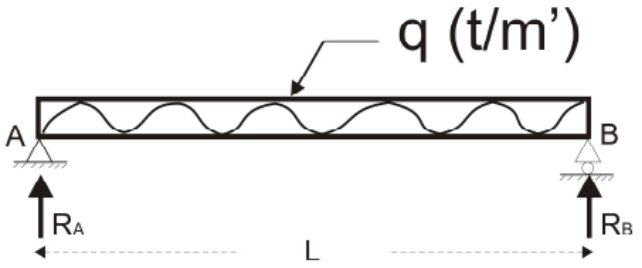


Balok Sederhana (*Simple Beam*)

Beam-structural member designed to support loads applied at various points along its length.

Balok sederhana (simple beam): Kedua ujungnya ditumpu oleh jenis tumpuan sendi dan Rol





- **Kesetimbangan**

  Keadaan dari suatu benda dimana resultante dari gaya-gaya yang bekerja sama dengan Nol

- persamaan kesetimbangan dapat dituliskan sebagai :

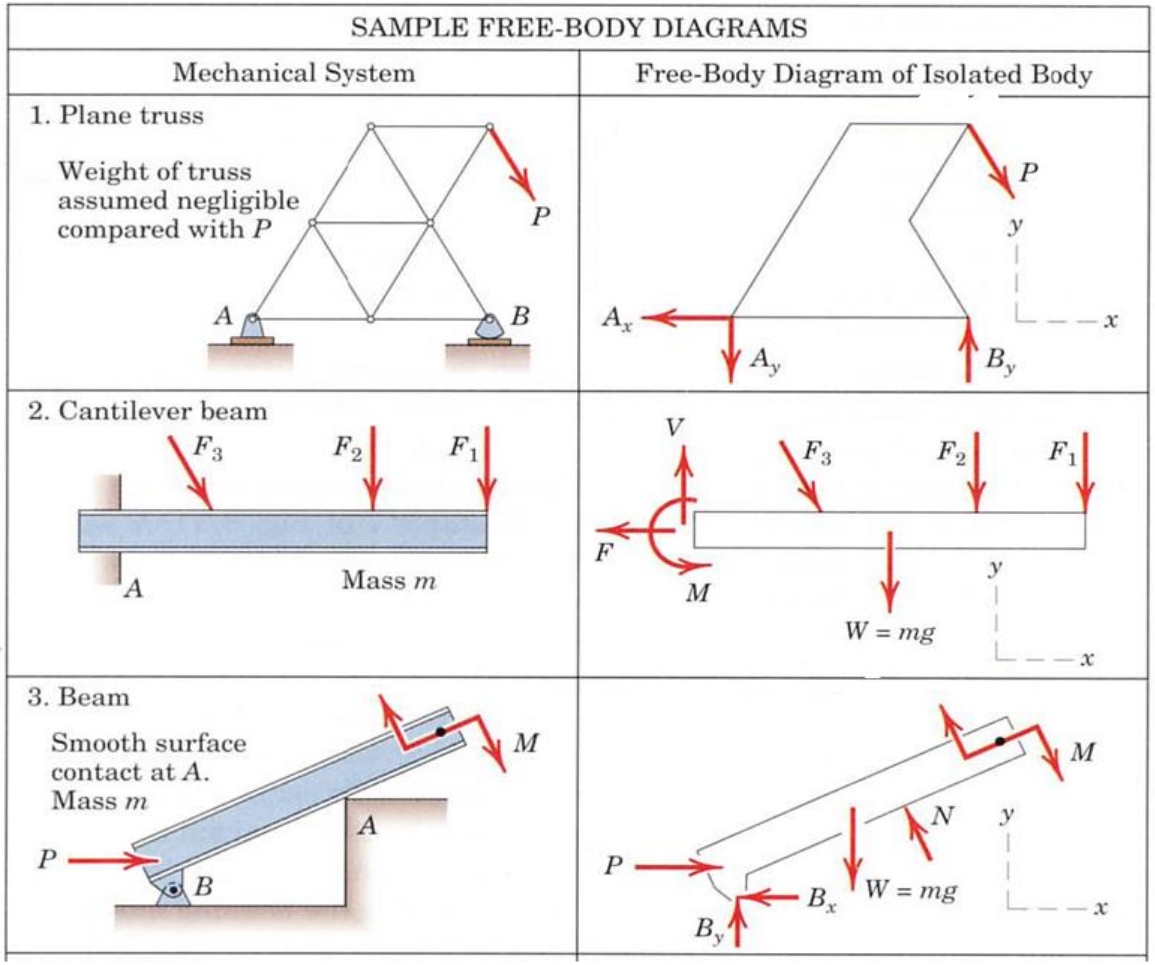
$$\Sigma F_x = 0$$
$$\Sigma F_y = 0$$
$$\Sigma M = 0$$

