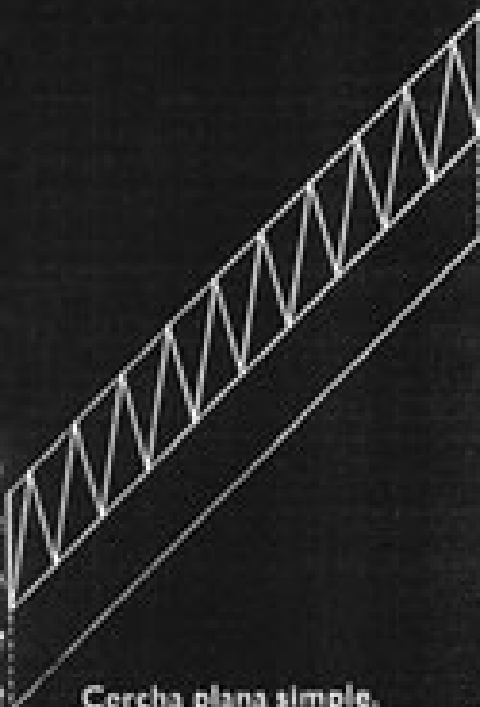


***ESTRUCTURAS DE BIELAS  
O  
RETICULADOS***

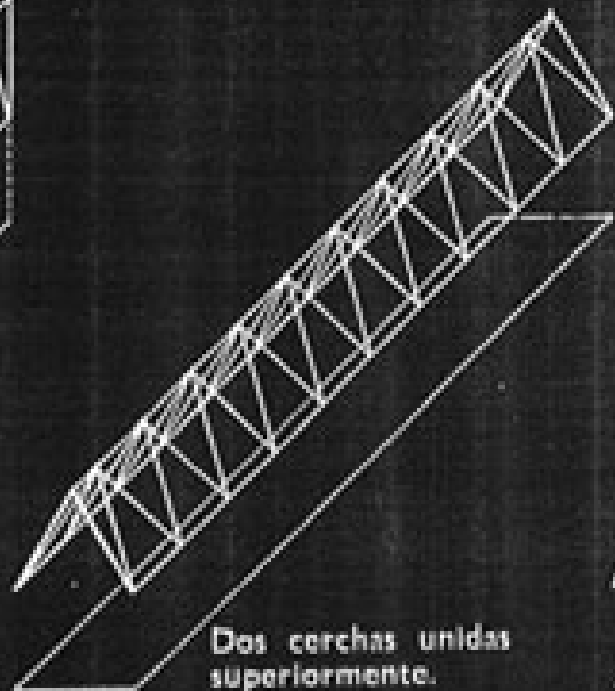
# ***SEGUNDA FAMILIA ESTRUCTURAS DE BIELAS***

**SON ESTRUCTURAS EN QUE LA FORMA ES  
INDEPENDIENTE DEL SISTEMA DE  
CARGAS.**

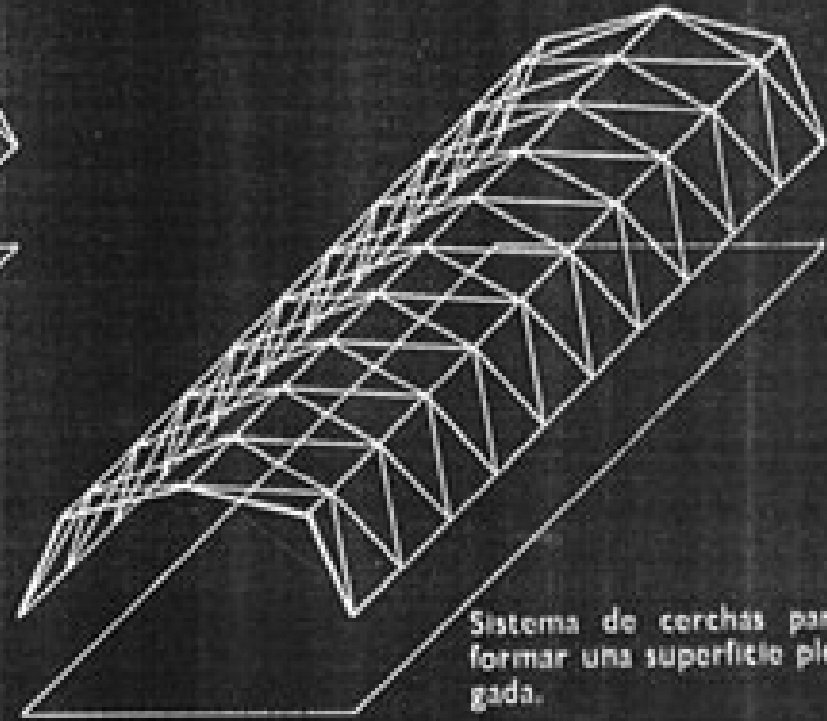
**LOS ESFUERZOS INTERNOS SIGUEN LOS  
EJES DE LOS ELEMENTOS QUE LA  
COMPONEN.**



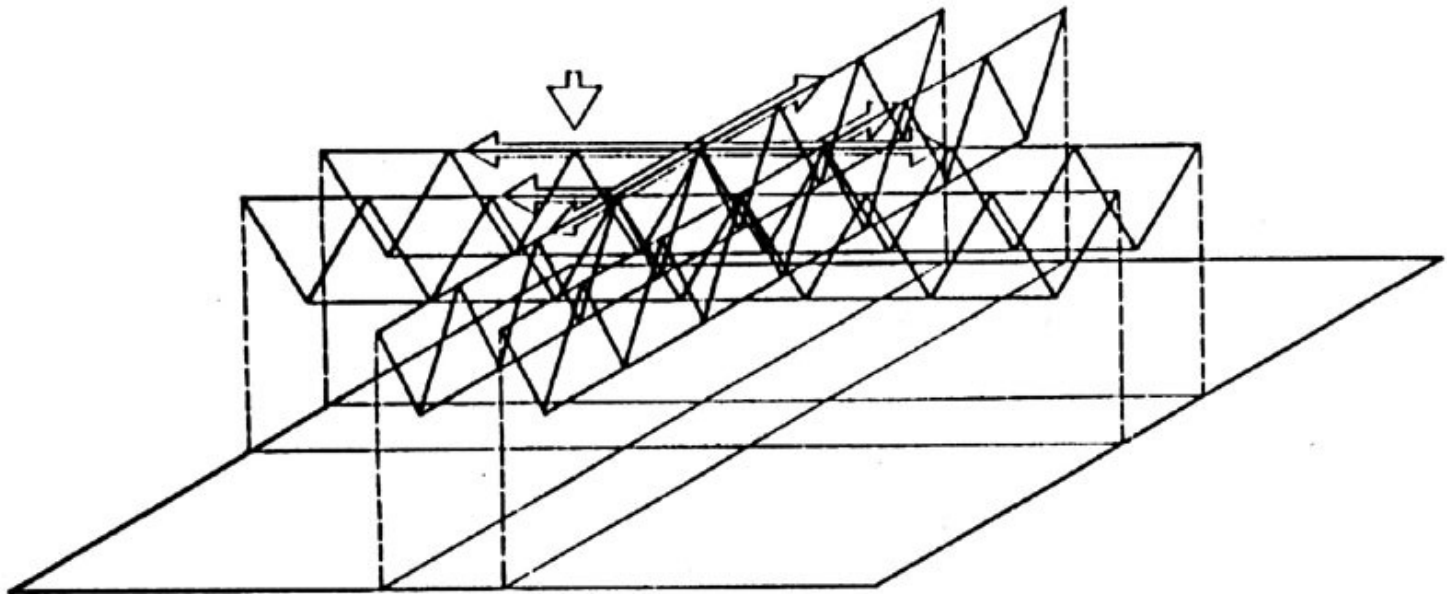
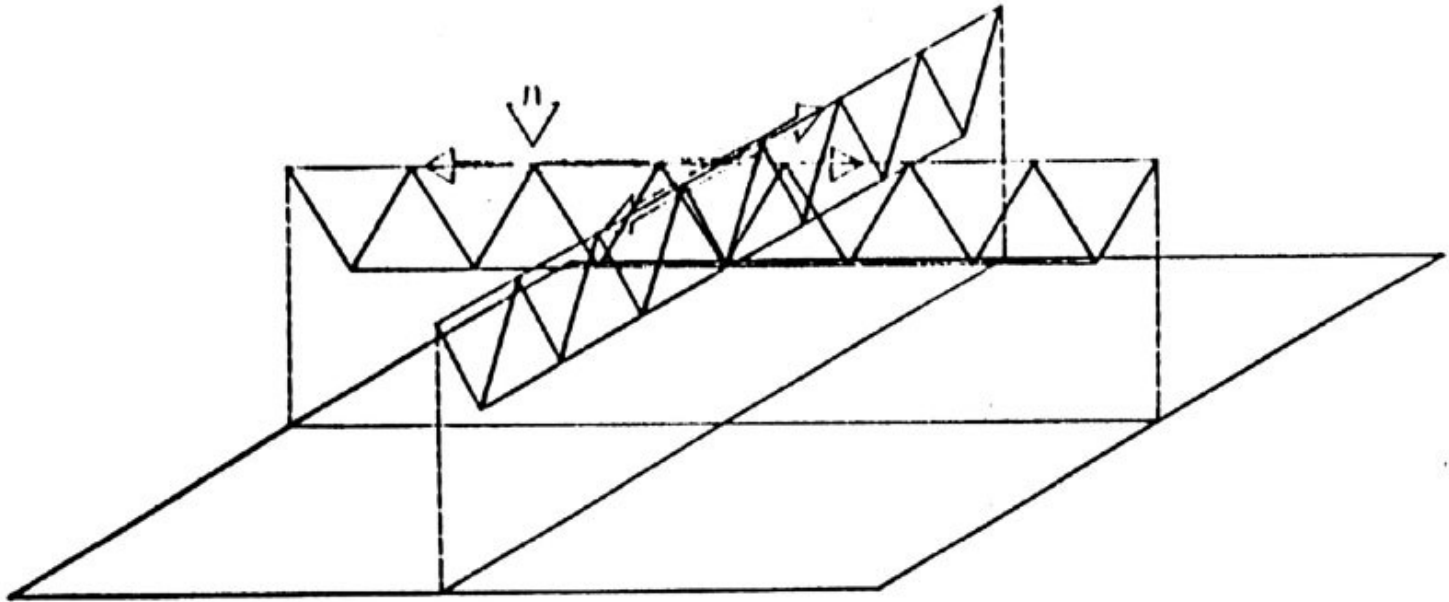
Cercha plana simple.



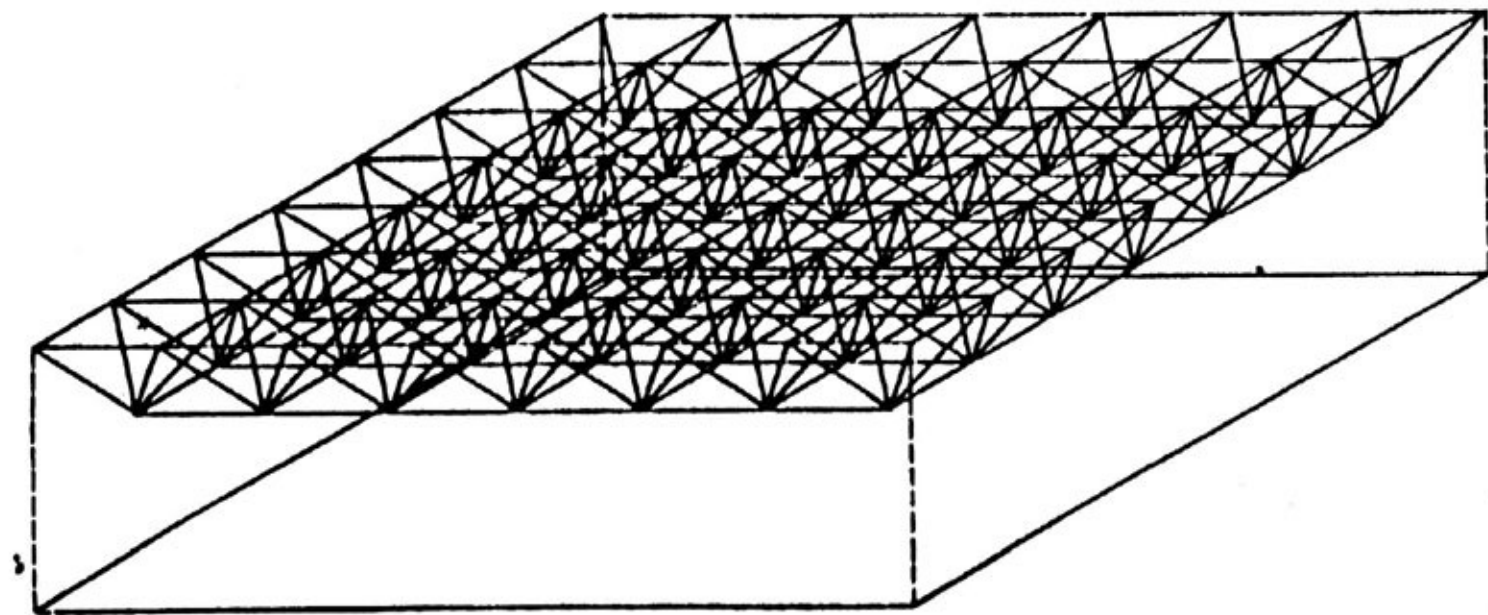
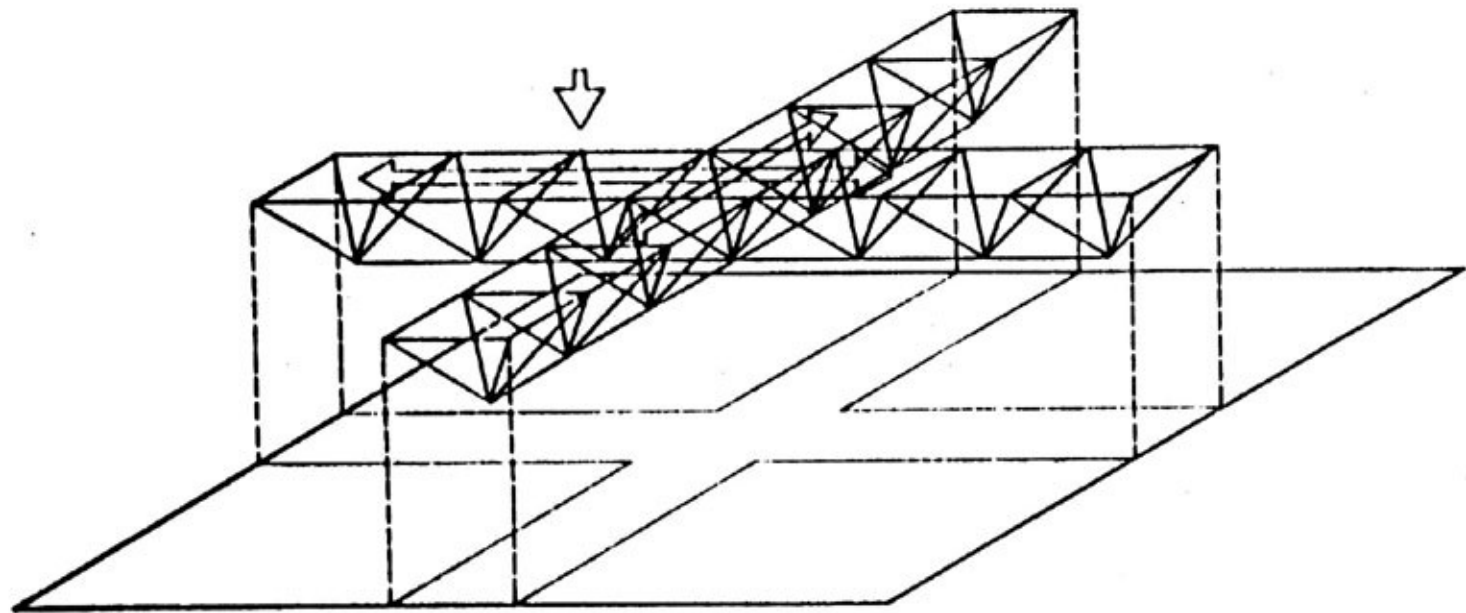
Dos cerchas unidas superiormente.

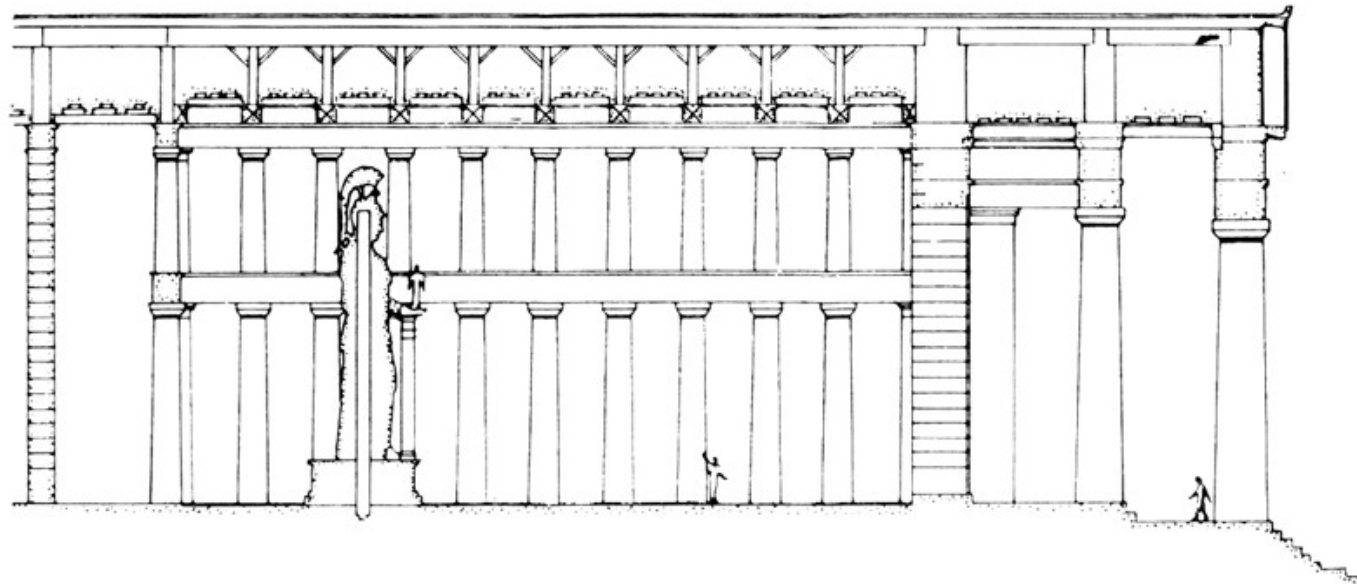
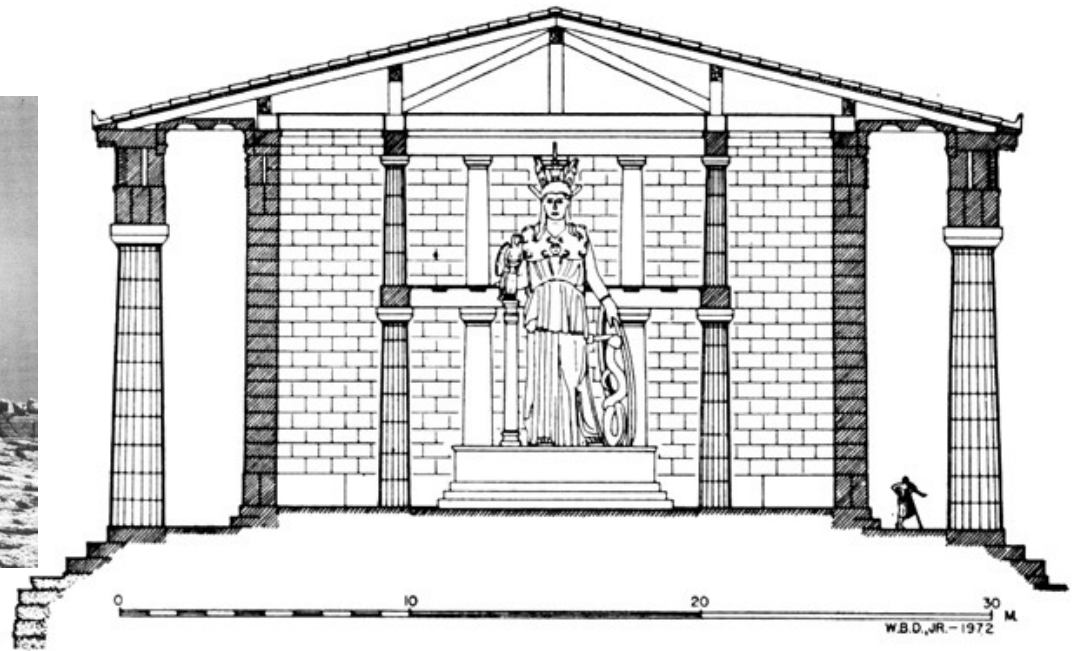


Sistema de cerchas para formar una superficie pligada.

