Frame determinacy

b = # of members btwn joints

r = # of external reactions supporting frame

j = # of joints

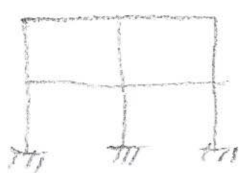
c = # of internal constraints

$^{\circ}_{ind} = (3b+r) - (3j+c)$

$3b+r < 3j+c$ unstable

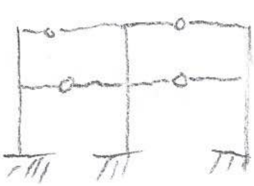
$3b+r = 3j+c$ determinate prov. stable

$3b+r > 3j+c$ indeterminate prov. stable



$b=10$
$r=9$
$j=9$
$c=0$

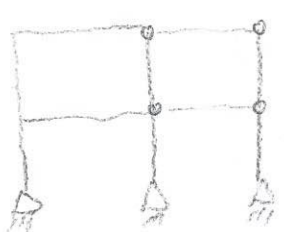
$39 > 27$, $12°$ ind and stable



Either ① or ②

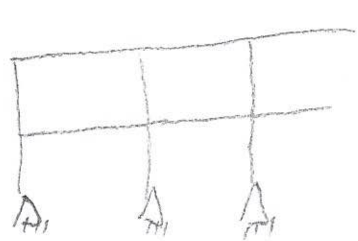
①	②
$b=10$	$b=14$
$r=9$	$r=9$
$j=9$	$j=13$
$c=4$	$c=4$
$39 > 31$	$51 > 43$

either way, ind $8°$



$b=10$
$r=6$
$j=9$
$c=8$

$36 > 35$, ind $1°$



$b=10$
$r=6$
$c=0$
$j=9$

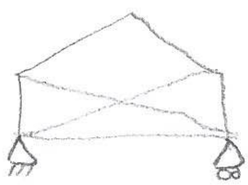
$36 > 27$, ind $9°$

Truss indeterminacy

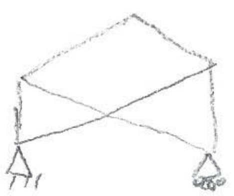
if $b+r<2j$, statically unstable

$b+r=2j$, statically determinate (prov. ~~also~~ stable)

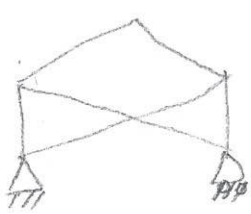
$b+r>2j$, indeterminate (prov. stable)



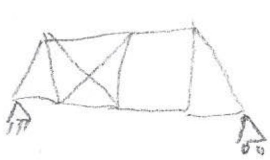
$b=7$, $r=3$, $j=5$, $\therefore 10=10$, determinate & stable



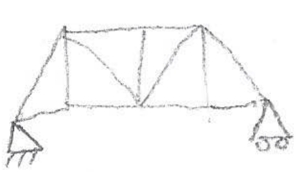
$b=6$, $r=3$, $j=5$, $9<10$ unstable



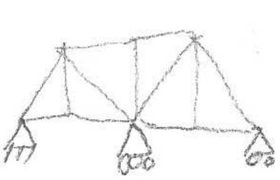
$b=6$, $r=4$, $j=5$, $10=10$ stable



$b=13$, $r=3$, $j=8$, det $(16=16)$, unstable (rec)



$b=13$, $r=3$, $j=8$, det $(16=16)$, stable



$b=13$, $r=4$, $j=8$ $17>16$, stable ind

$R=4 \quad C=1$

let R = # reactions (forces or moments)