- Jika tidak memenuhi persyaratan tersebut, maka benda dikatakan dalam keadaan tidak seimbang (mengalami gerak translasi, rotasi, atau kombinasi keduanya)

FreeBody Diagram

- Gaya reaksi dengan arah dan besarnya menyeimbangkan gaya-gaya yang beraksi pada benda
- Free Body Diagram (diagram benda bebas) akan mempermudah untuk menentukan besar dan arah gaya reaksi tersebut.

the free-body diagram is the most important single step in the solution of problems in mechanics.


SAMPLE FREE-BODY DIAGRAMS
Mechanical System
Free-Body Diagram of Isolated Body
1. Plane truss
Weight of truss assumed negligible compared with P
P
A
B
P
y
x
A_x
A_y
B_y
2. Cantilever beam
F_3
F_2
F_1
A
Mass m
V
F_3
F_2
F_1
F
M
y
W = mg
x
3. Beam
Smooth surface contact at A.
Mass m
M
A
P
B
M
N
y
P
B_x
W = mg
B_y
x

Determinacy

- The equilibrium equations provide both the *necessary and sufficient* conditions for equilibrium.
- When all the forces in a structure can be determined strictly from these equations, the structure is referred to as ***statically determinate***.
- Structures having more unknown forces than available equilibrium equations are called ***statically indeterminate***.

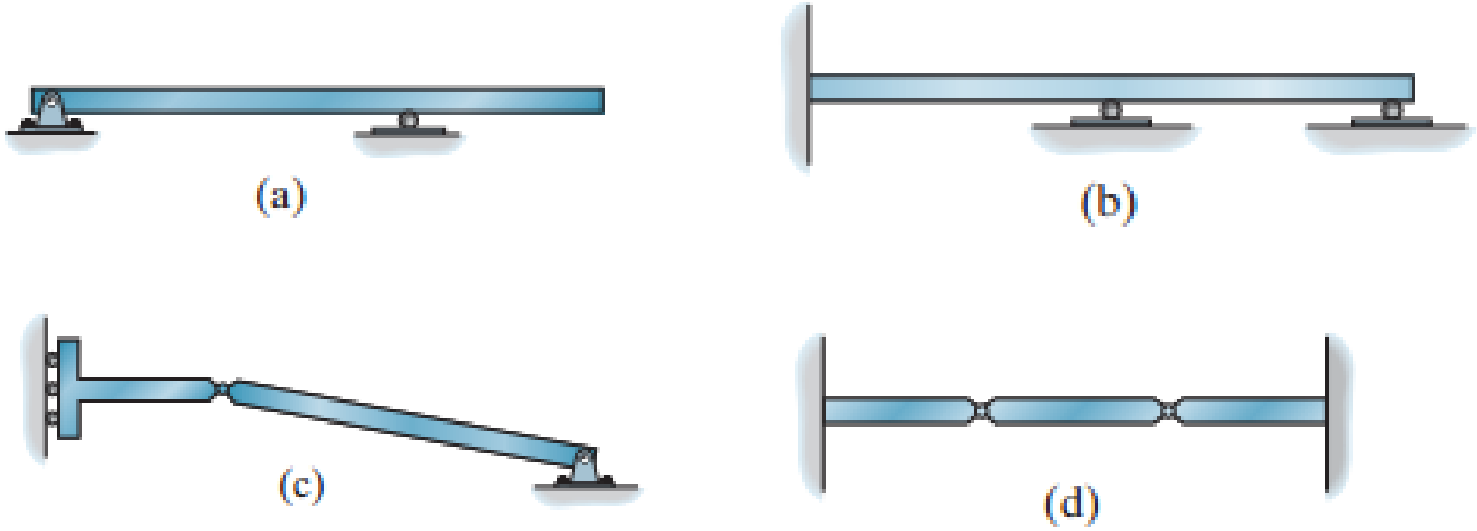
- For a coplanar structure there are at most *three* equilibrium equations for each part, so that if there is a total of *n* parts and *r* force and moment reaction components