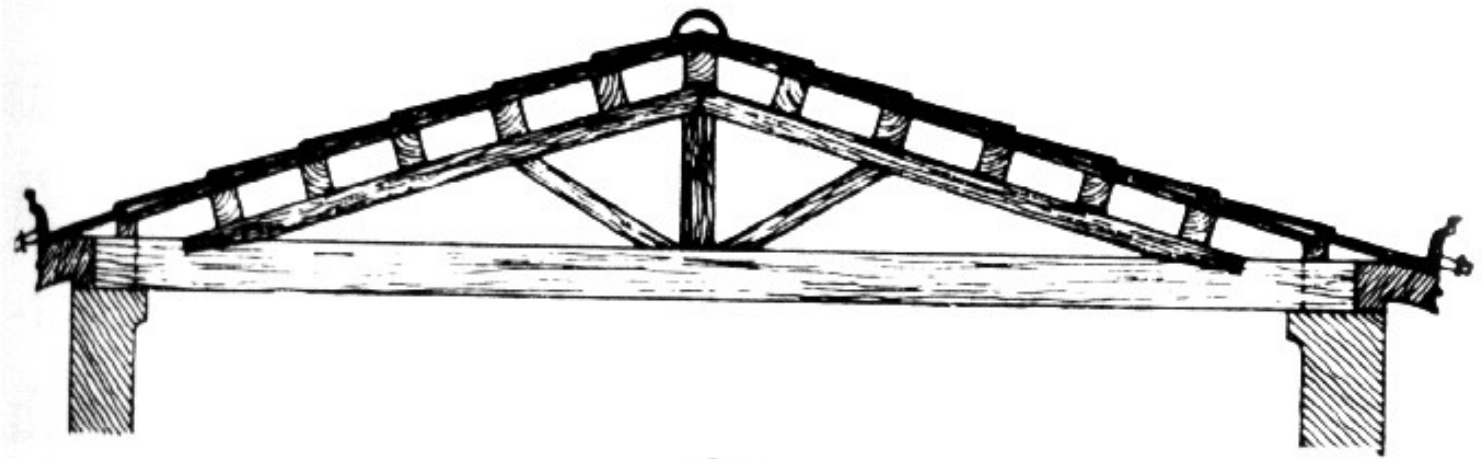






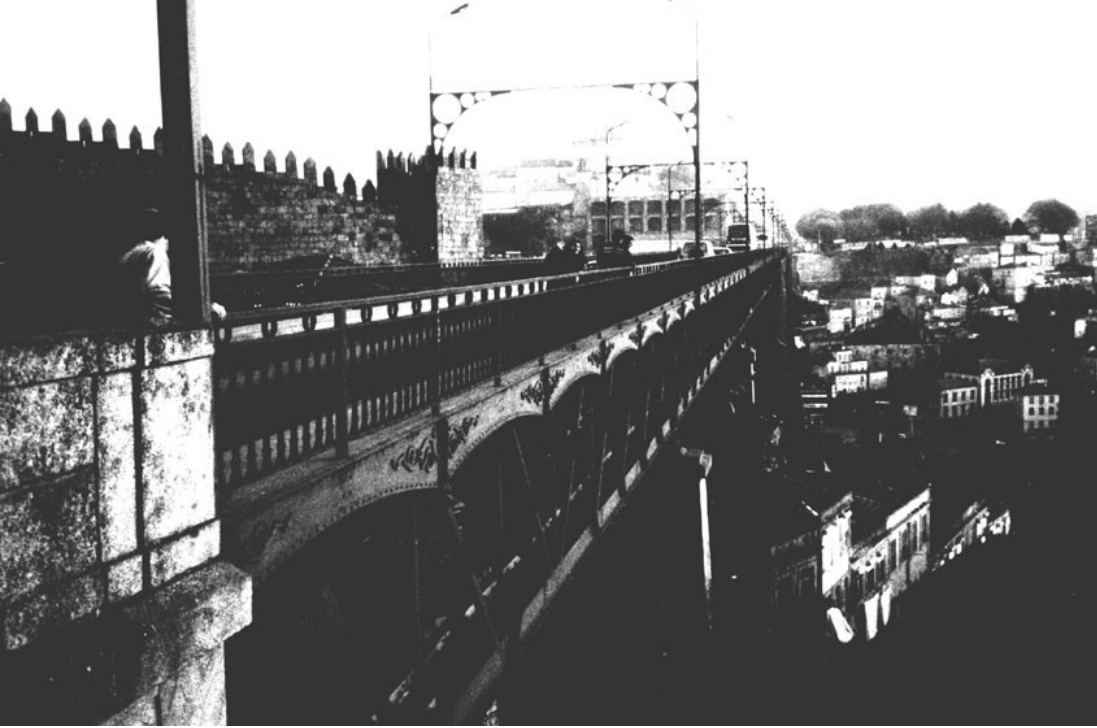


**Partenón**





**Torre Eiffel - 1889**



**Puente en Lisboa - G. Eiffel**





**Bolsa de Amsterdam 1902 - Berlage**







**Vivienda Bianchi, 1973 - Mario Botta**





**Estudio Eames - Frank Israel**



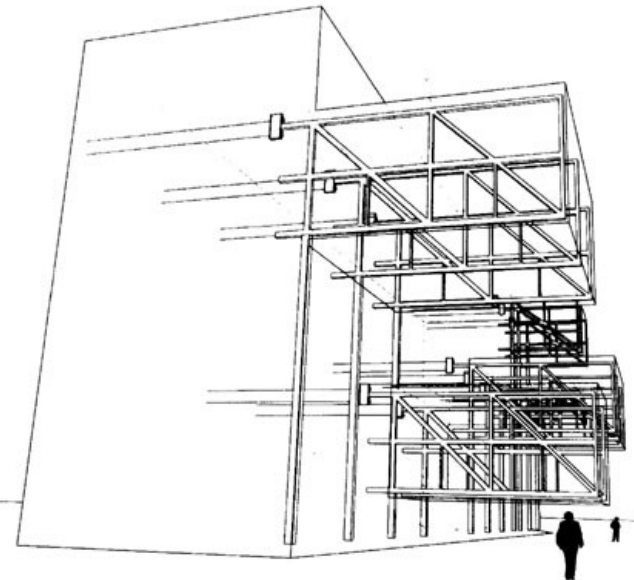
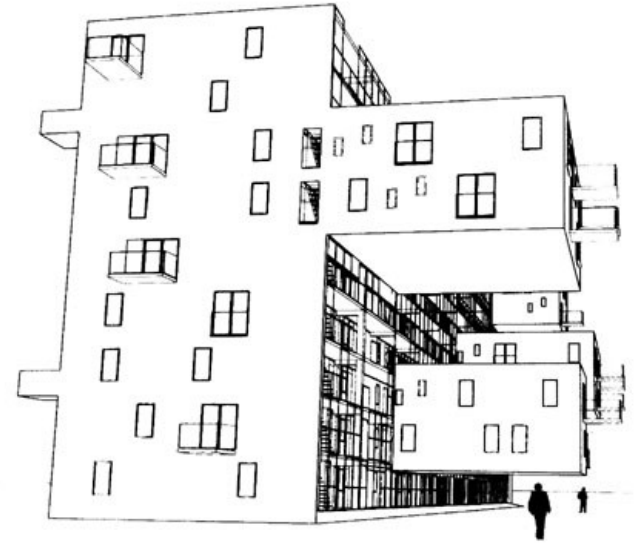


**Edificio Wozoco's - Amsterdam 1997 - MVRDV**

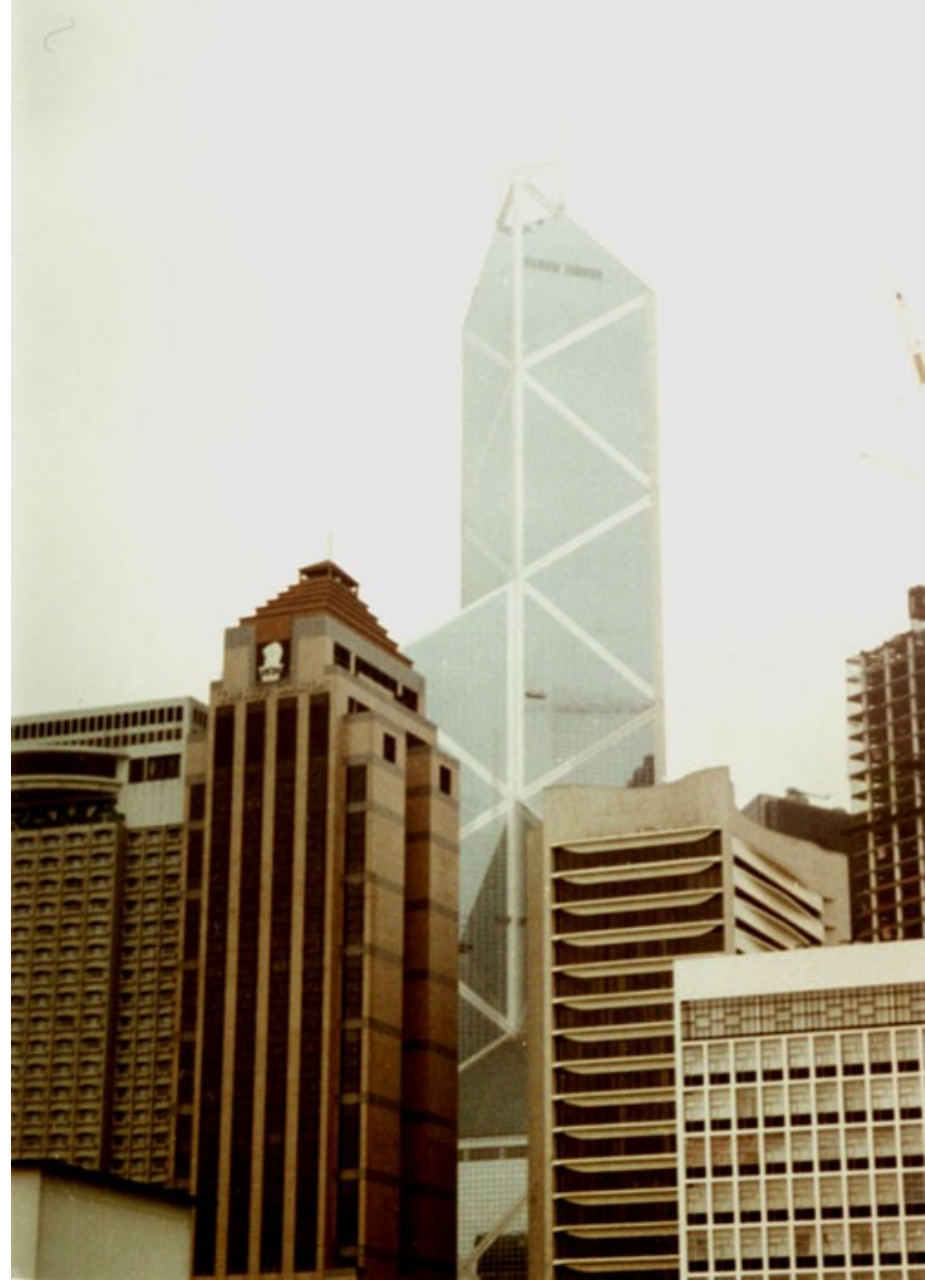












**Banco de China en Hong Kong 1997 - I. M. Pei**







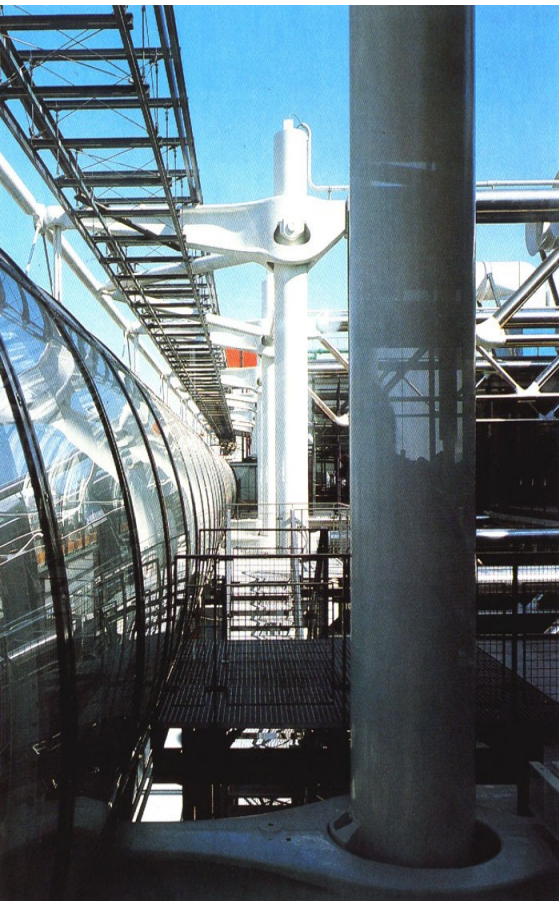






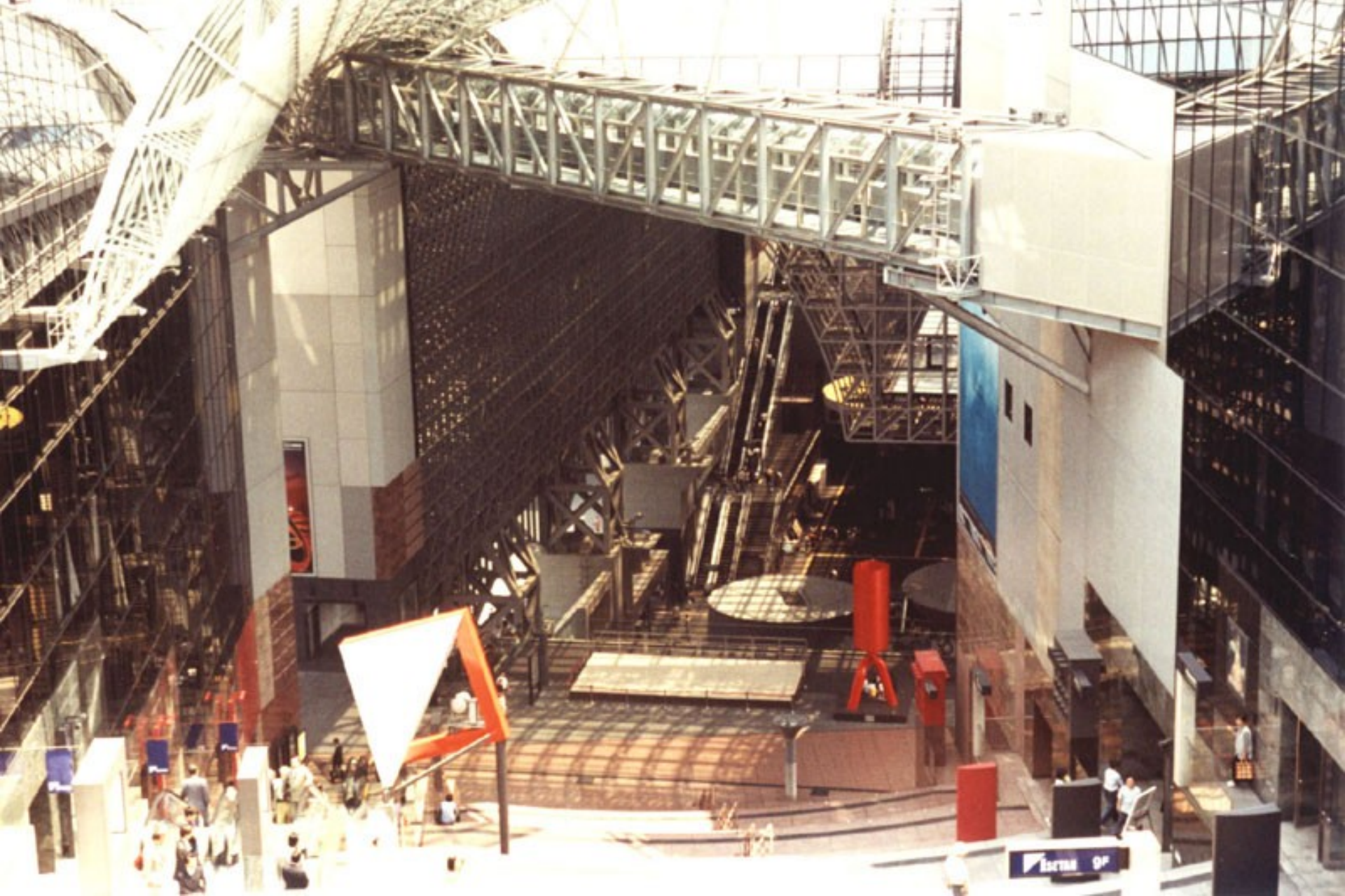
**Centro Pompidou, 1977 - Rogers y Piano**