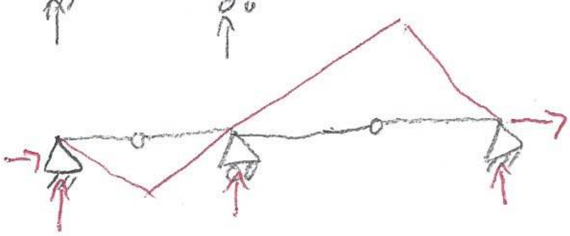
let C = # internal conditions (internal release)

degree of indeterminacy = $R-(3+C)$

- if 0, det if stable
- if <0, unstable
- if >0,

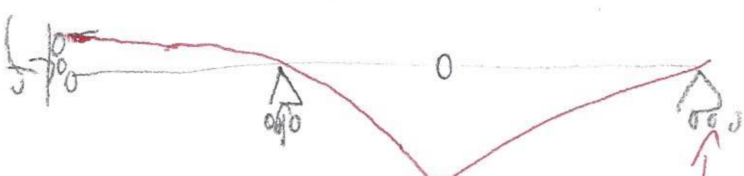
Eg.

$R=6$, $C=2$, $6-(3+2)=1^{\circ}$

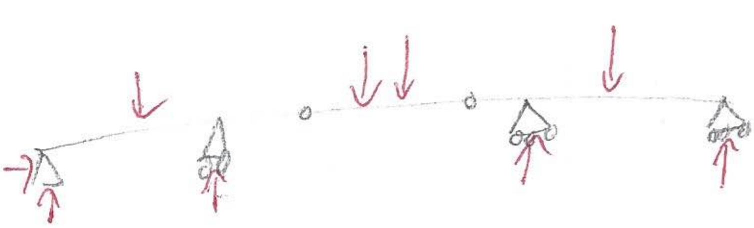


$R=5$, $C=2$, $5-(3+2)=0$, det, unstable

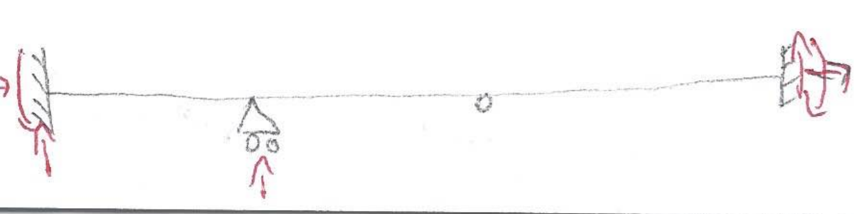
↳ deforms, ~~[illegible]~~ second-order effects



$R=4$ $C=1$, $4=4$, unstable det



$R=6$, $C=2$, stable det → Break into little pieces



$R=7$ 2° det. Stable

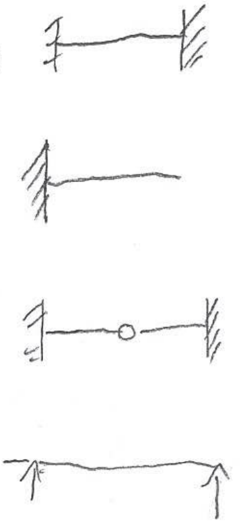
$C=2$

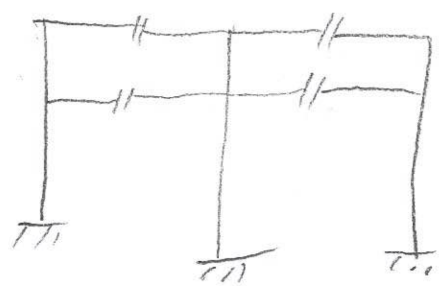
Rather than formulae method, one can introduce releases to system until it becomes strictly stable. The # of releases = °indeterminacy

1

2

"





-> To analyze indeterminate structure, find enough unknowns in system to render determinate (force method and displacement method)

Must satisfy

- linear-elastic behavior
- equilibrium
- compatibility

Force Method (Flexibility)

- redundant forces solved
- Solve remainder using equilibrium
- compatibility is explicitly satisfied
- Equilibrium is implicitly satisfied

Displacement Method (Stiffness)

- Equilibrium and force displacement relationships used to solve for nodal displacement
- Equilibrium and compatibility explicitly satisfied