$r = 3n$, statically determinate

$r > 3n$, statically indeterminate

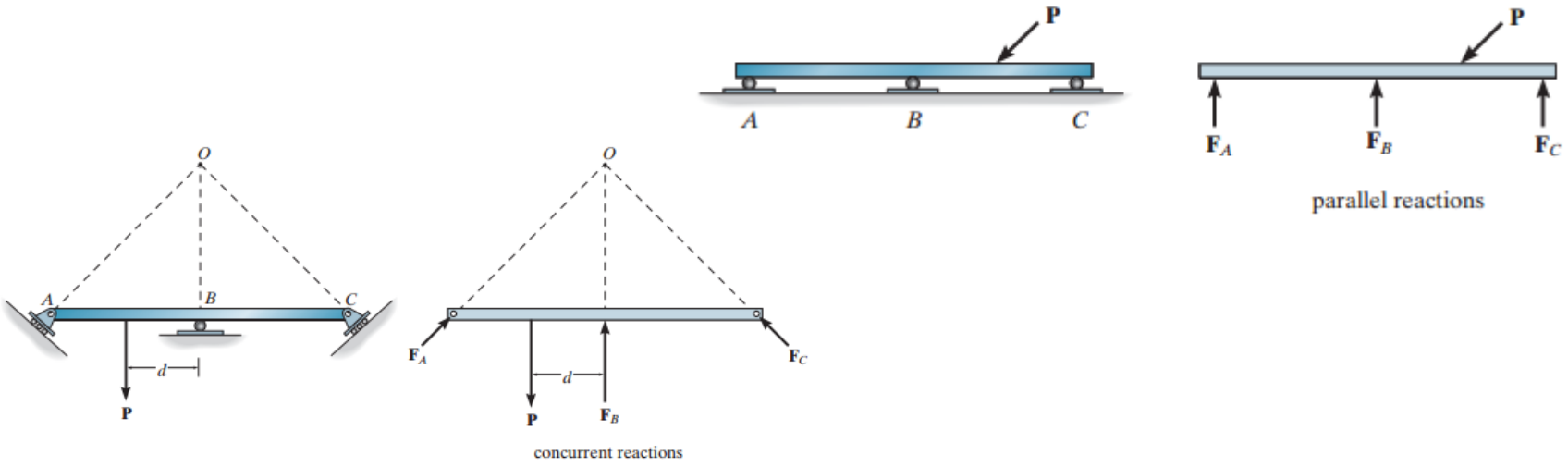
Example 1

- Classify each of the beams shown in Fig. *a* through *d* as statically determinate or statically indeterminate.