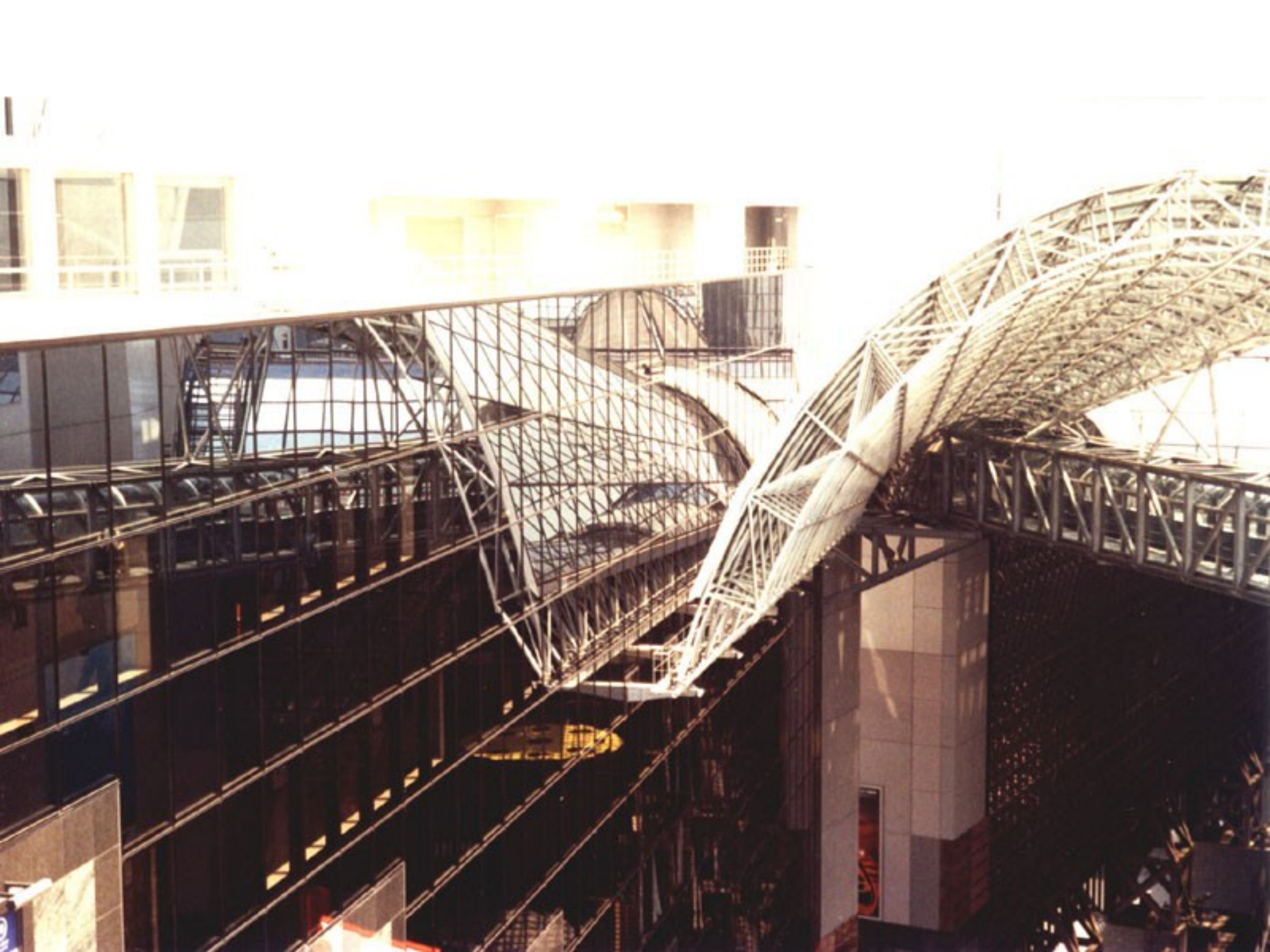






**Estación de trenes de Kyoto - Hiroshi Hara**









**Estación de trenes de Tokyo**









**Gimnasio de Alicante - Miralles - Pinós**











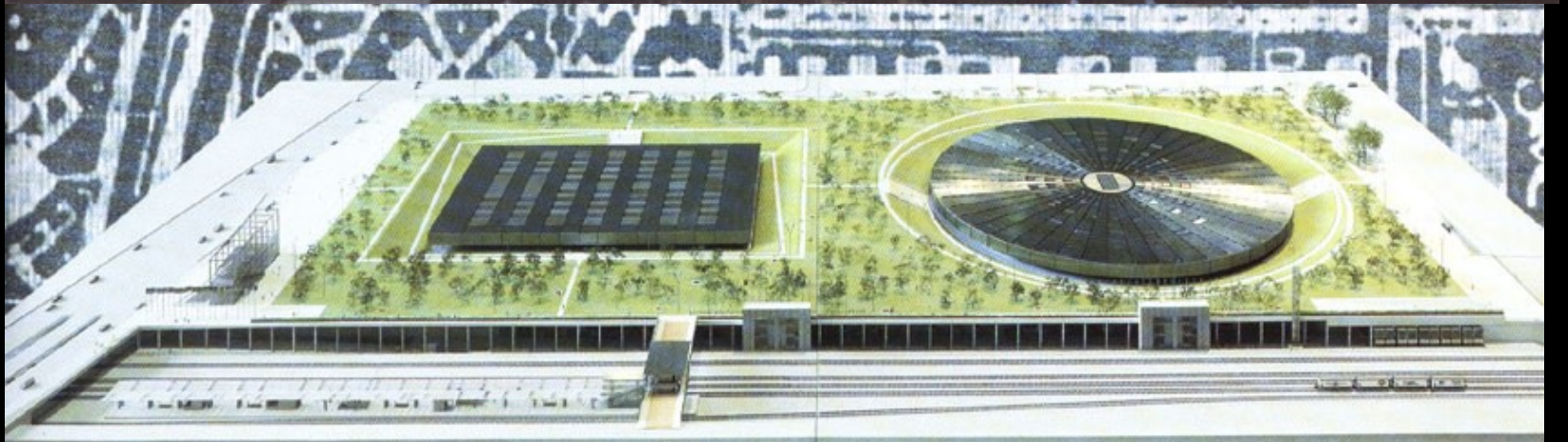
**Parque La Villette - B. Tschumi**





**Velódromo de Berlín 1998 - D. Perrault**



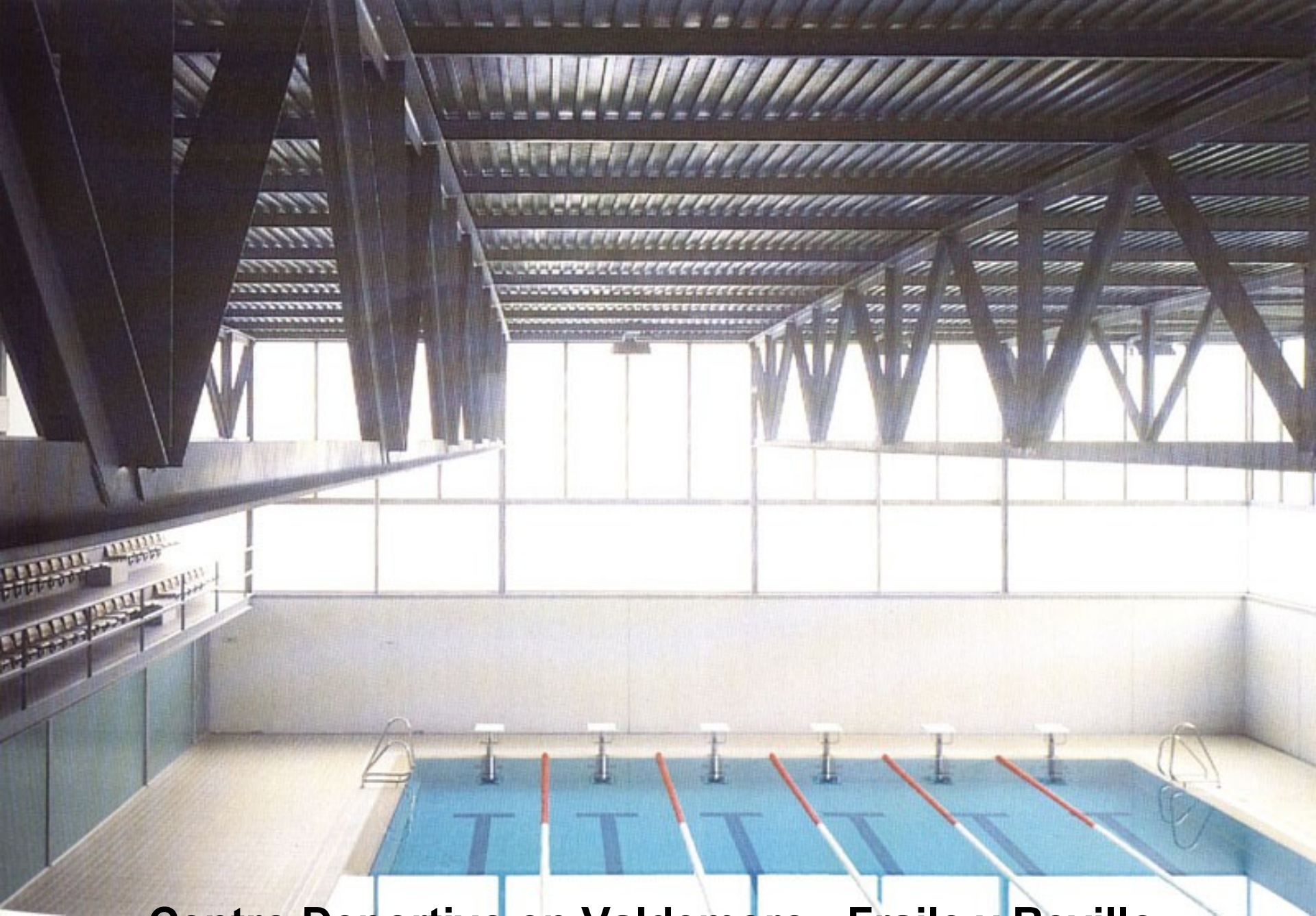






**Polideportivo en Valladolid, 1990 - Abalos y Herreros**





**Centro Deportivo en Valdemoro - Fraile y Revillo**









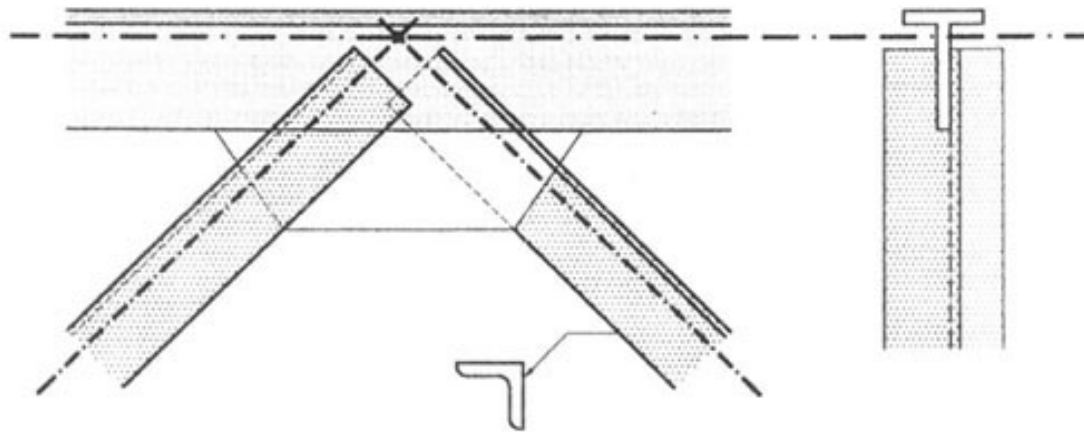


# CARACTERÍSTICAS

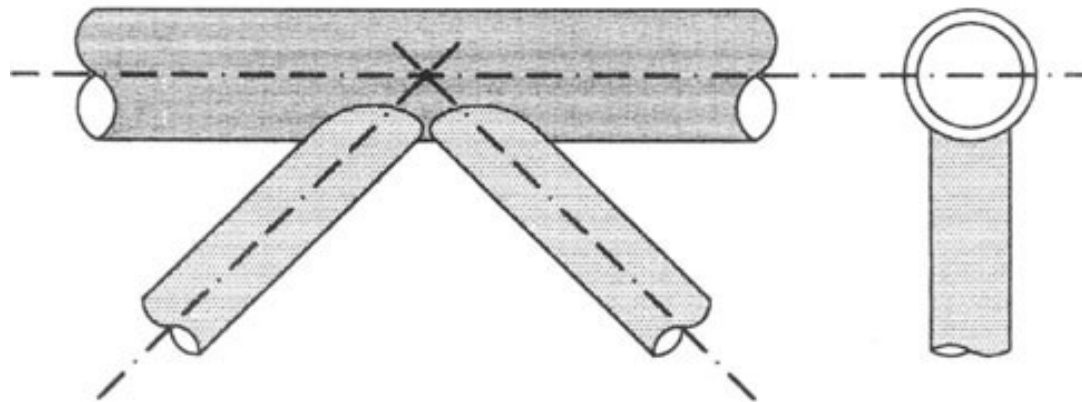
***PIEZAS:*** BARRAS DE LONGITUD PREDOMINANTE EN RELACIÓN A LAS DIMENSIONES DE LAS SECCIONES.

***NUDOS:*** ARTICULACIÓN DONDE CONCURREN VARIAS BARRAS, Y DONDE SE EJERCEN ACCIONES Y REACCIONES.

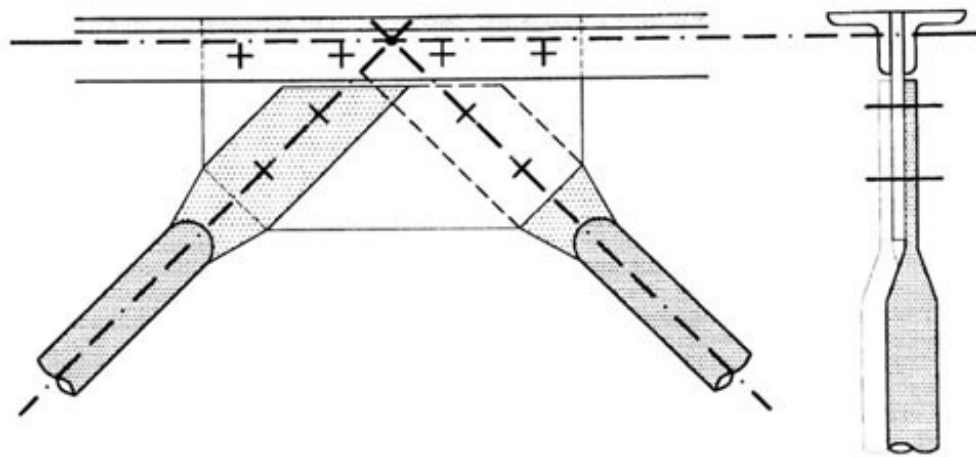
***APOYOS:*** NUDO COMPLETADO CON UN DISPOSITIVO DE UNIÓN CON EL RESTO DE LA ESTRUCTURA.



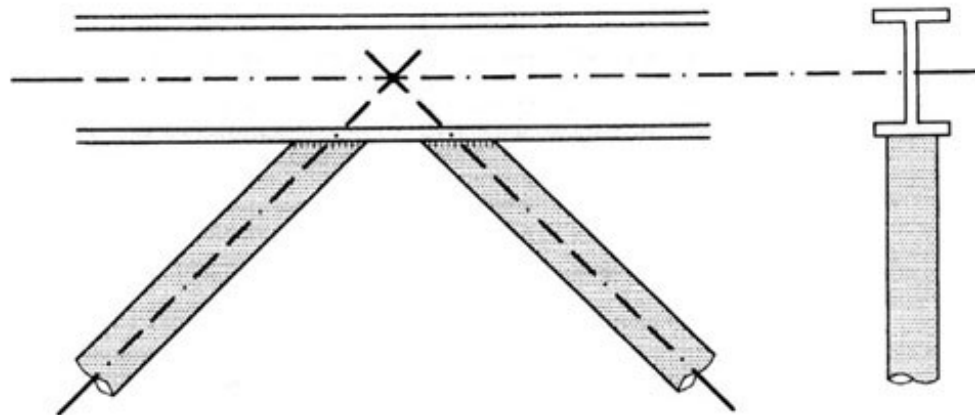
- NUDO: UNION DE PERFIL T CON PERFILES L  
MEDIANTE PLANCHUELA SOLDADA



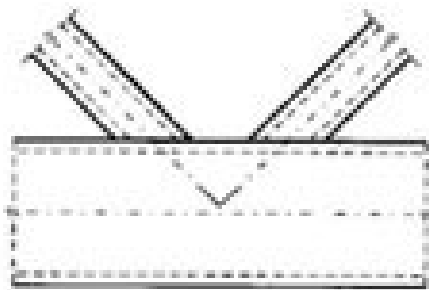
- NUDO: UNION SOLDADA DE TUBOS DE SECCION  
CIRCULAR



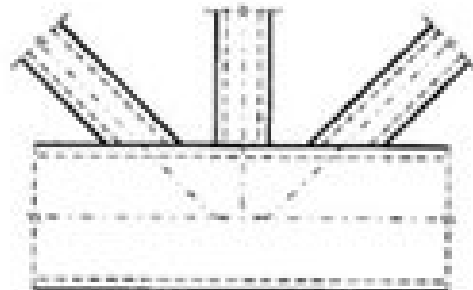
- NUDO: UNION DE TUBOS DE SECCION CIRCULAR DE  
EXTREMOS ACHATADOS CON DOS PERFILES L  
MEDIANTE PLANCHUELA CON REMACHES O ABULONAD



