

Stability and Determinacy of Frames

1- Open frames

$r < C+3$, unstable

$r = C+3$, determinate if stable

$r > C+3$, indeterminate if stable

Ex1:- Find the stability and determinacy of frame below

$$C_1 = m-1, C_1 = 2-1 = 1$$

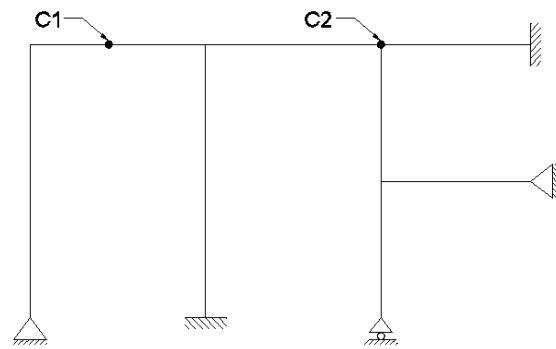
$$C_2 = m-1, C_2 = 3-1 = 2$$

$$C = C_1 + C_2, C = 3$$

$$r = 11$$

$$C+3 = 6$$

$r > C+3$, the frame is stable & indeterminate 5th degree.

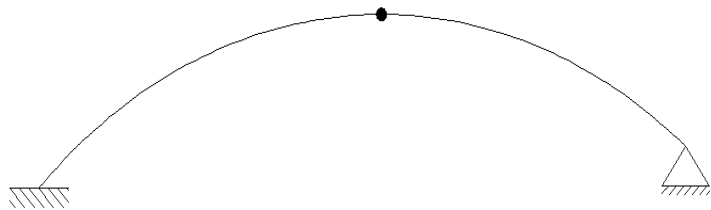


Ex2:-

$$r = 5$$

$$C = 2-1 = 1$$

$r > C+3$, the frame is stable & indeterminate 1st degree.



Ex3:-

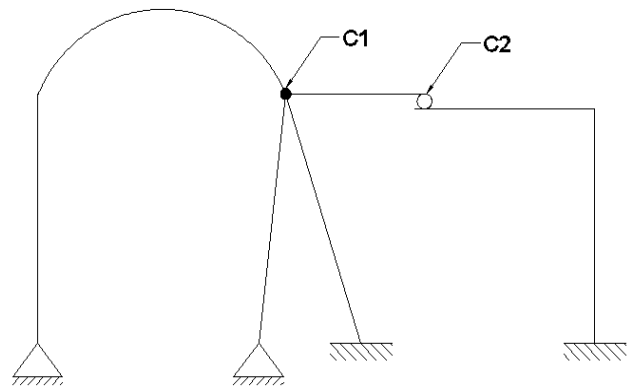
$$C_1 = m-1, C_1 = 4-1 = 3$$

$$C_2 = 2$$

$$C = C_1 + C_2, C = 5$$

$$r = 10$$

$$C+3 = 8$$



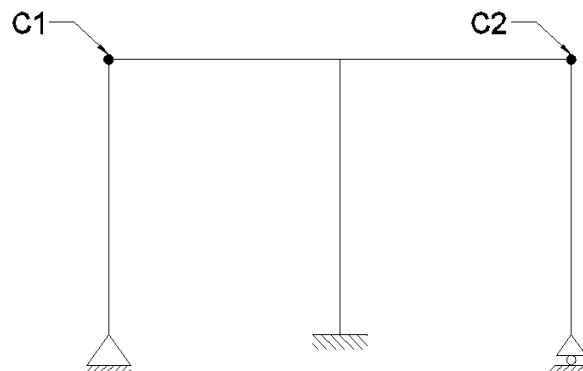
$r > C+3$, the frame is stable & indeterminate 2nd degree.