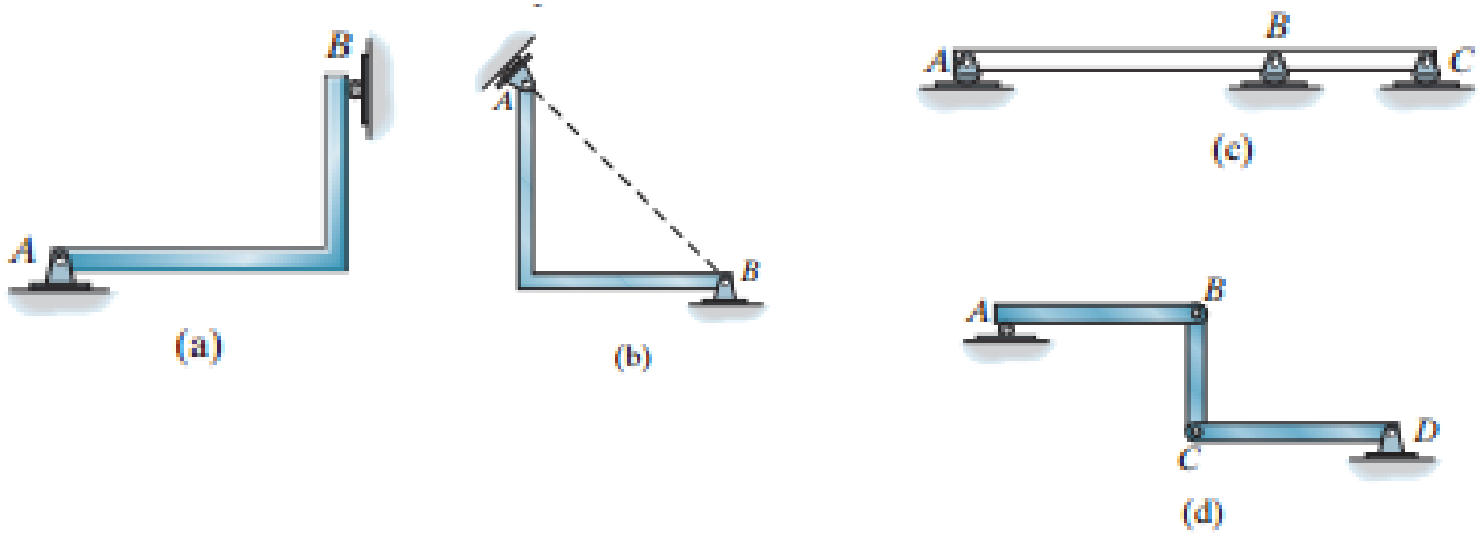
- Stability

$r < 3n$	unstable
$r \geq 3n$	unstable if member reactions are concurrent or parallel or some of the components form a collapsible mechanism



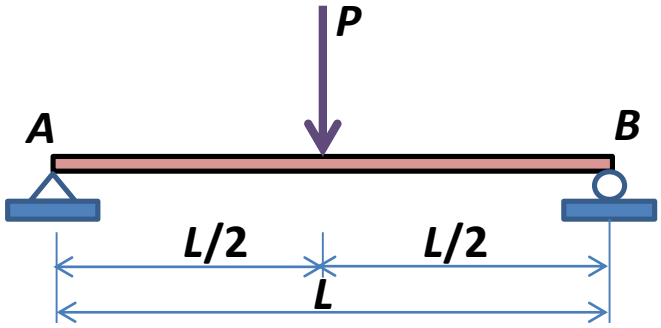
Example 2

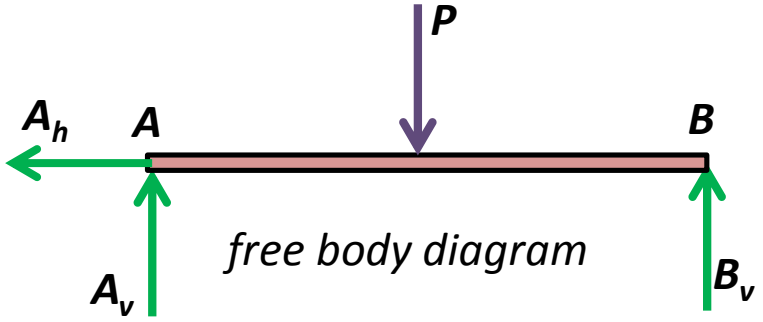
- Classify each of the structures in Fig. *a* through *d* as stable or unstable.



Example 3

- Determine the reaction of the beam





$\Sigma M_A = 0$

$+P(L/2) - B_v(L) = 0$

$B_v(L) = P(L/2)$

$B_v = P/2$

$\Sigma M_B = 0$

$-P(L/2) + A_v(L) = 0$

$A_v(L) = P(L/2)$

$A_v = P/2$

$\Sigma F_y = 0$

$A_v - P + B_v = 0$

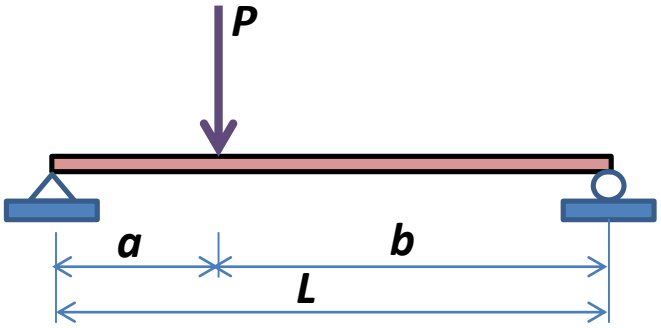
$P/2 - P - P/2 = 0$ (OK!)