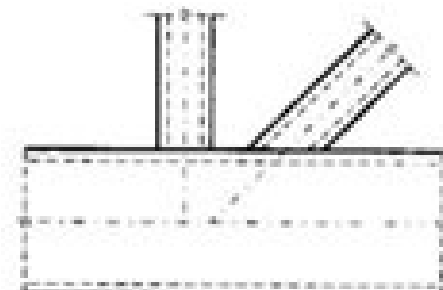
- NUDO: UNION SOLDADA DE PERFIL DOBLE T  
CON TUBO DE SECCION CIRCULAR



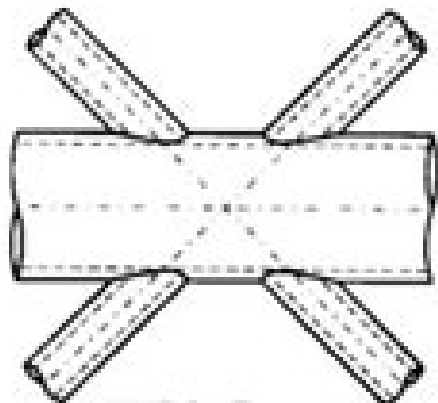
NUDO EN K



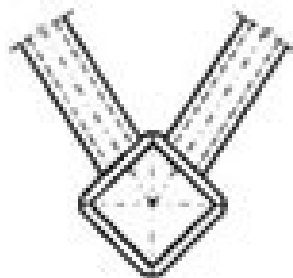
NUDO EN KT



NUDO EN N



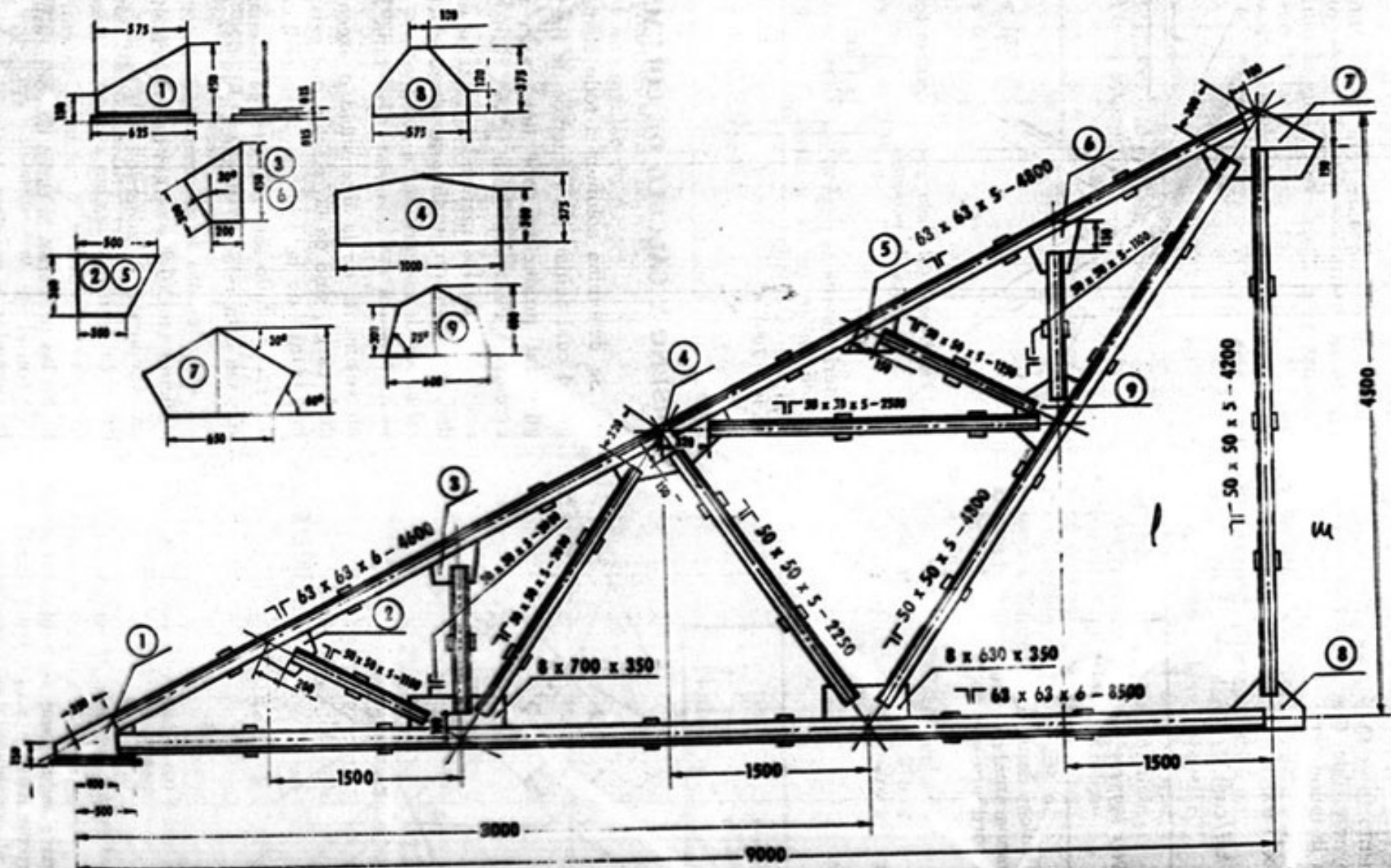
NUDO EN DK



NUDO EN KK









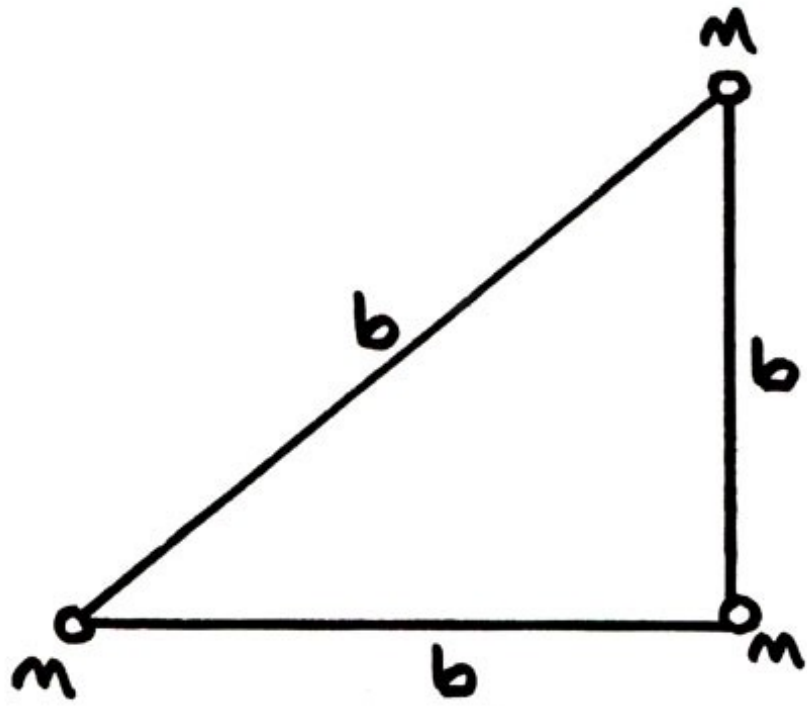




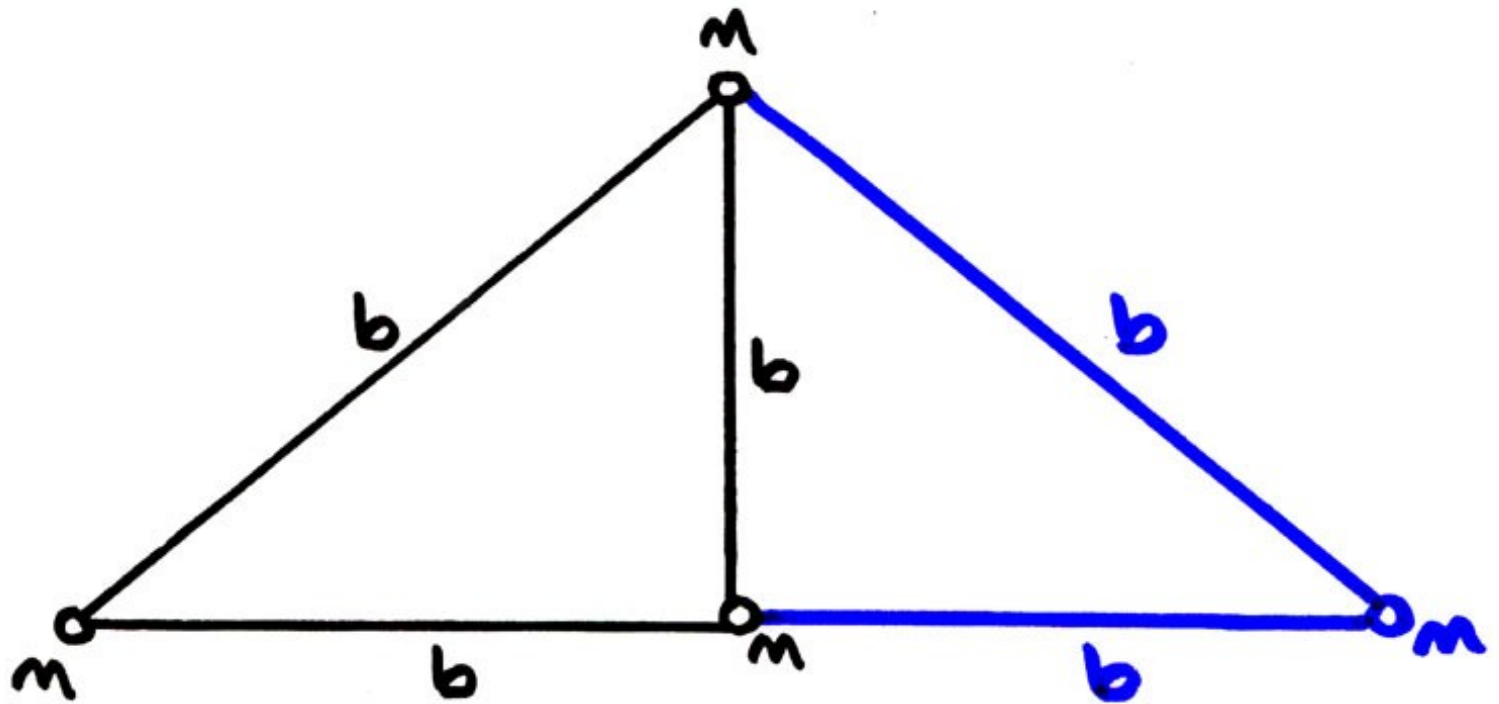


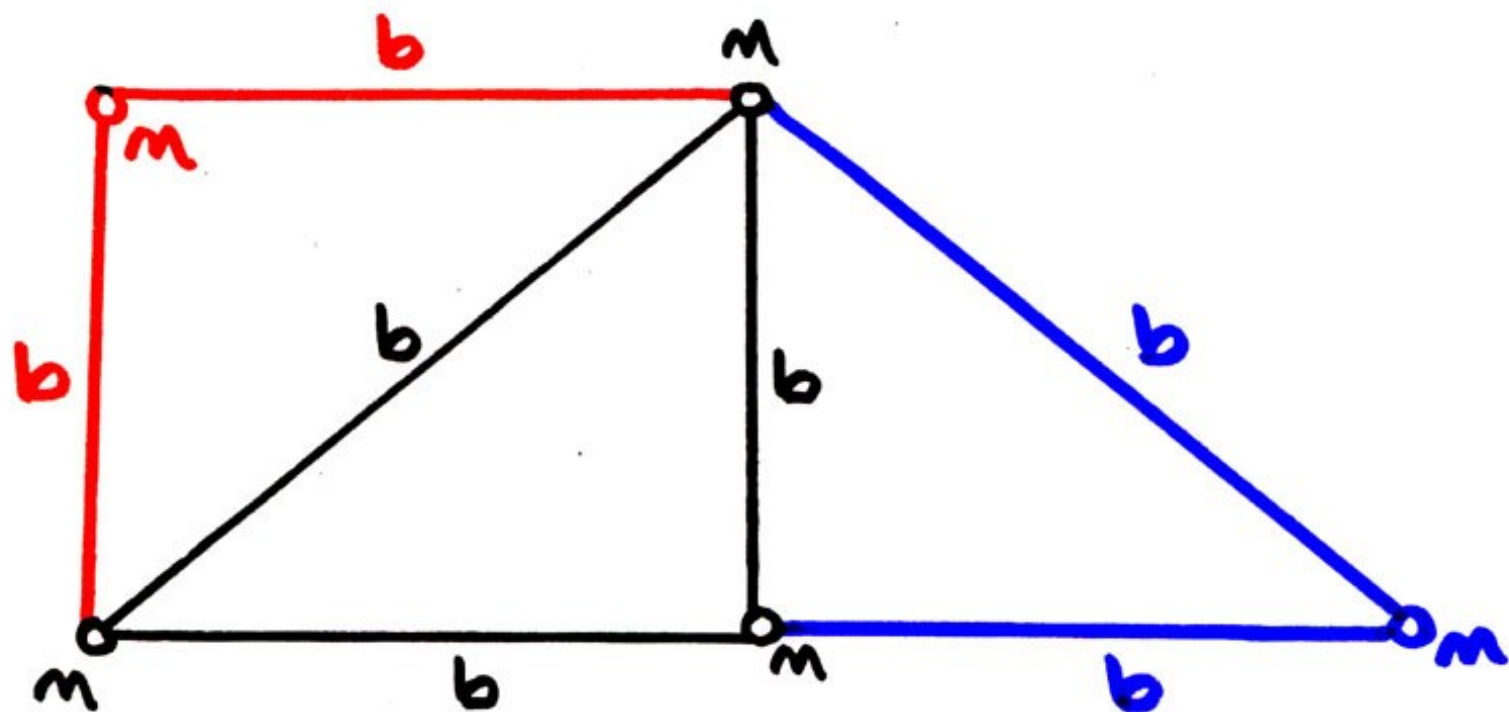
# **CONFIGURACIÓN GEOMÉTRICA**

**TRABAJANDO CON RETICULADOS  
ANALIZABLES EN UN PLANO, LA UNIDAD  
GEOMÉTRICA BÁSICA SERÁ EL  
TRIÁNGULO.**

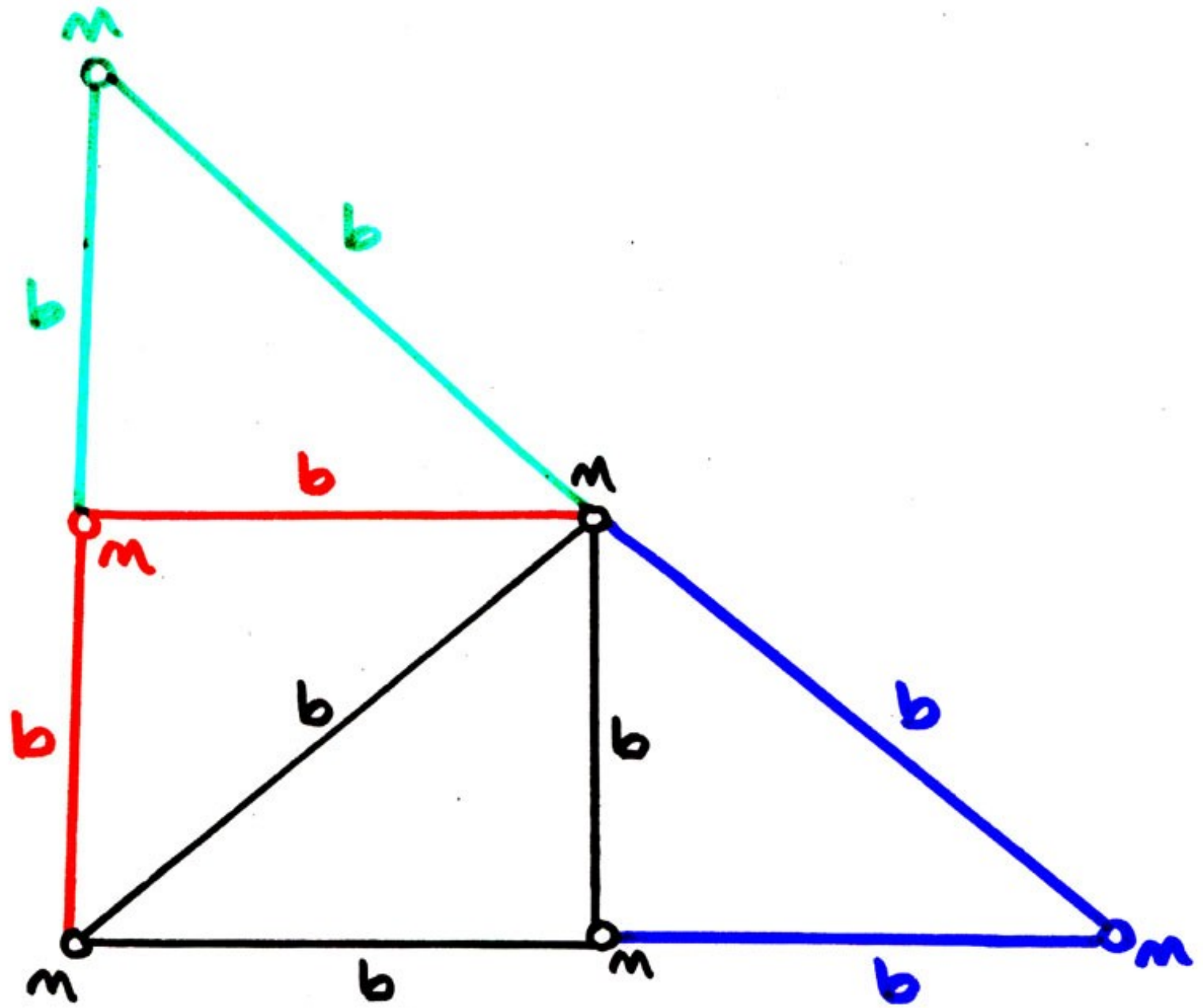


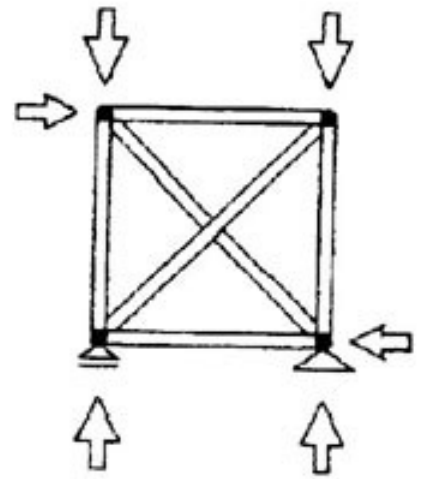
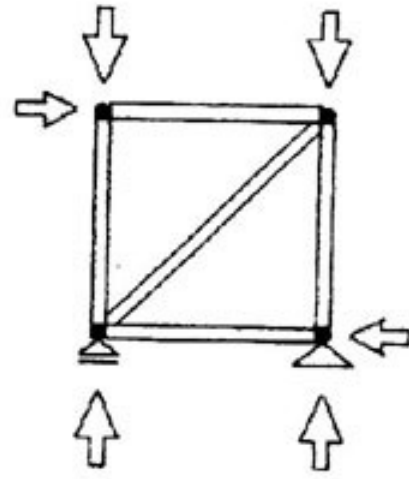
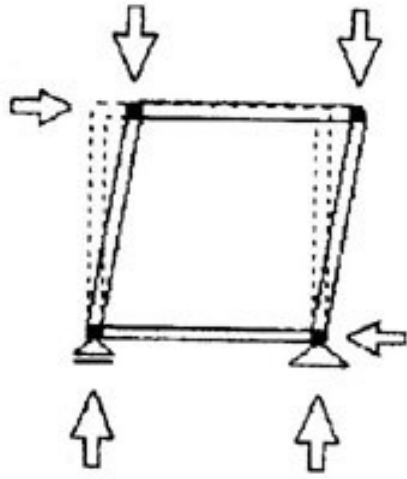
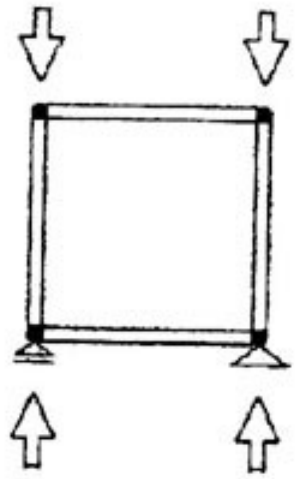








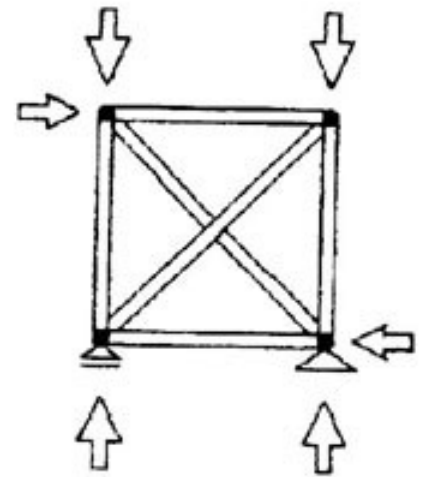
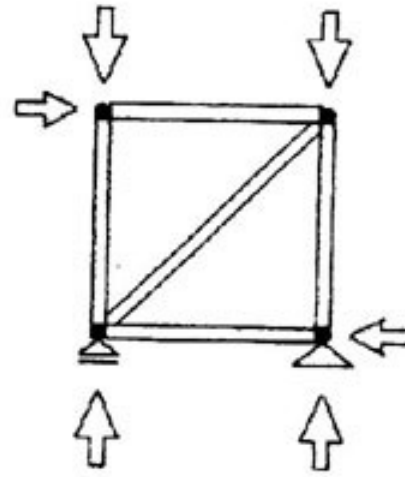
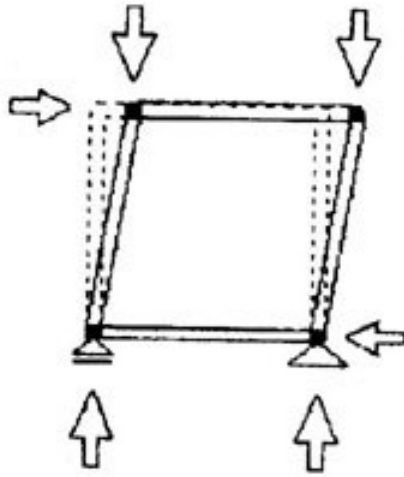
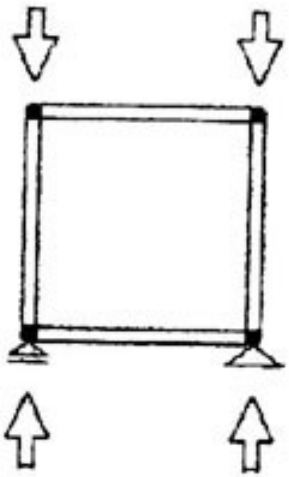






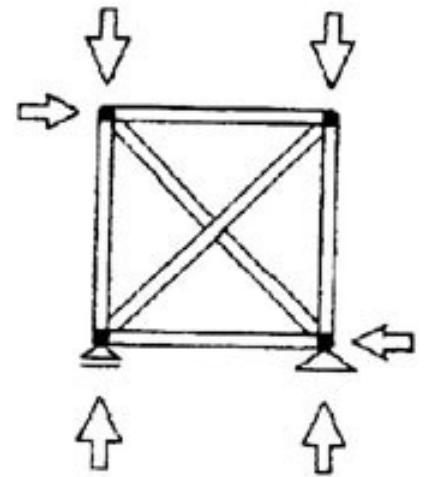
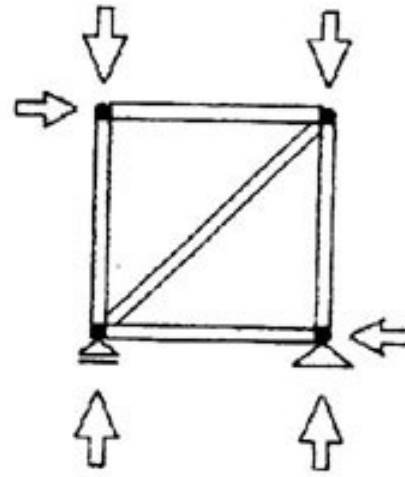
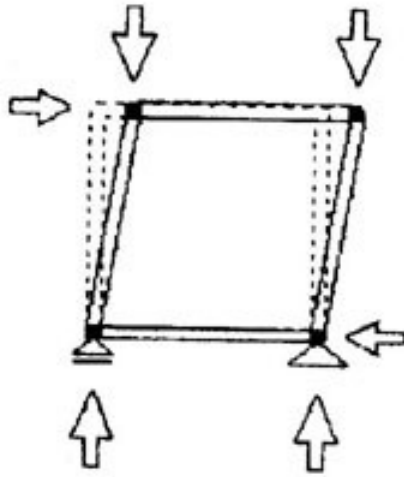
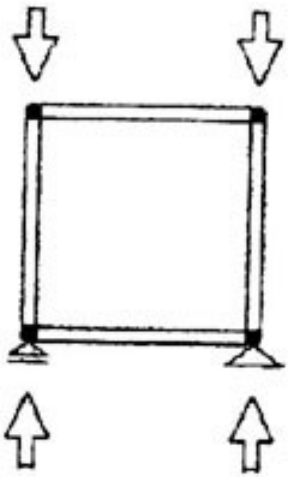
$$2n - b = 3$$

$b$  - nº de barras  
 $n$  - nº de nodos



$$2n - b = 3$$

$b$  - nº de barras  
 $n$  - nº de nodos

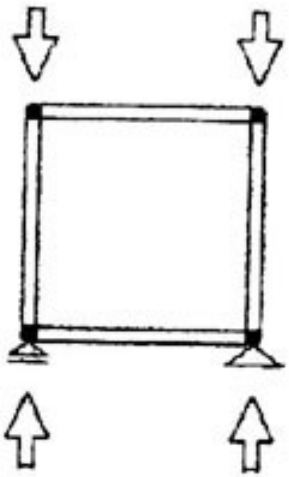


$8 - 4 = 4 > 3$   
hipostática

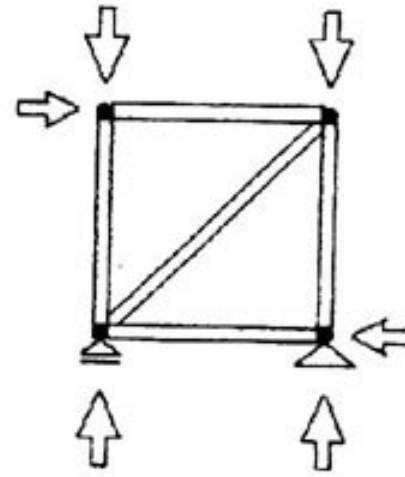
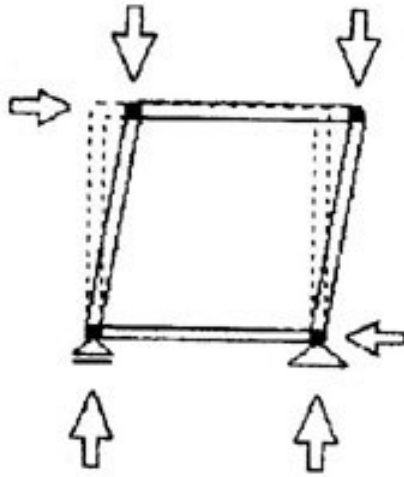


$$2n - b = 3$$

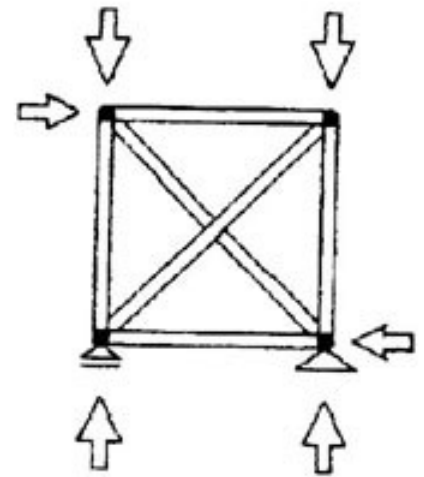
$b$  - nº de barras  
 $n$  - nº de nodos



$8 - 4 = 4 > 3$   
hipostática

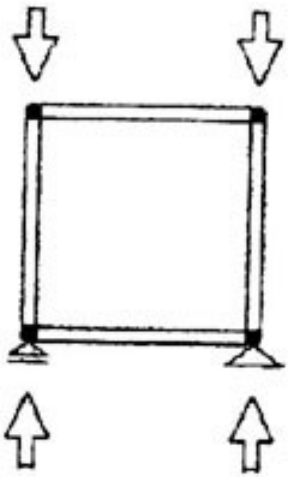


$8 - 5 = 3$   
isostática

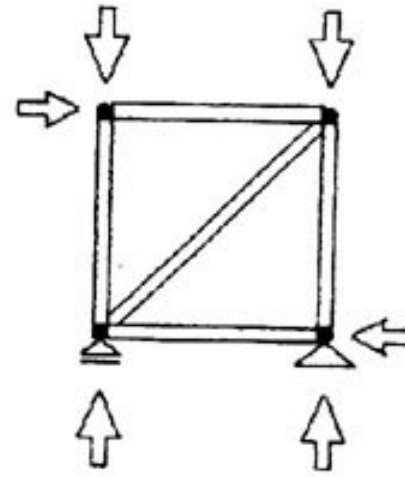
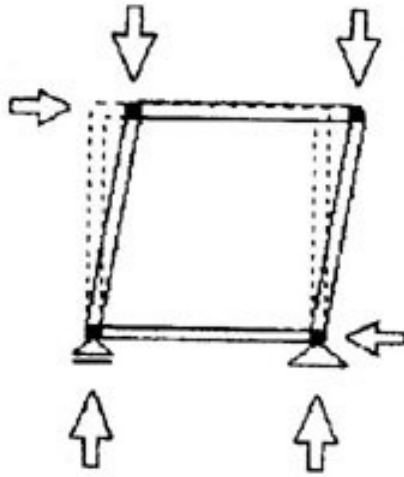


$$2n - b = 3$$

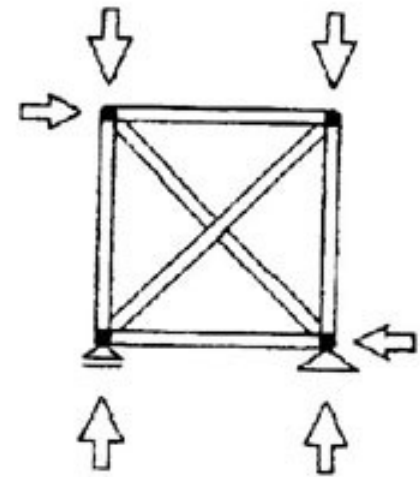
$b$  - nº de barras  
 $n$  - nº de nodos



$8 - 4 = 4 > 3$   
hipostática



$8 - 5 = 3$   
isostática



$8 - 6 = 2 < 3$   
hiperestática



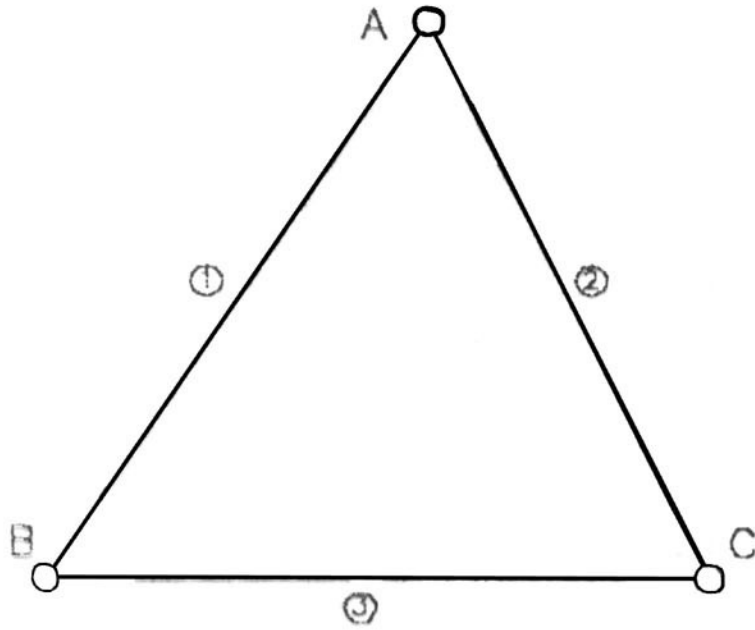
# **MODELOS**

***MODELO FUNCIONAL:*** LOS EJES DE LAS BARRAS CONCURREN EN UN PUNTO (NUDO IDEAL) ASIMILABLE A UNA ARTICULACIÓN. LAS ACCIONES EXTERNAS, ASIMILADAS A FUERZAS CONCENTRADAS, ESTÁN APLICADAS EN LOS NUDOS.