Ex4:-

$$r = 6$$

$$C = 2$$

$$r > C+3$$



The frame is unstable because of internal geometric instability

2- Closed Frames:-

$$3b+r < 3j+c, \text{ unstable}$$

$$3b+r = 3j+c, \text{ determinate if stable}$$

$$3b+r > 3j+c, \text{ indeterminate if stable}$$

Where,

$$3b+r = \text{unknown}$$

$$3j+c = \text{equations}$$

b = No. of members

r = No. of reactions

j = No. of joints

Ex1:-

$$b = 10$$

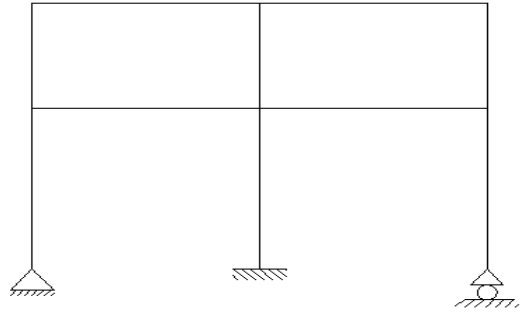
$$r = 6$$

$$j = 9$$

$$3b+r = 36$$

$$3j+c = 27$$

$3b+r > 3j+c$, stable & indeterminate 9th degree



Ex2:-

$$b = 10$$

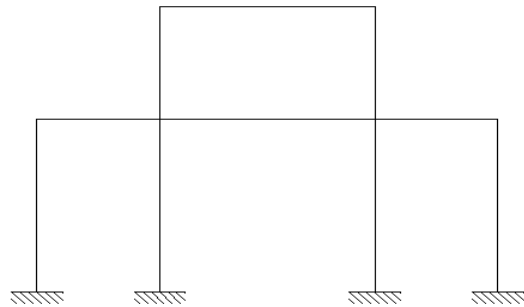
$$r = 12$$

$$j = 10$$

$$3b+r = 42$$

$$3j+c = 30$$

$3b+r > 3j+c$, stable & indeterminate 12th degree



Ex3:-

$$b = 4$$

$$r = 6$$

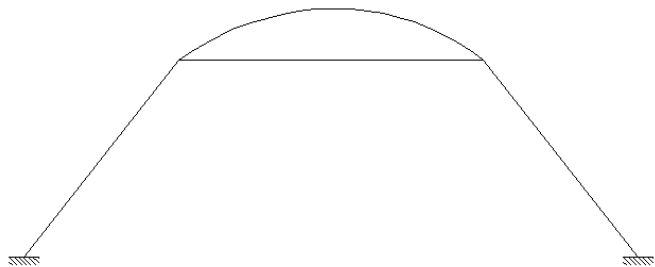
$$j = 4$$

$$c = 0$$

$$3b+r = 18$$

$$3j+c = 12$$

$3b+r > 3j+c$, stable & indeterminate 6th degree



Ex4:-

$$b = 9$$

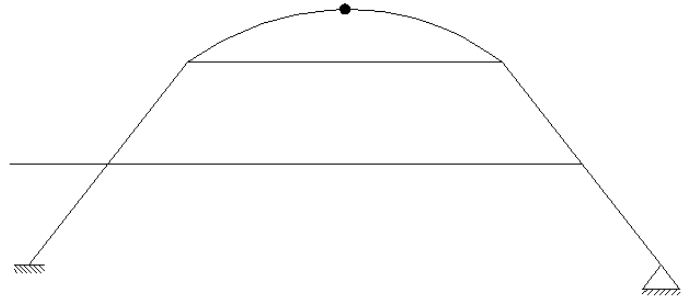
$$r = 5$$

$$j = 7$$

$$c = m - 1 \Rightarrow c = 1$$

$$3b + r = 32$$

$$3j + c = 22$$

$$3b + r > 3j + c, \text{ stable \& indeterminate } 10^{\text{th}} \text{ degree}$$


Ex5:-

$$b = 10$$

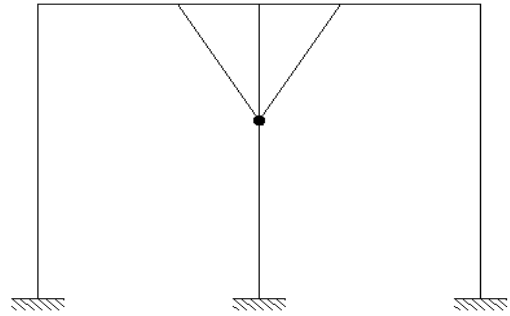
$$r = 9$$

$$j = 9$$

$$c = m - 1 \Rightarrow c = 4 - 1 \Rightarrow c = 3$$

$$3b + r = 39$$

$$3j + c = 30$$

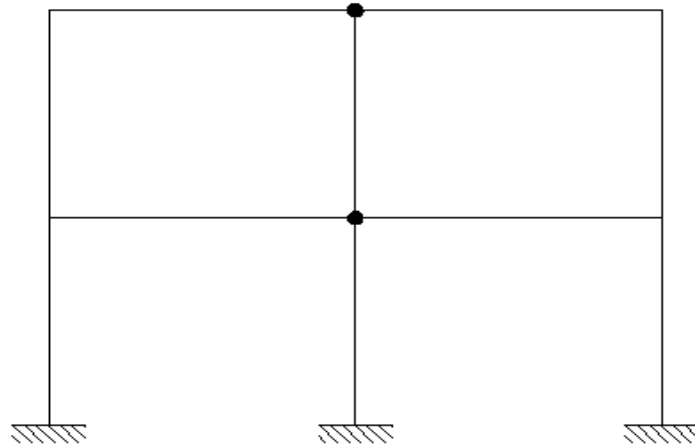


$$3b + r > 3j + c, \text{ stable \& indeterminate } 9^{\text{th}} \text{ degree}$$

ملاحظة:- اذا جاء ال internal hinge في بداية او نهاية الضلع فيحسب منه (c & j) اما اذا جاء في داخل الضلع فيحسب منه c فقط

Home work:

H.W1: Find the stability and determinacy of frame below



H.W2: Find the stability and determinacy of frame below