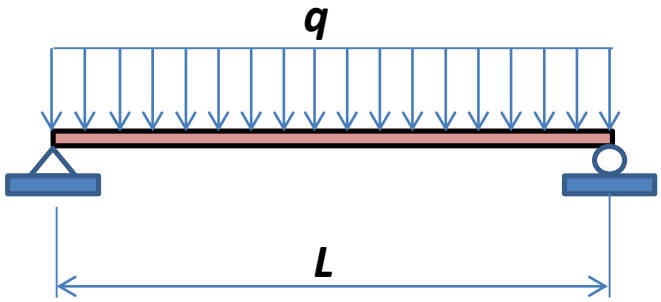
$\Sigma F_x = 0$

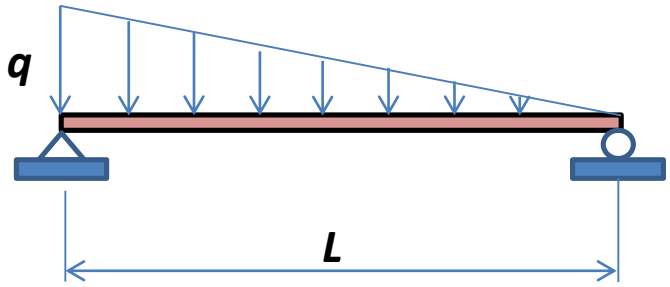
$A_h = 0$

Example 4

- Determine the reaction of the beam

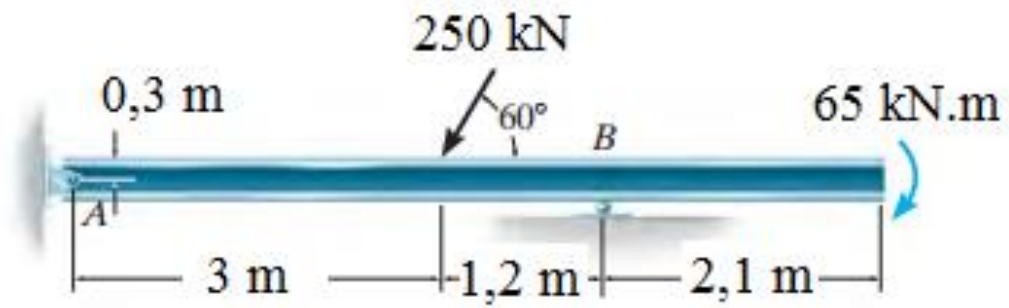






Example 4

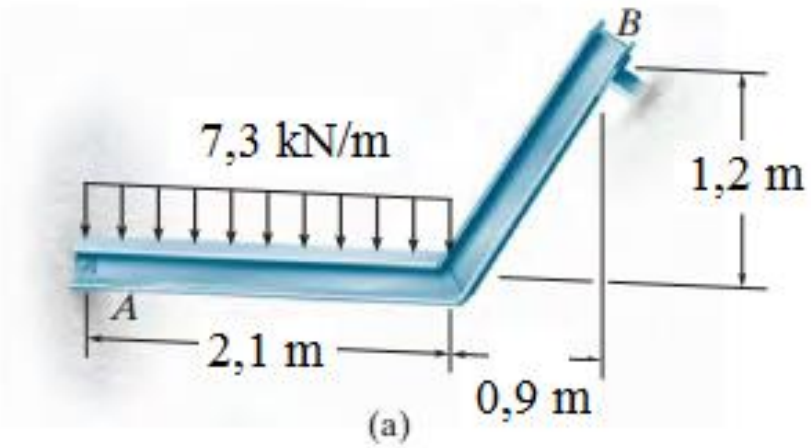
- Determine the reaction on the beam. A is pin and B is a roller support



(a)