***MODELO DE COMPORTAMIENTO:***

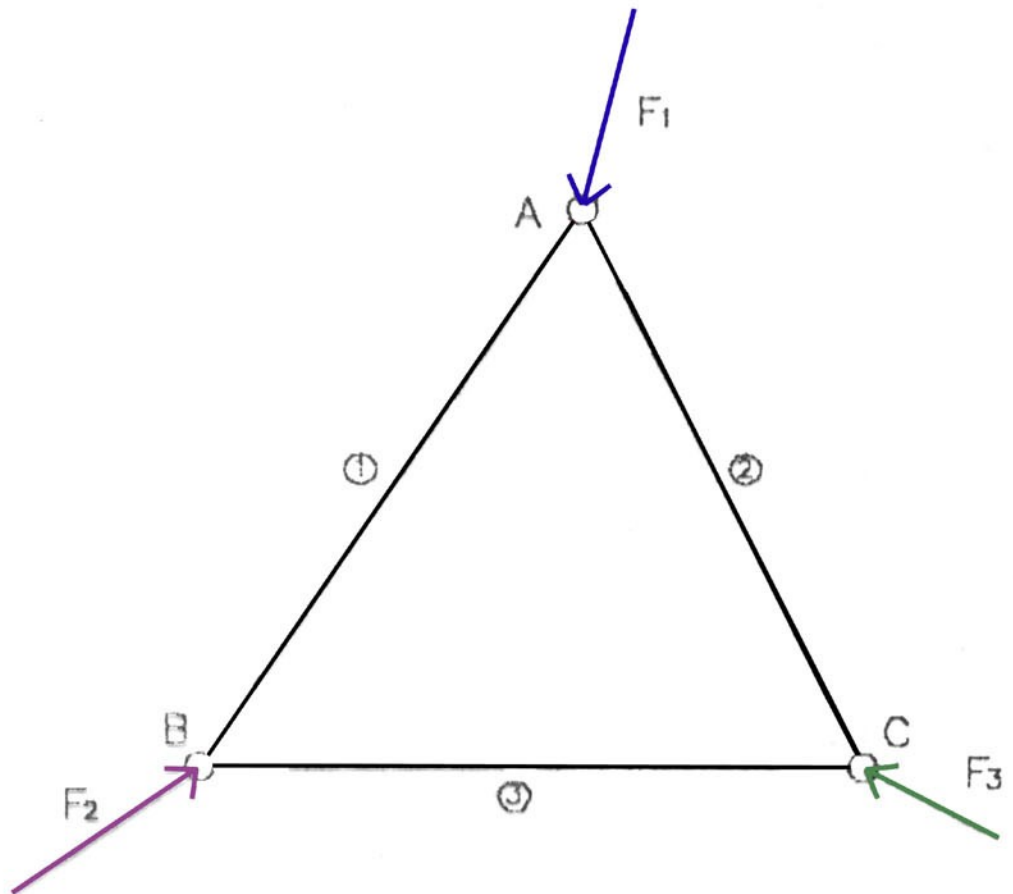
LAS BARRAS ESTÁN SOLICITADAS POR FUERZAS AXILES DE TRACCIÓN O COMPRESIÓN.

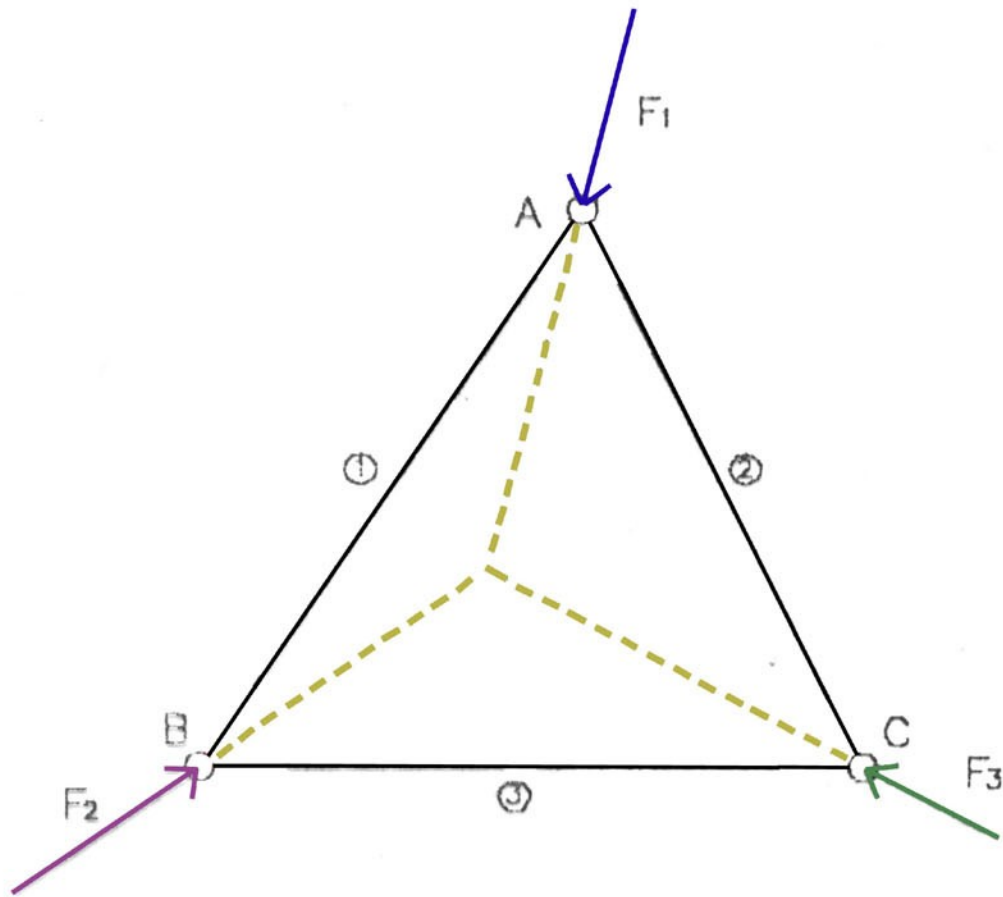
***MODELO DE MATERIAL:*** HOMOGÉNEO Y CONTÍNUO.



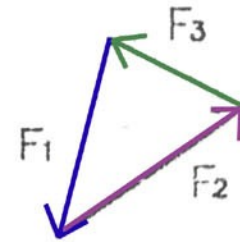
**UNIDAD GEOMÉTRICA ELEMENTAL**



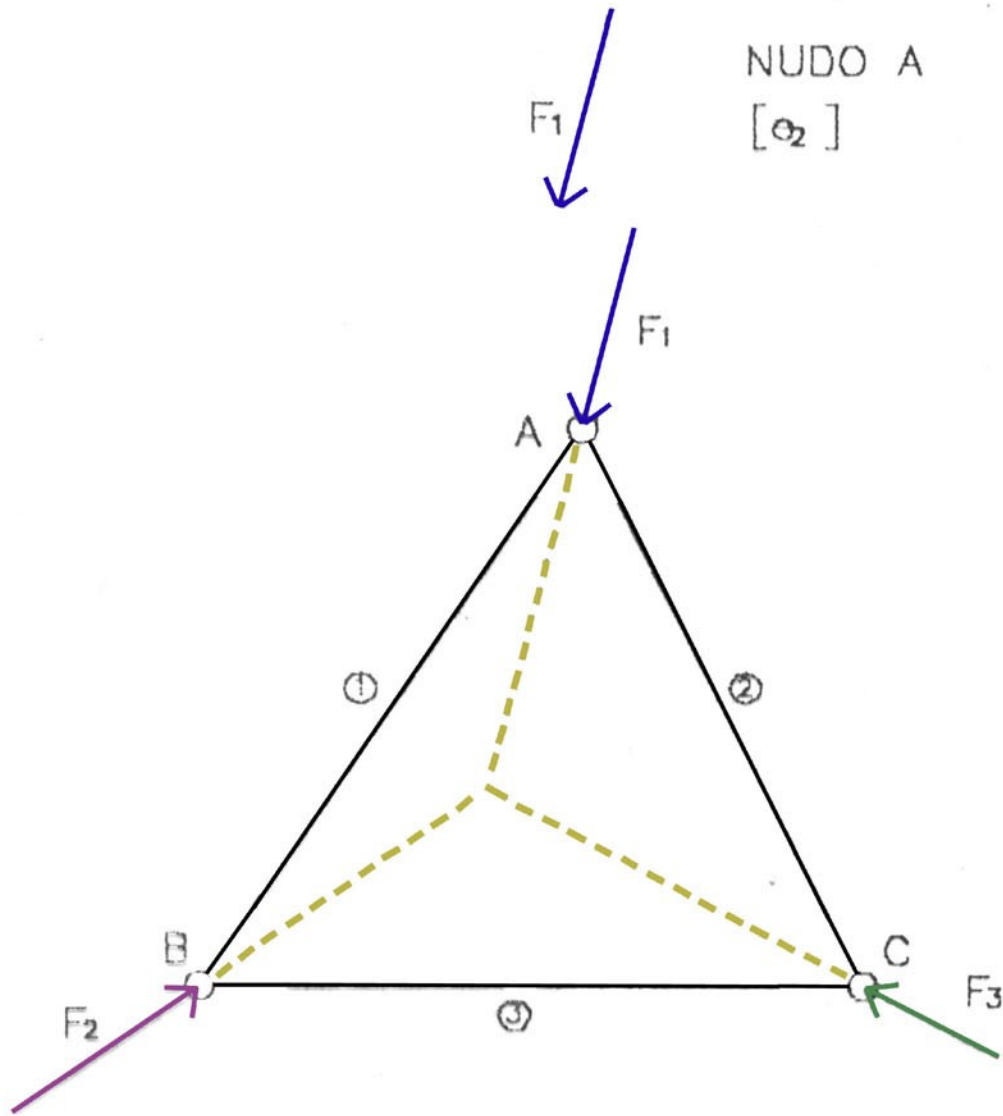




Equilibrio de conjunto

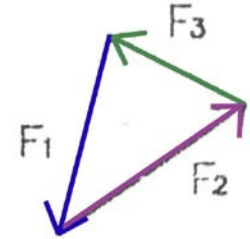


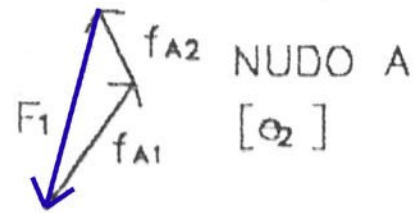
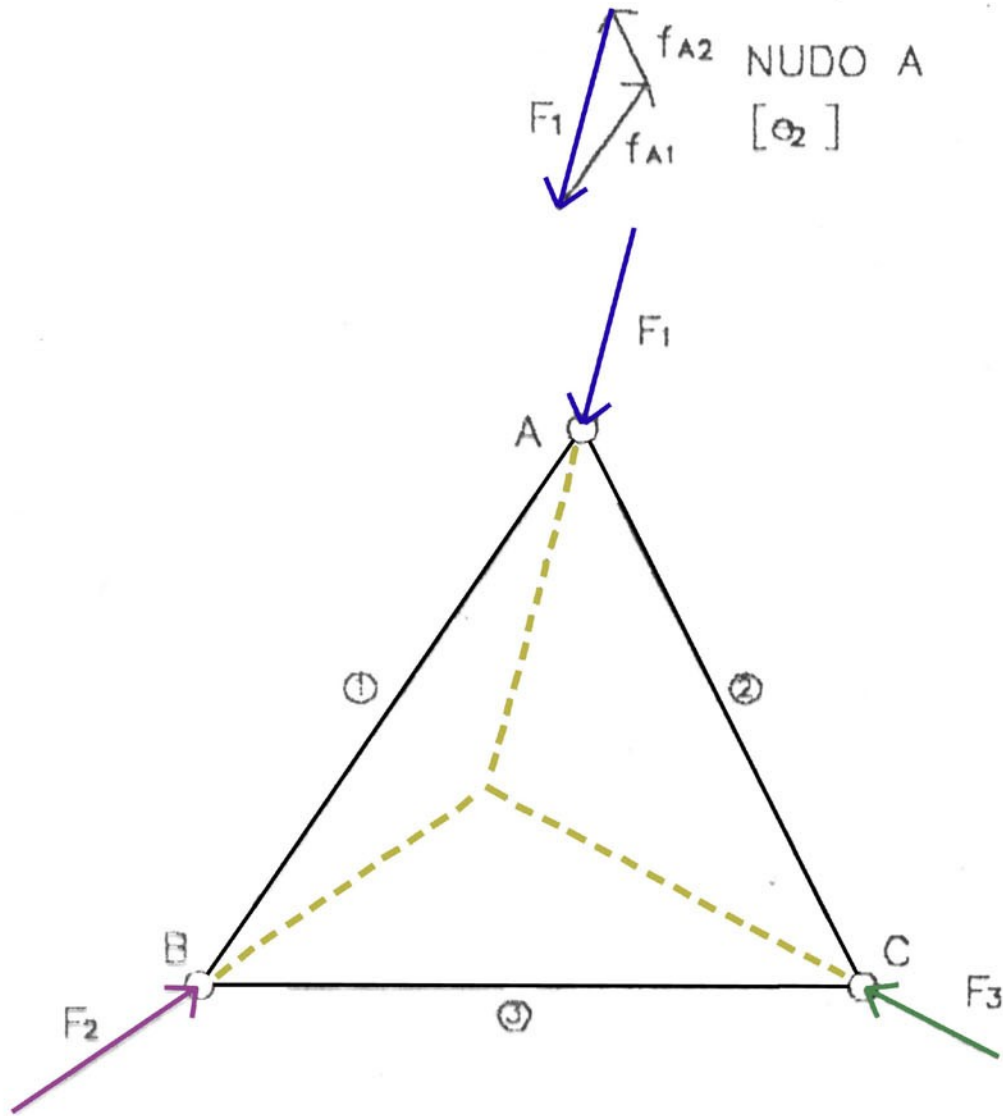




NUDO A  
 $[e_2]$

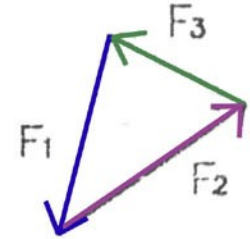
Equilibrio de conjunto  
 $[e_2]$

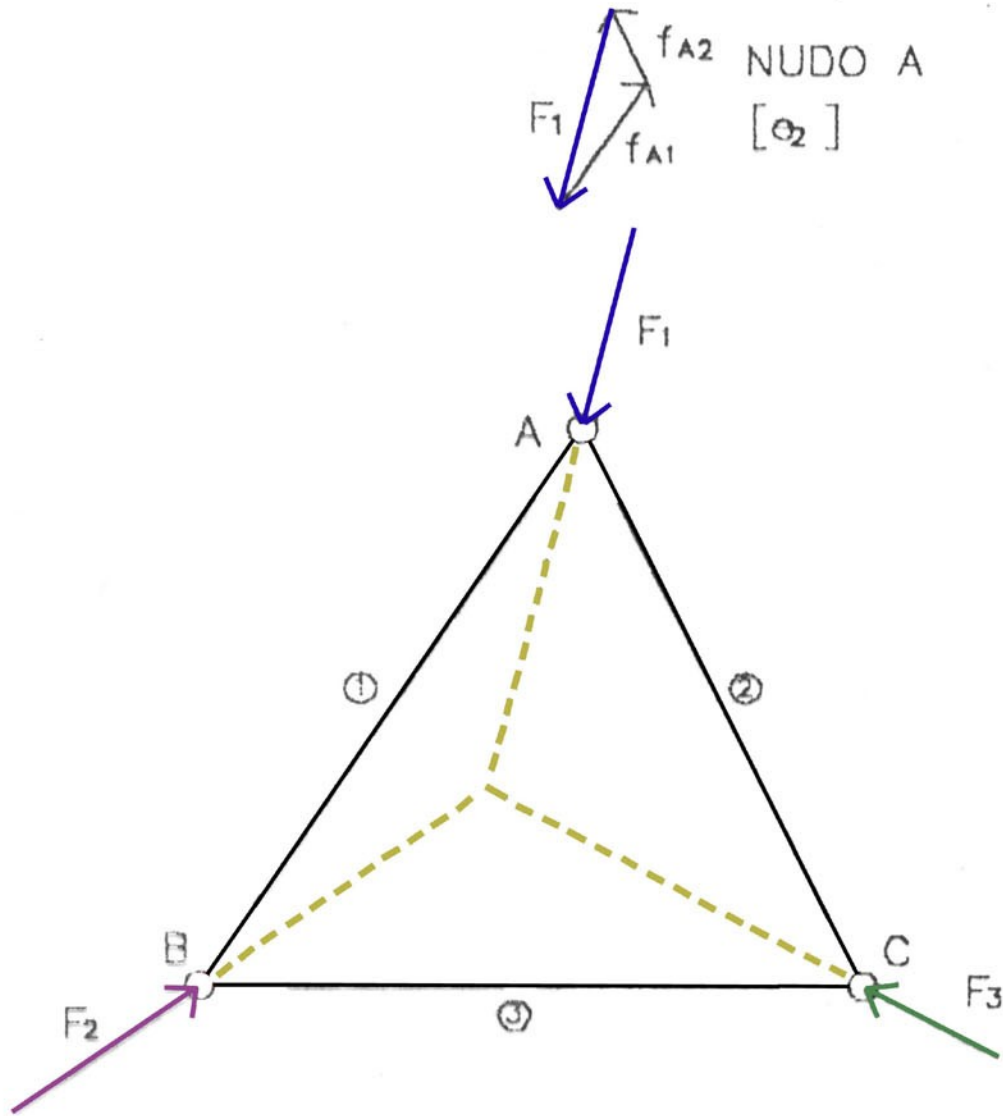




NUDO A  
[ $e_2$ ]

Equilibrio de conjunto  
[ $e_2$ ]

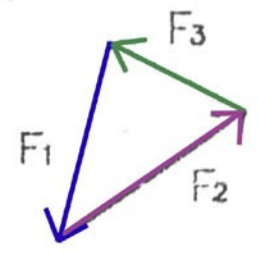




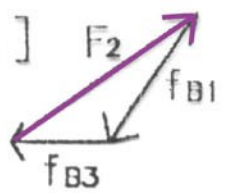
NUDO A  
[e<sub>2</sub>]



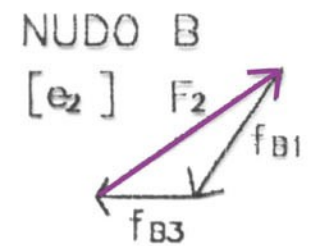
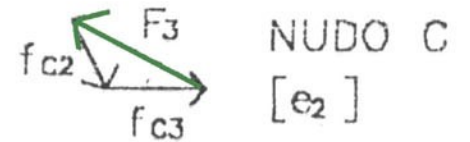
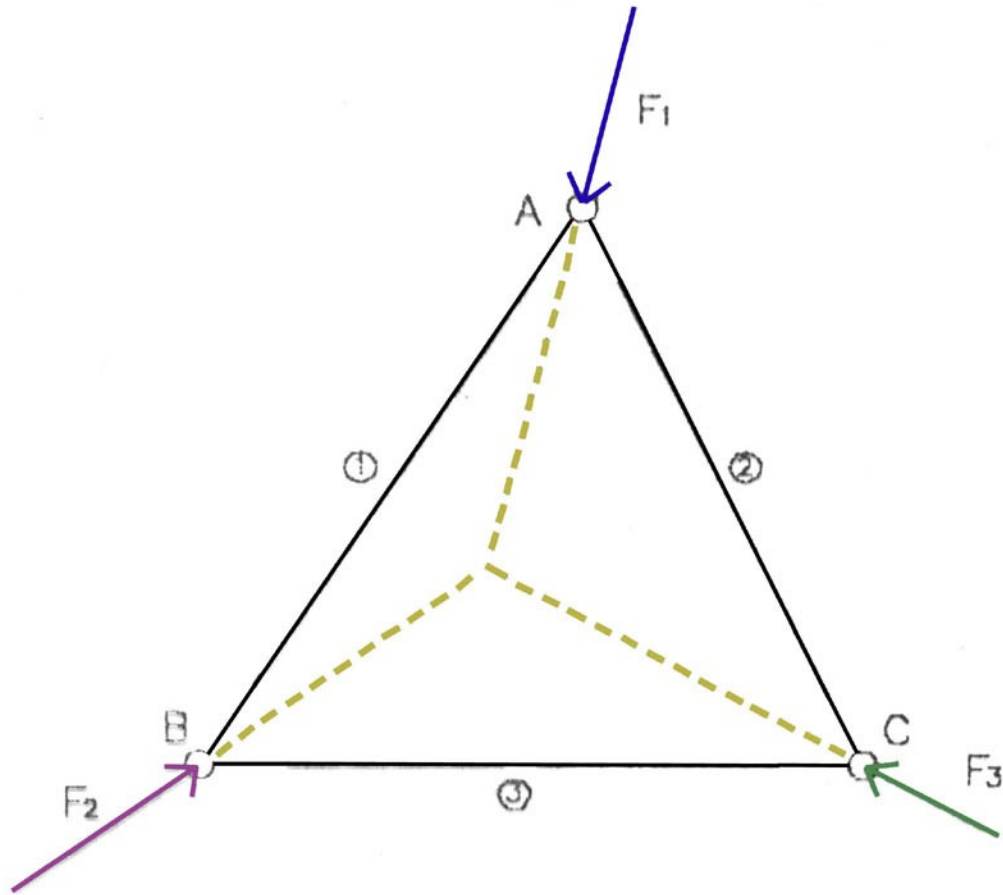
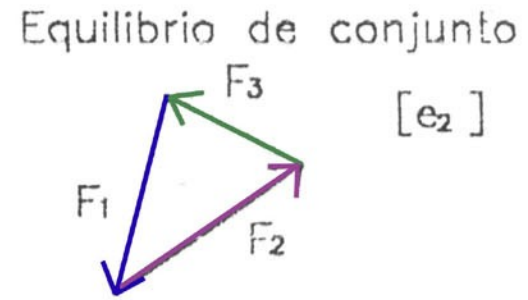
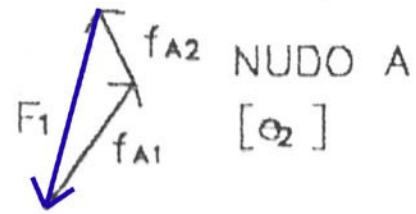
Equilibrio de conjunto  
[e<sub>2</sub>]

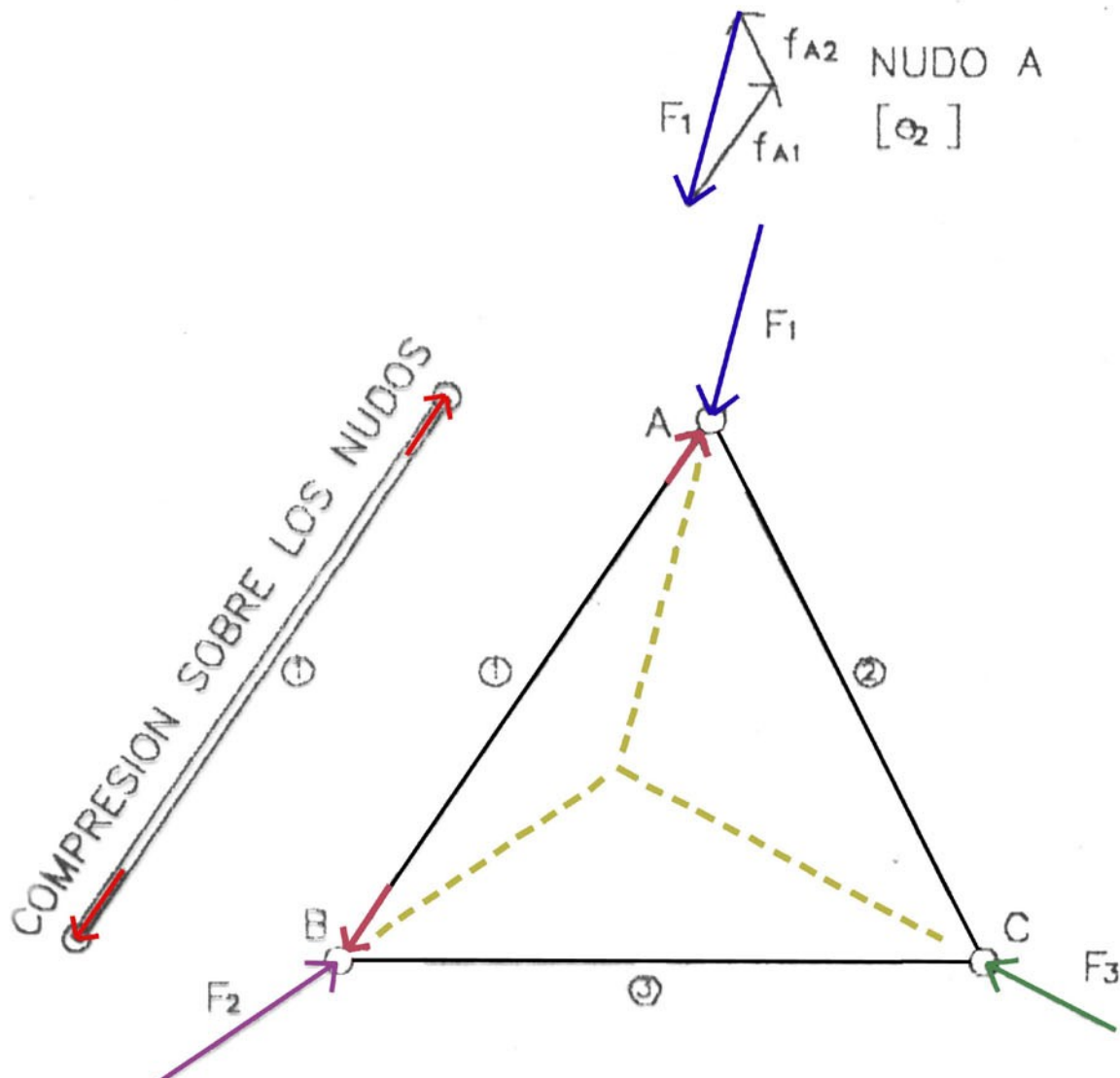


NUDO B  
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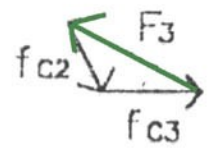
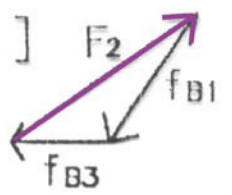


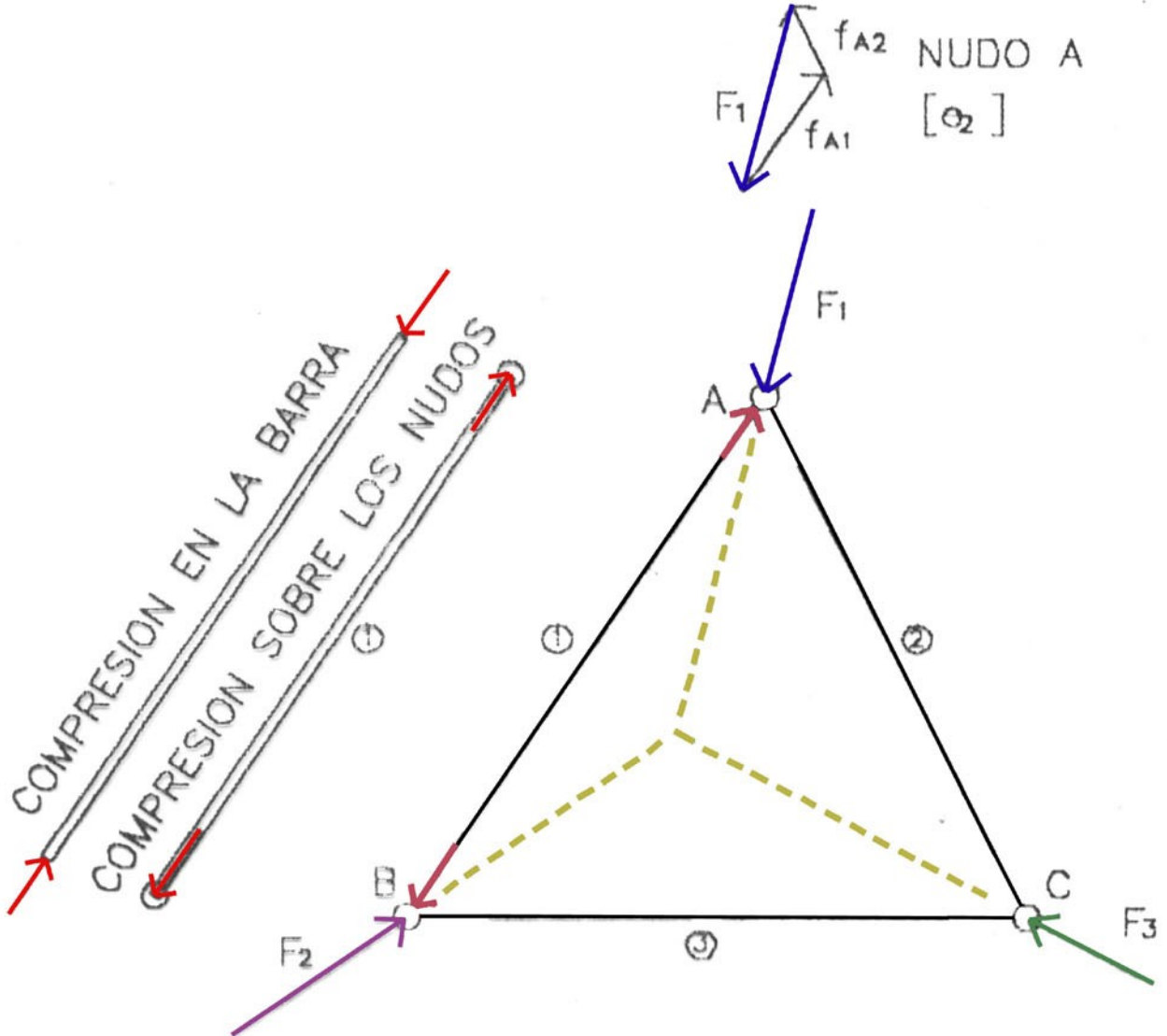
NUDO A  
[e<sub>2</sub>]

Equilibrio de conjunto  
[e<sub>2</sub>]

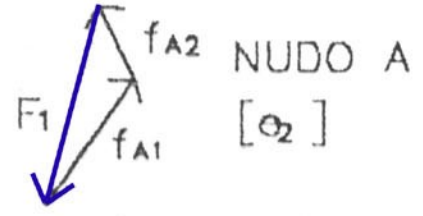
NUDO B  
[e<sub>2</sub>]

NUDO C  
[e<sub>2</sub>]



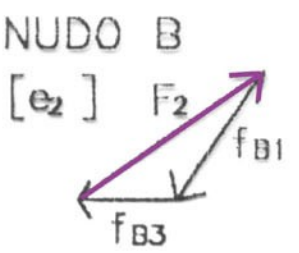
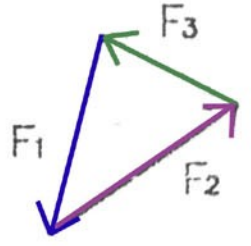


COMPRESION EN LA BARRA  
 COMPRESION SOBRE LOS NUDOS

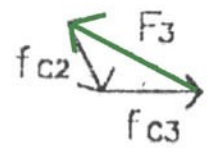


NUDO A  
 $[e_2]$

Equilibrio de conjunto  
 $[e_2]$

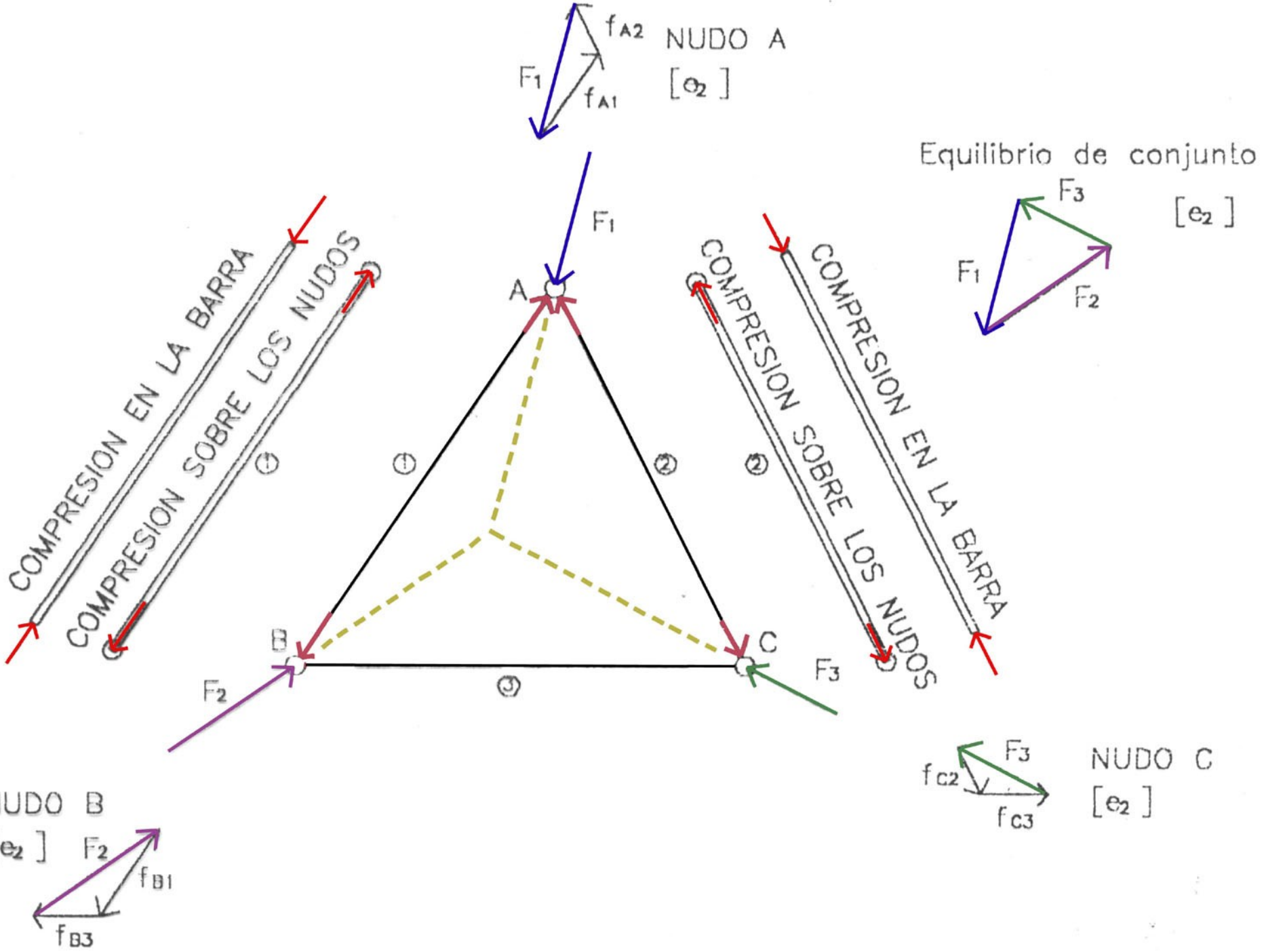


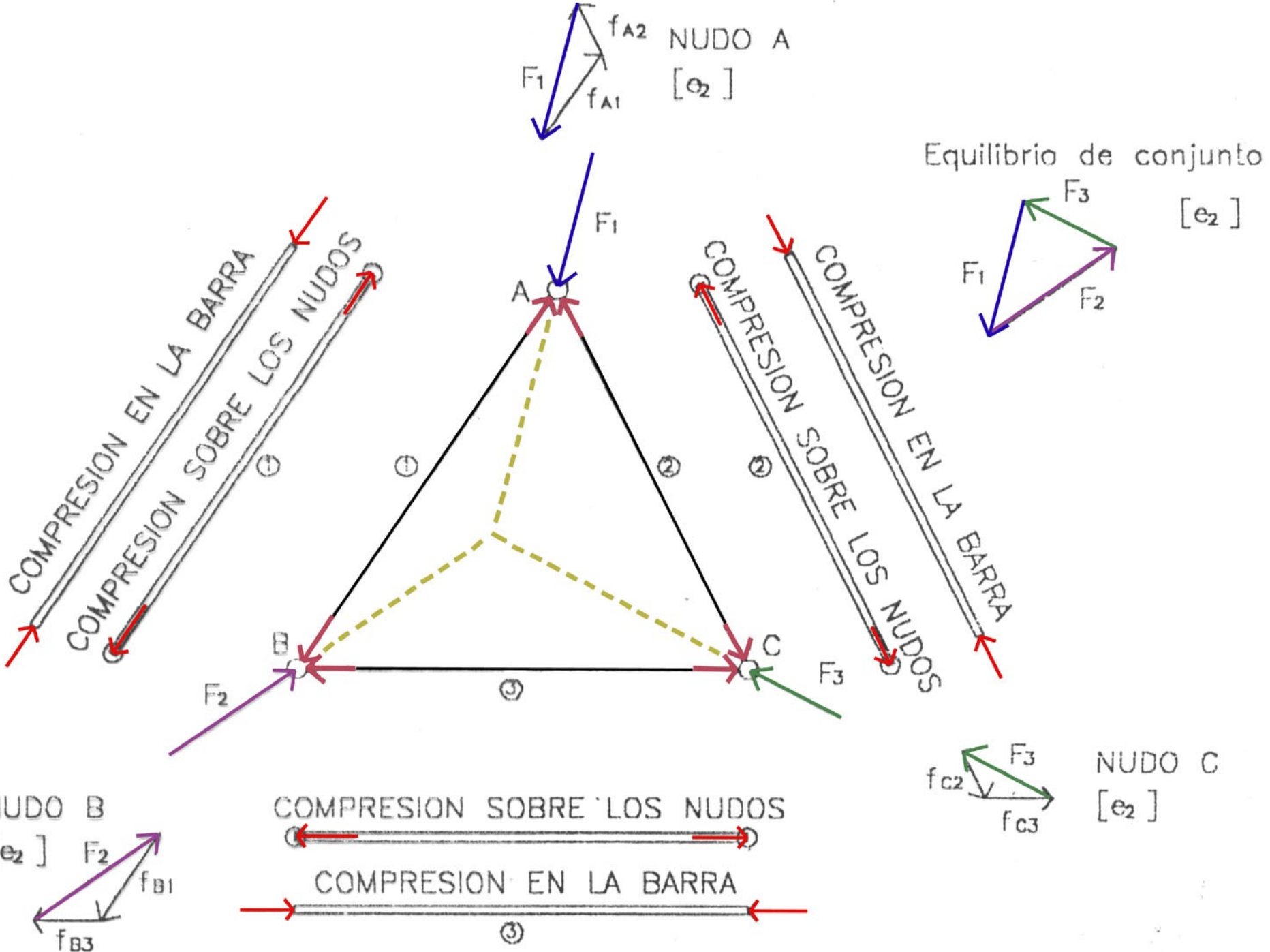
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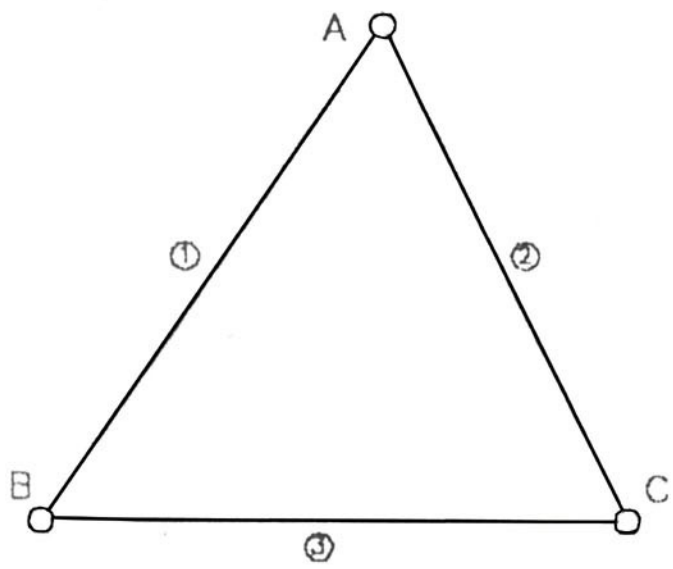


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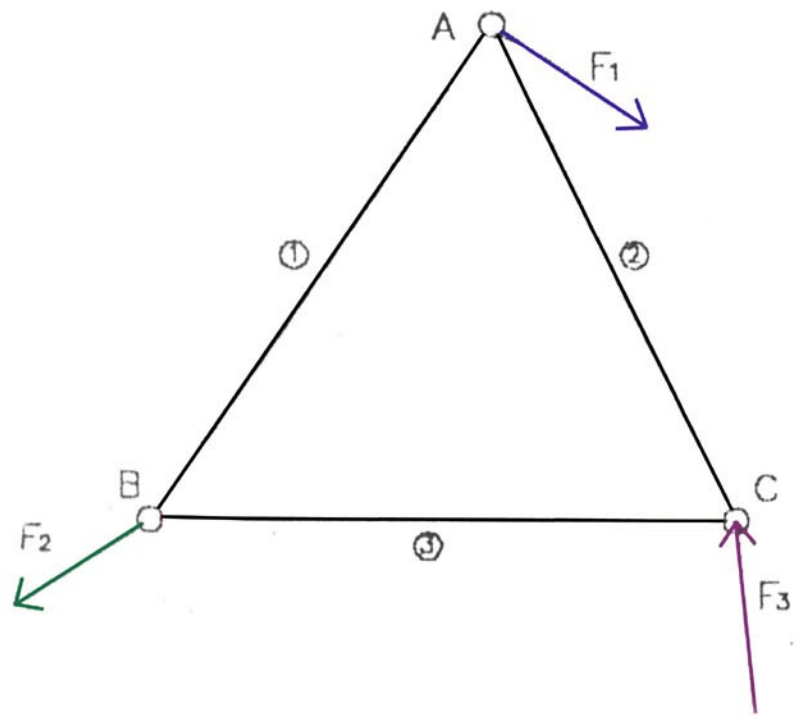