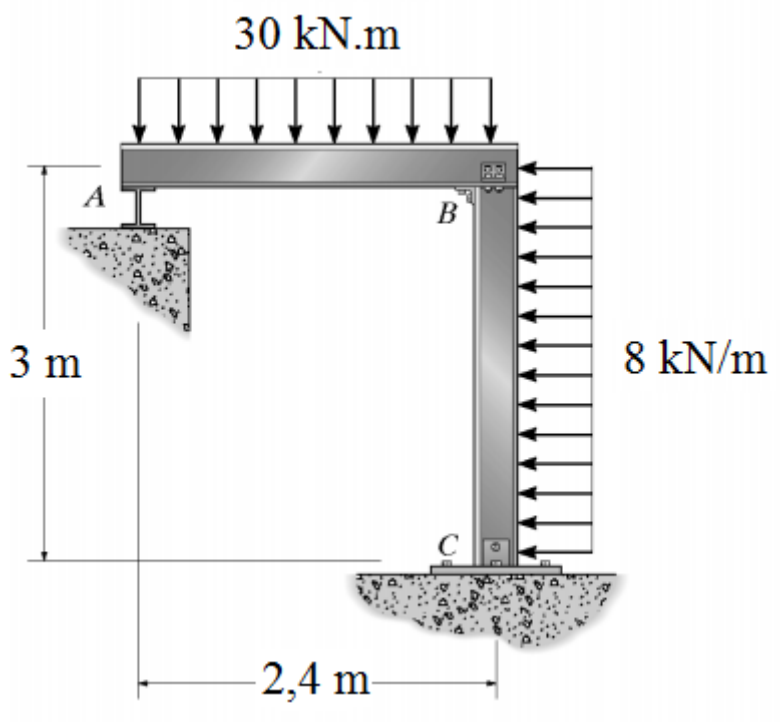
Example 5

- Determine the reaction on the beam



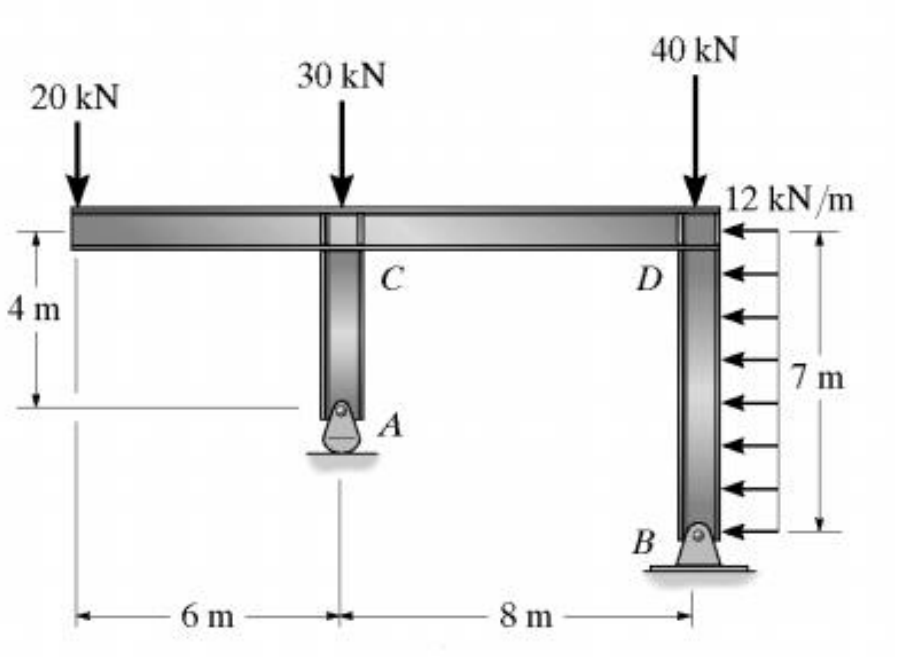
Example 6

- Determine the reactions at the supports A and C. Assume the support at A is a roller, B is a fixed-connected joint and C is a pin.



Example 7

- Determine the horizontal and vertical components of reaction at the supports A (roller) and B (pin). The joints at C and D are fixed connections



- Graphical Method

Panjang, dan beban harus diskalakan
misal : 1m = 1cm; 10 kN = 1 cm