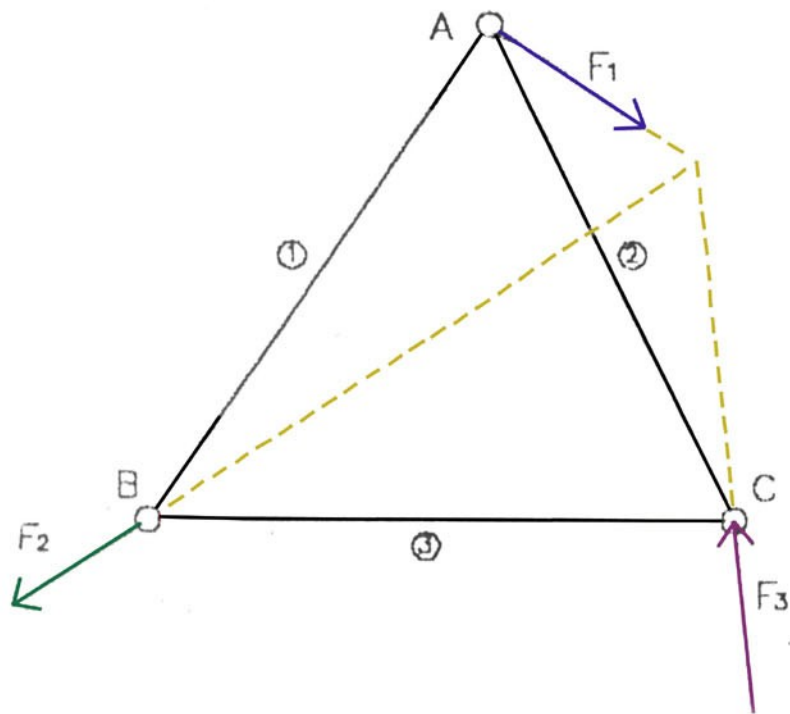




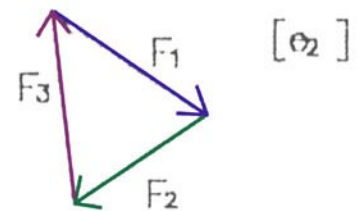


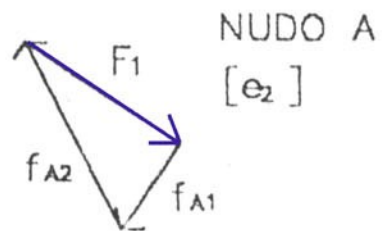




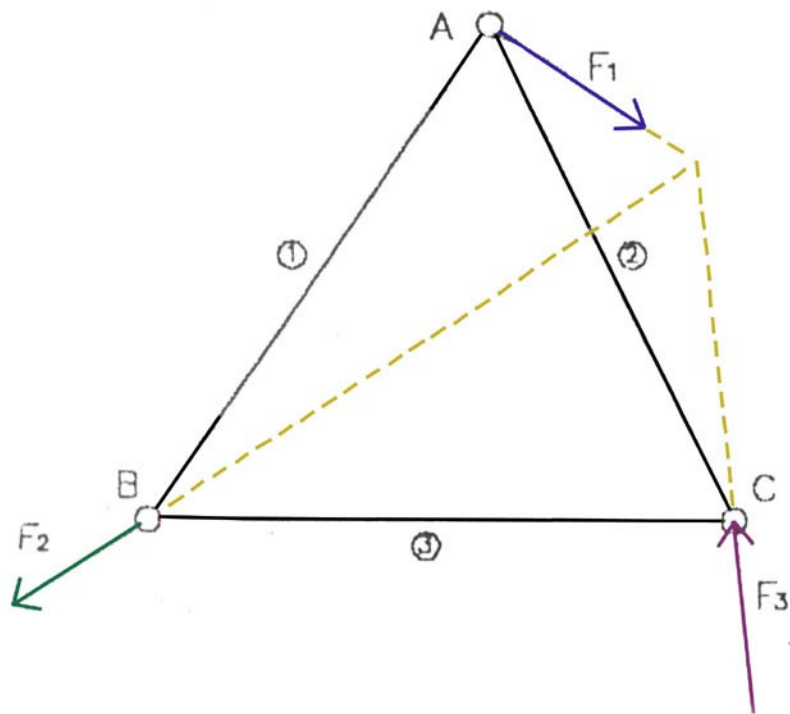
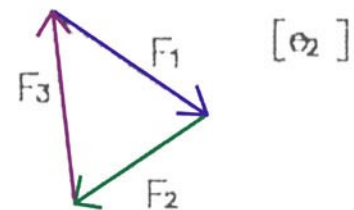


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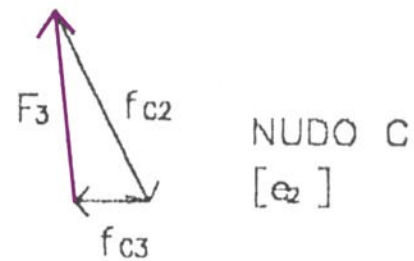
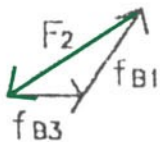




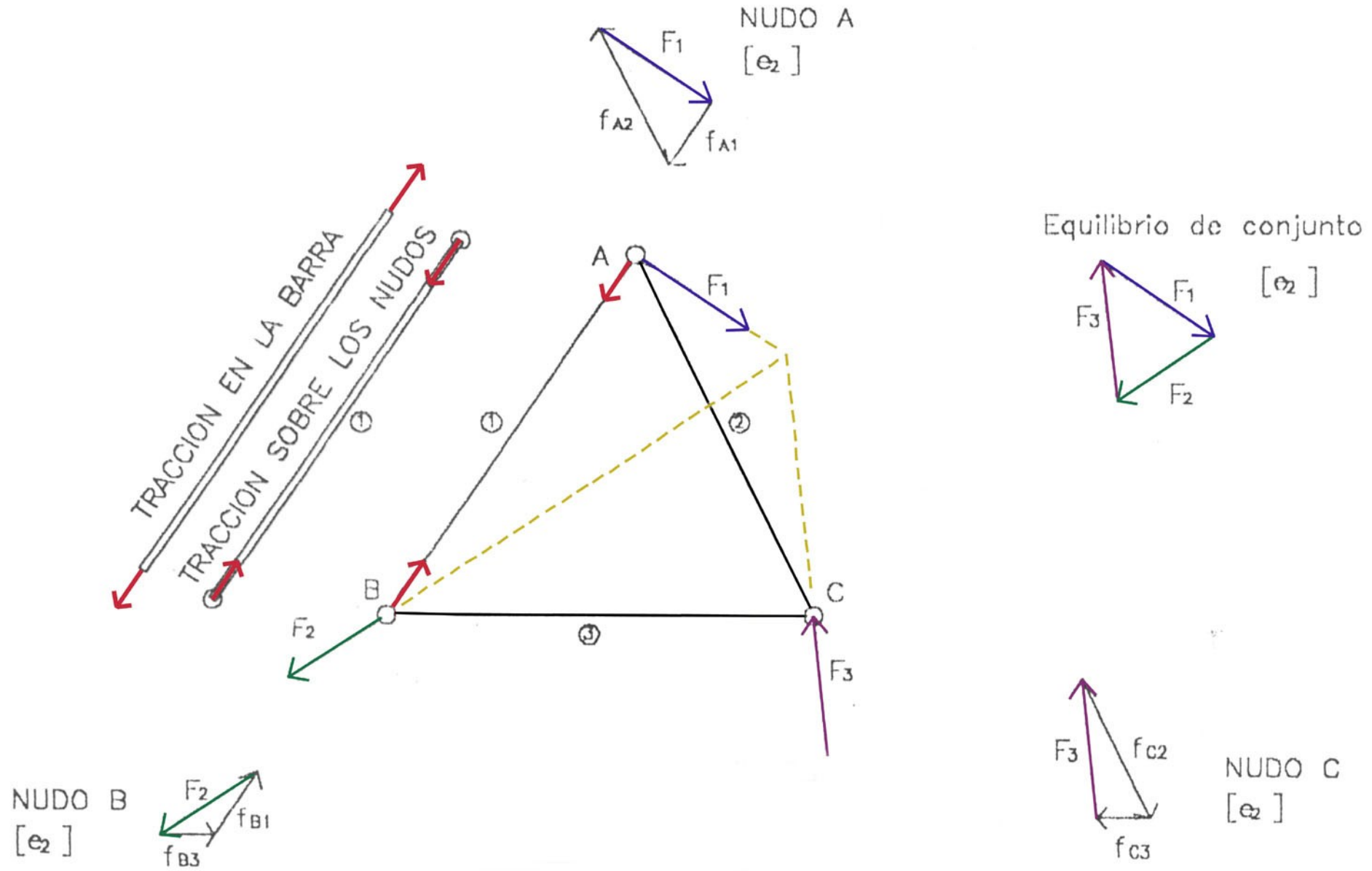
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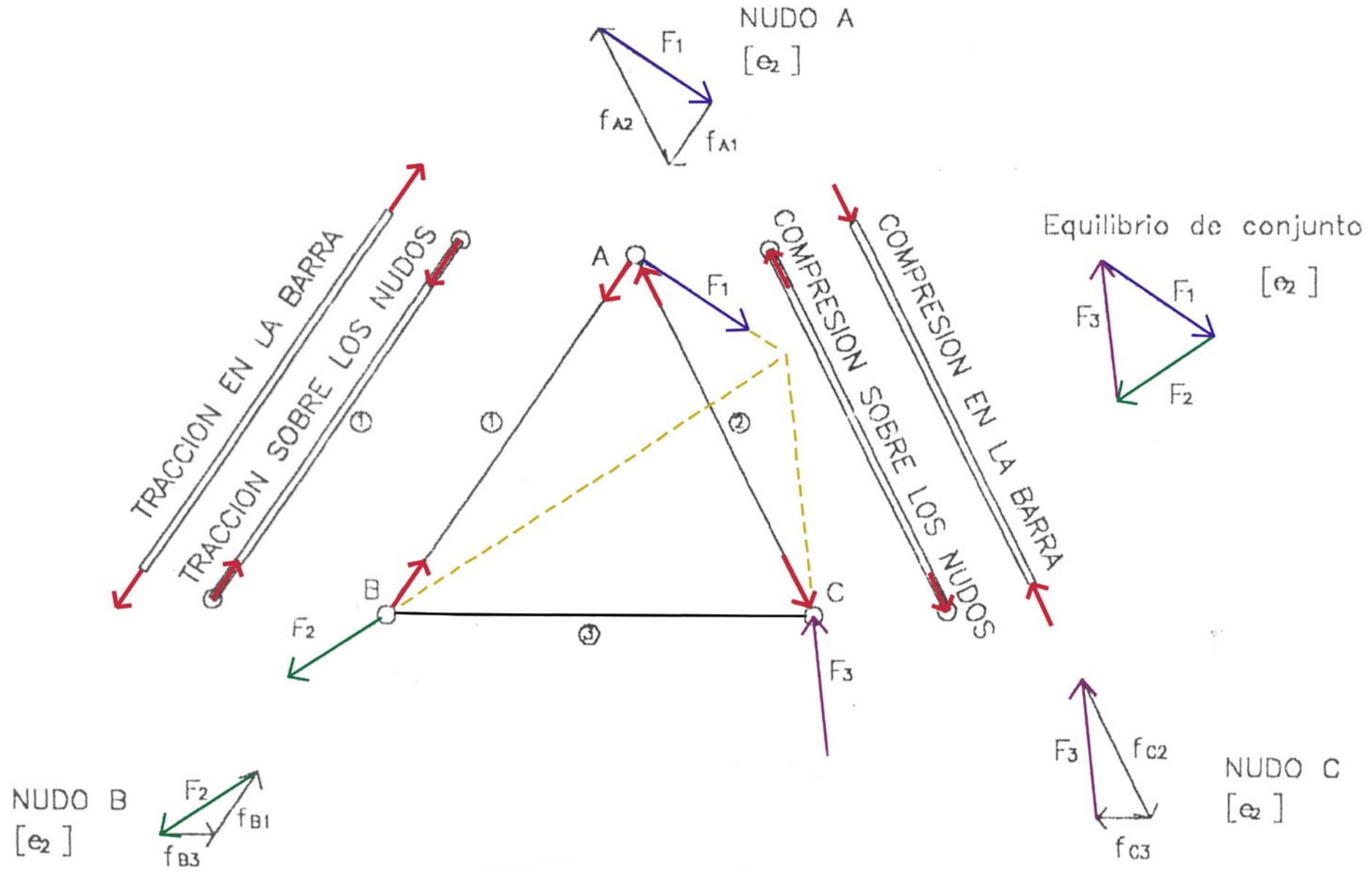


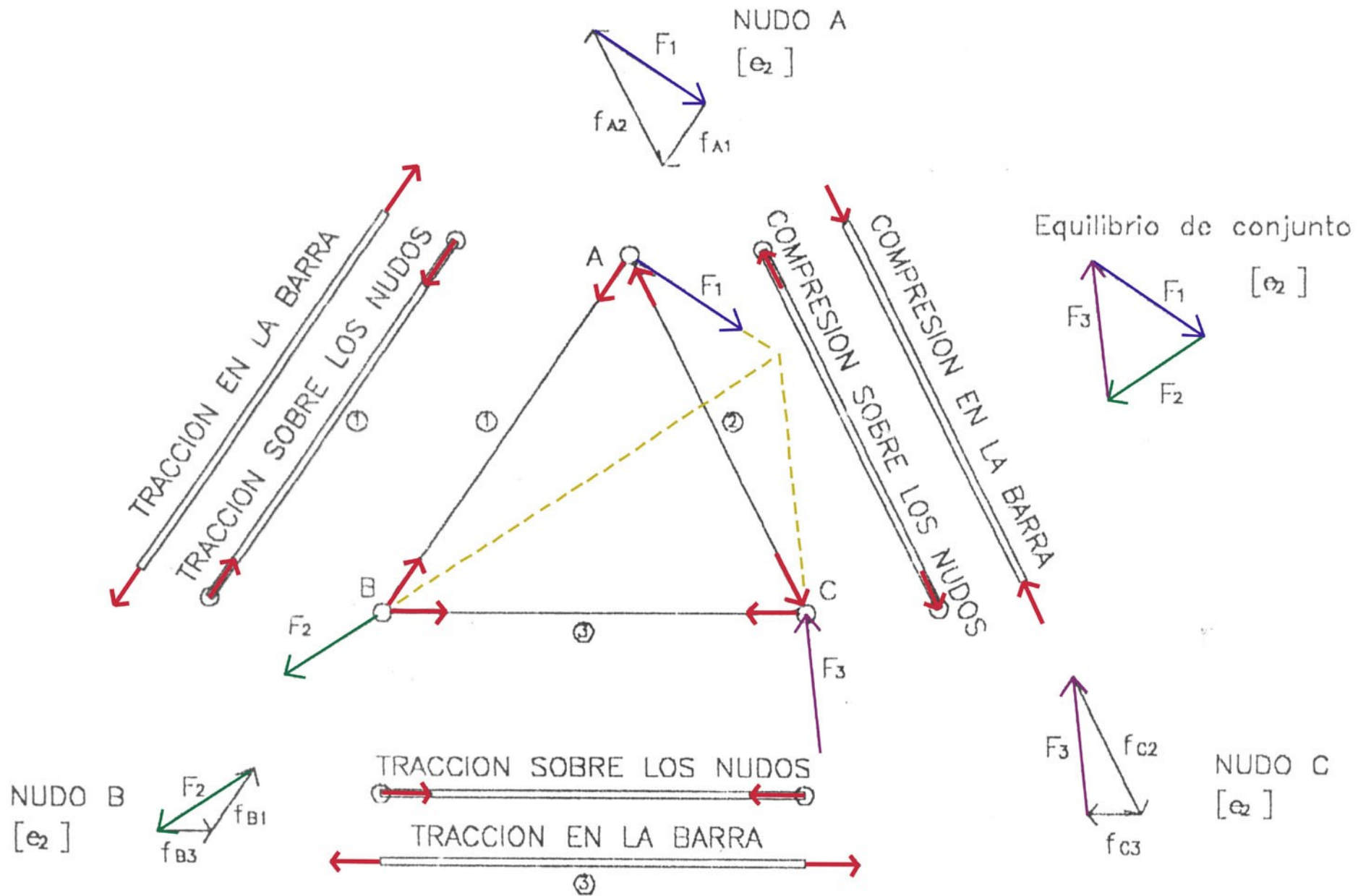
NUDO B  
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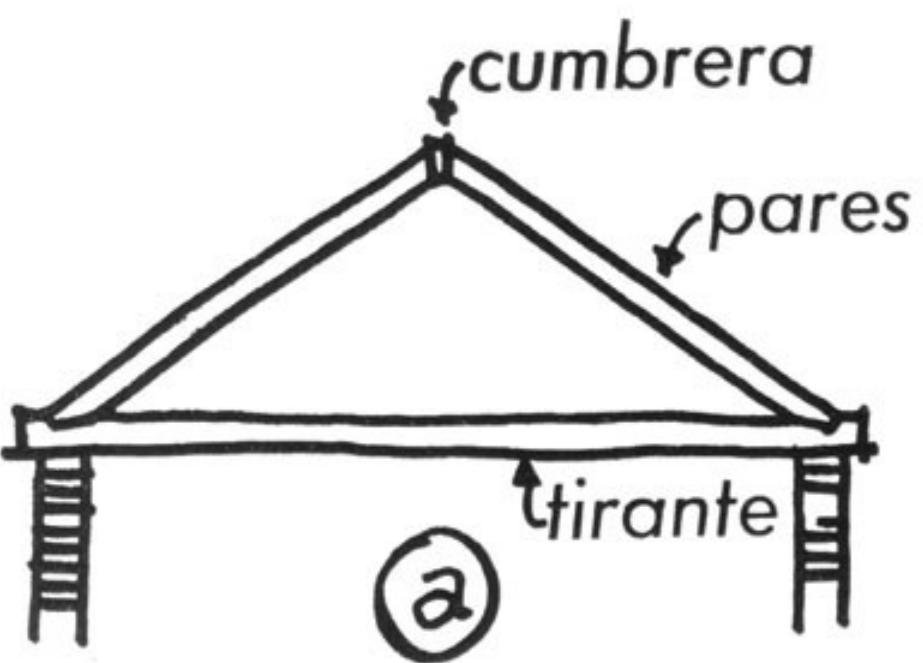


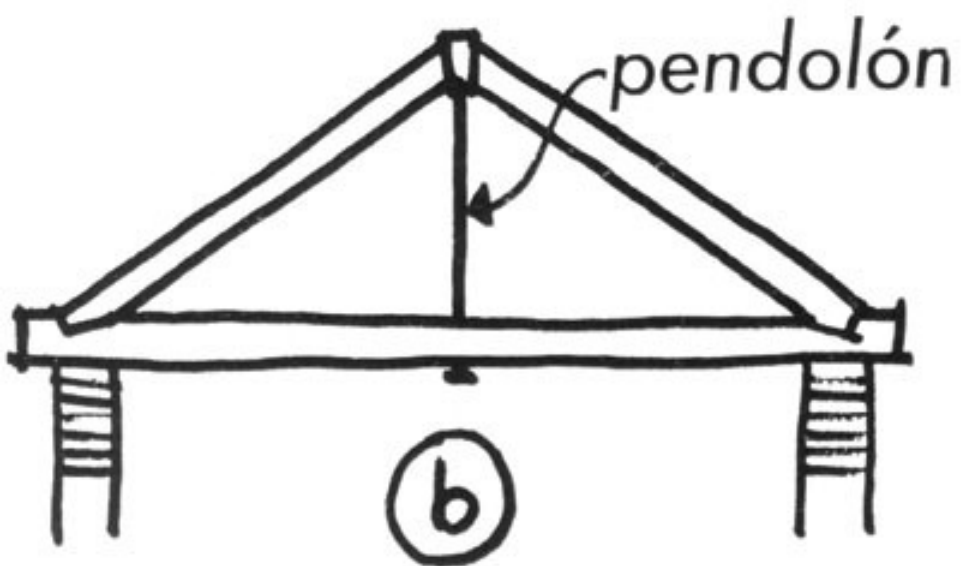
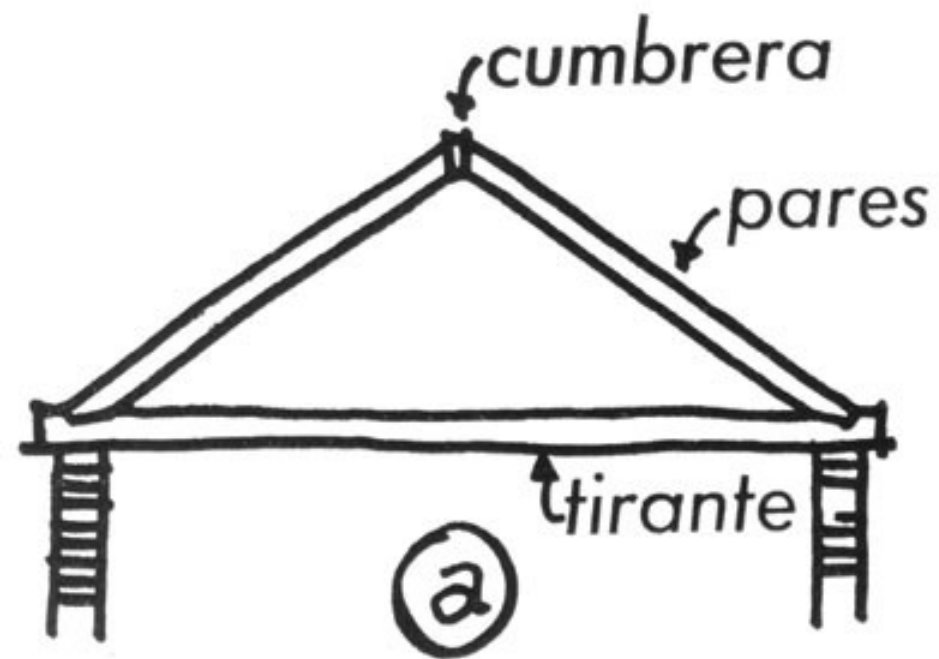


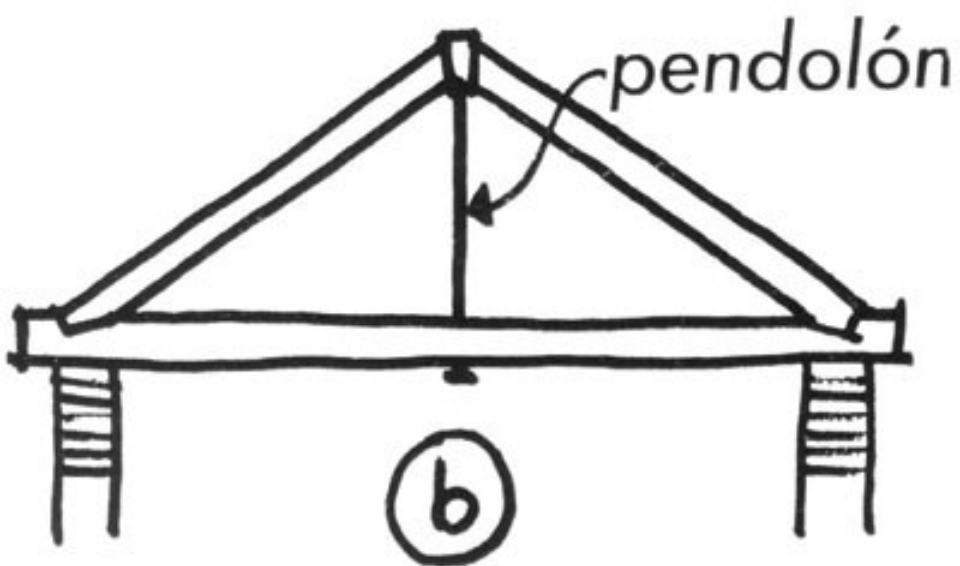
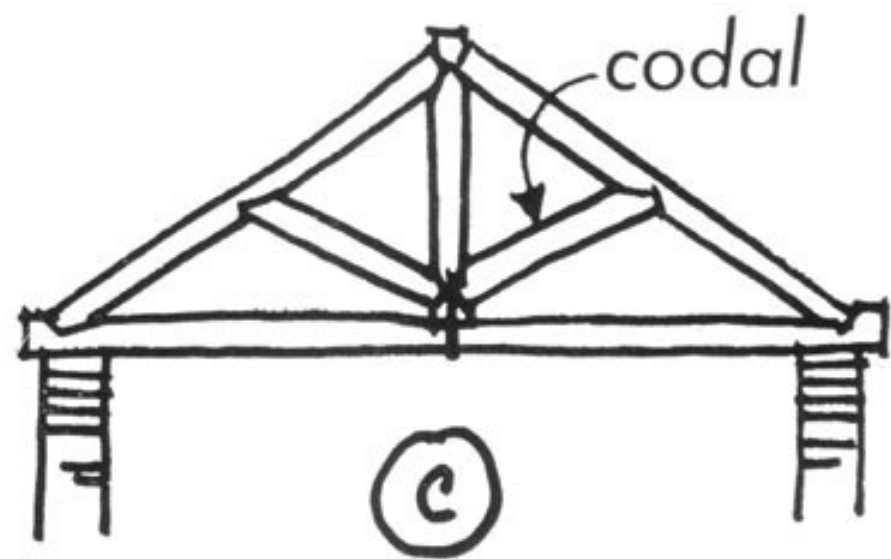
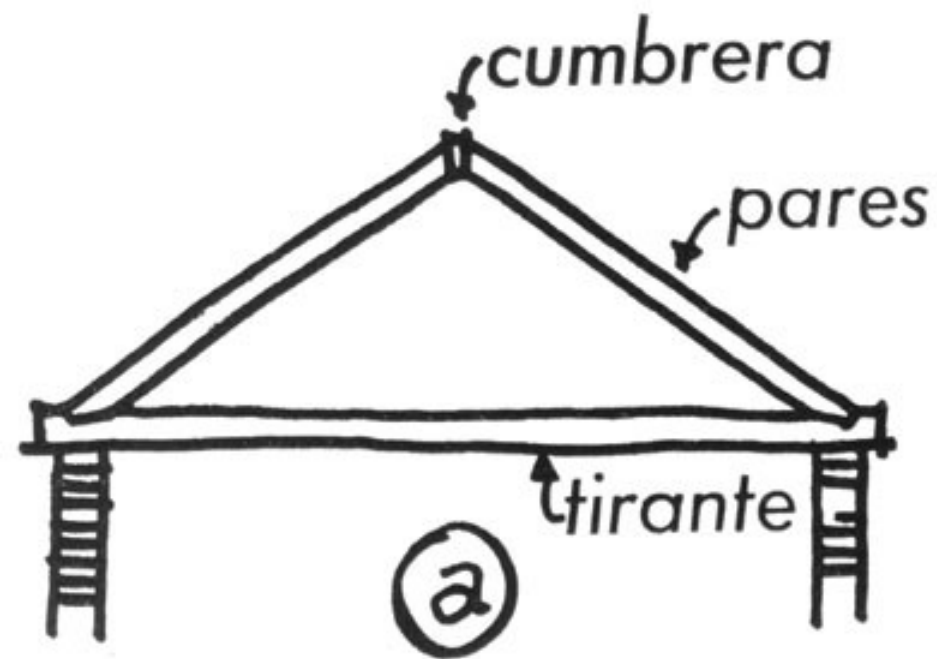




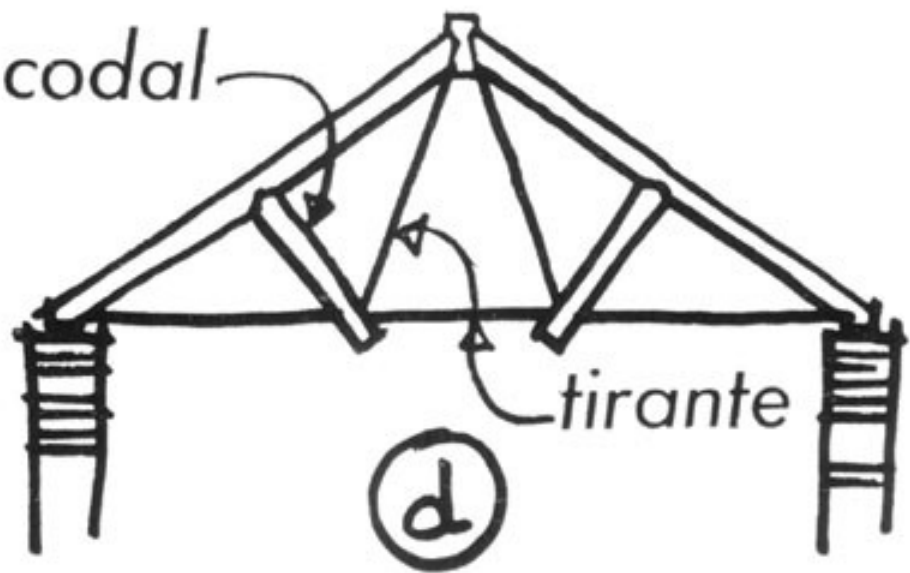
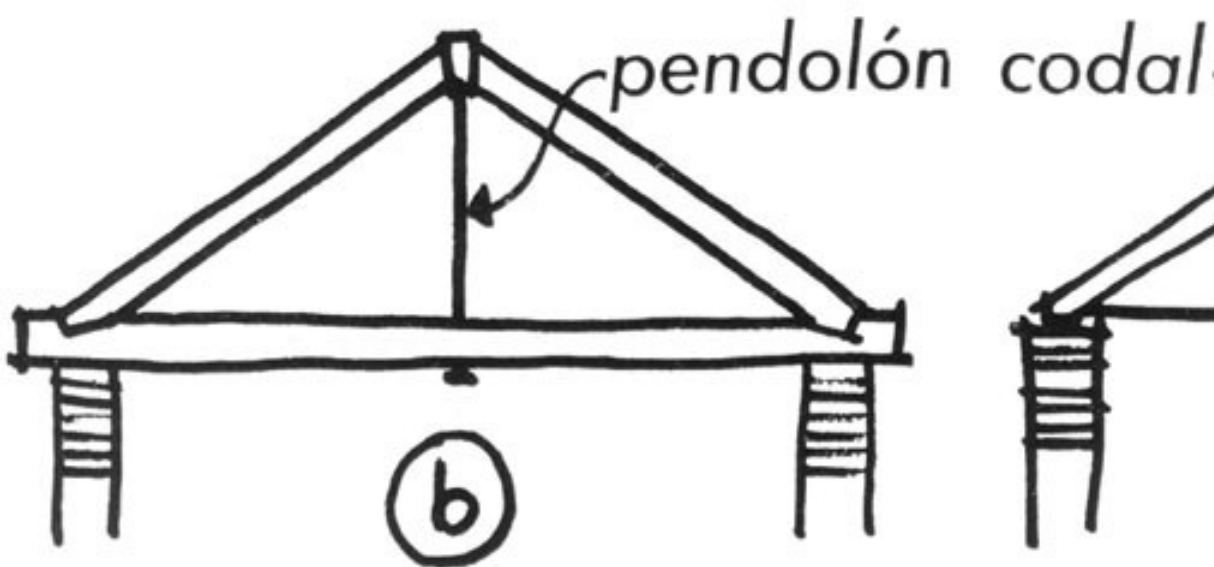
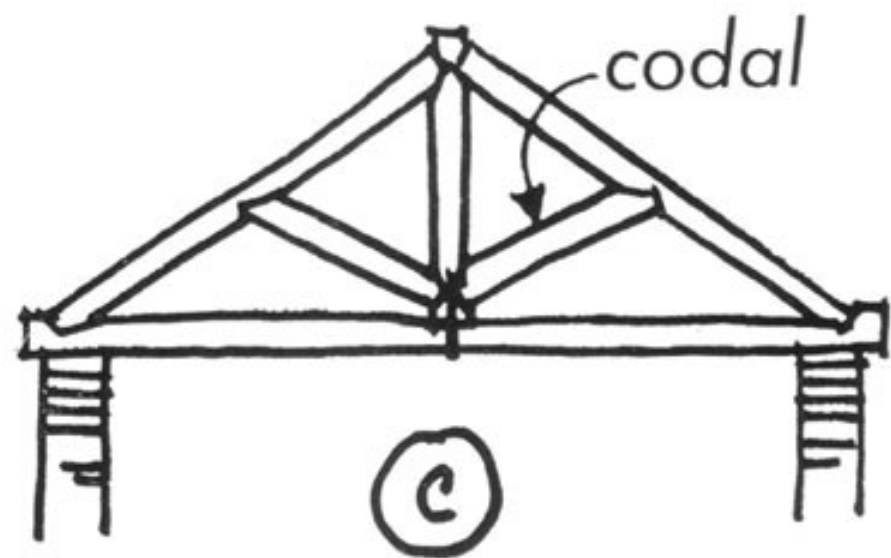
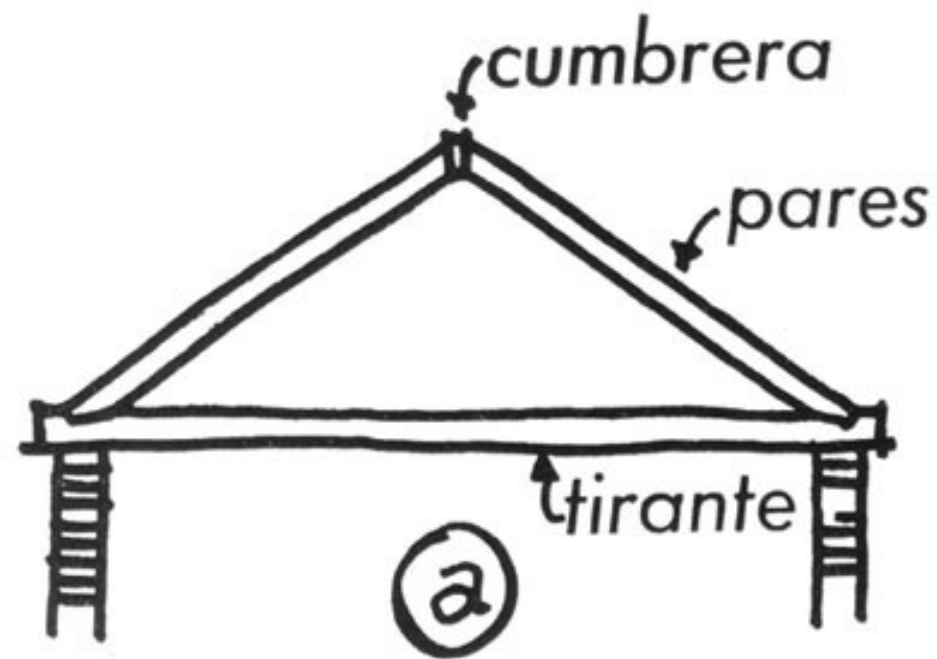












# MÉTODOS DE ANÁLISIS DE LOS ESFUERZOS INTERNOS

MÉTODOS NODALES

MÉTODO DE LOS NUDOS

MÉTODO DE CREMONA

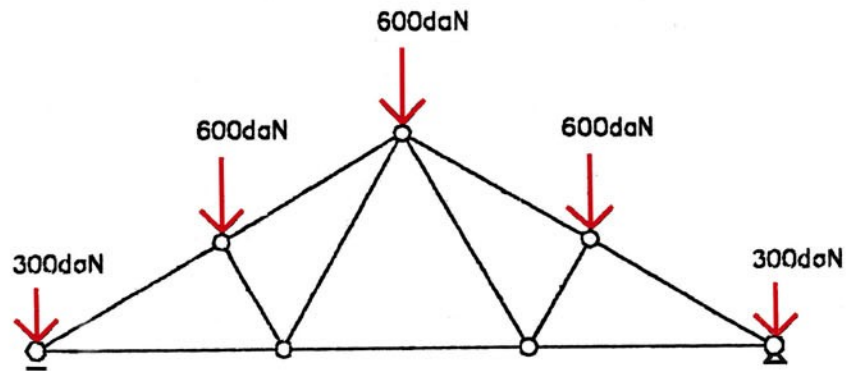
MÉTODOS DE LAS SECCIONES

MÉTODO DE CULMANN

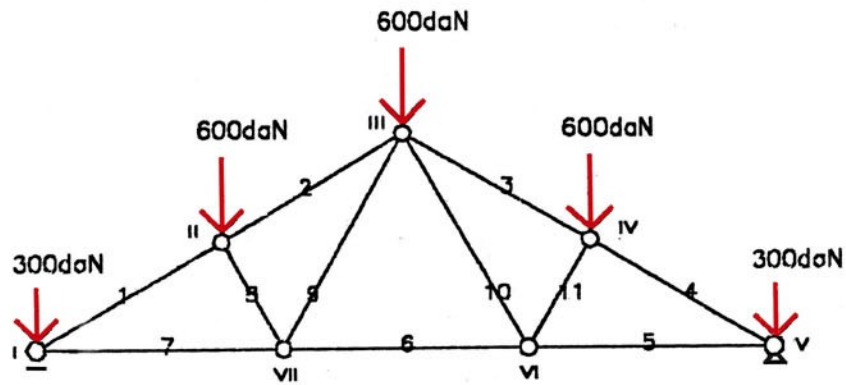
MÉTODO DE RITTER

# **MÉTODO DE LOS NUDOS**

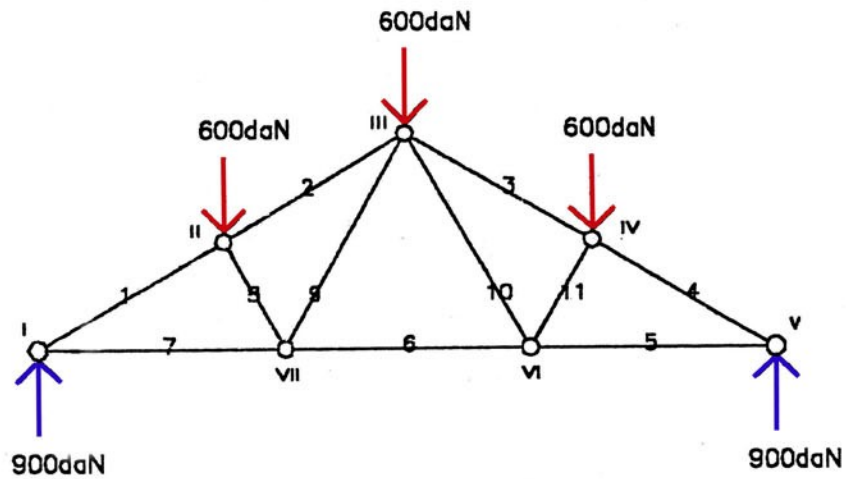




## MÉTODO DE LOS NUDOS

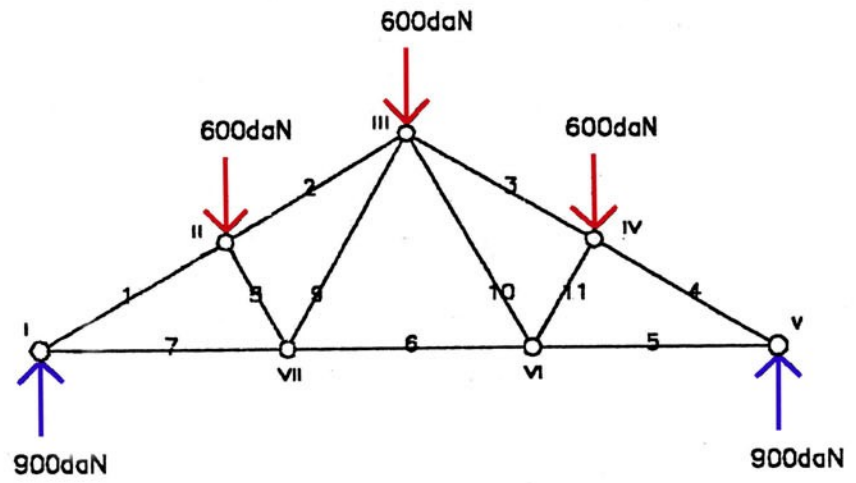
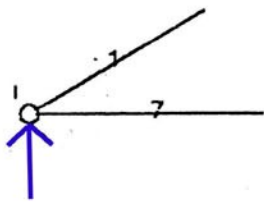


## MÉTODO DE LOS NUDOS

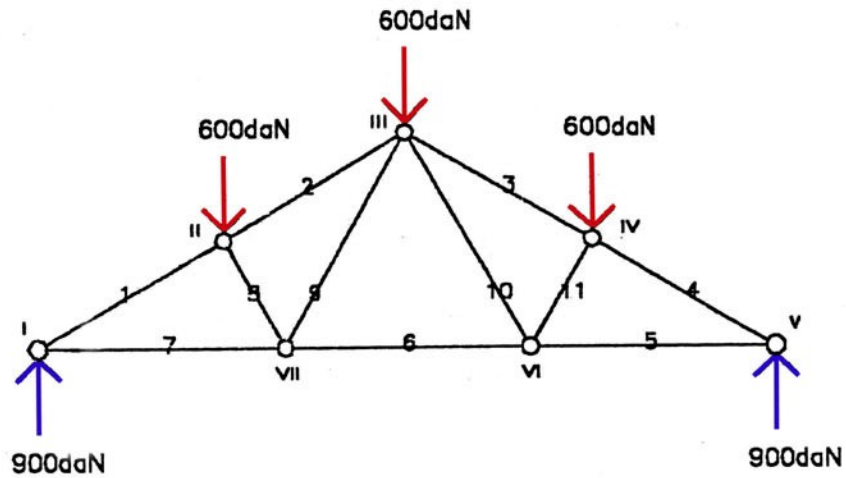
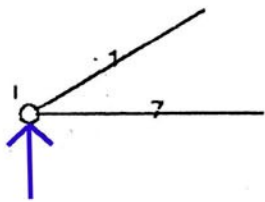


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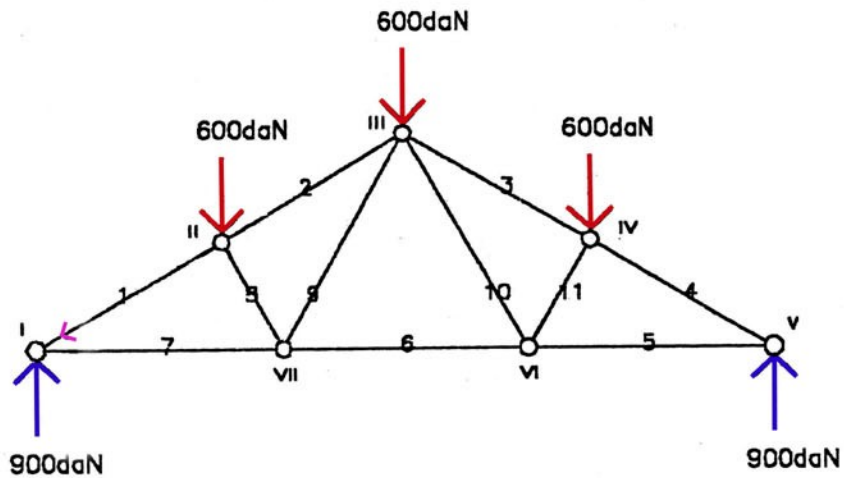
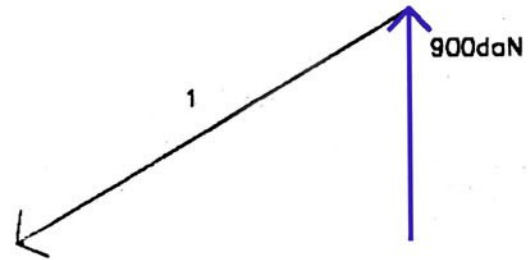
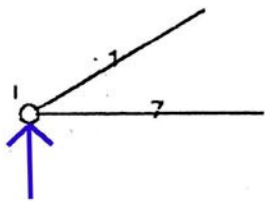




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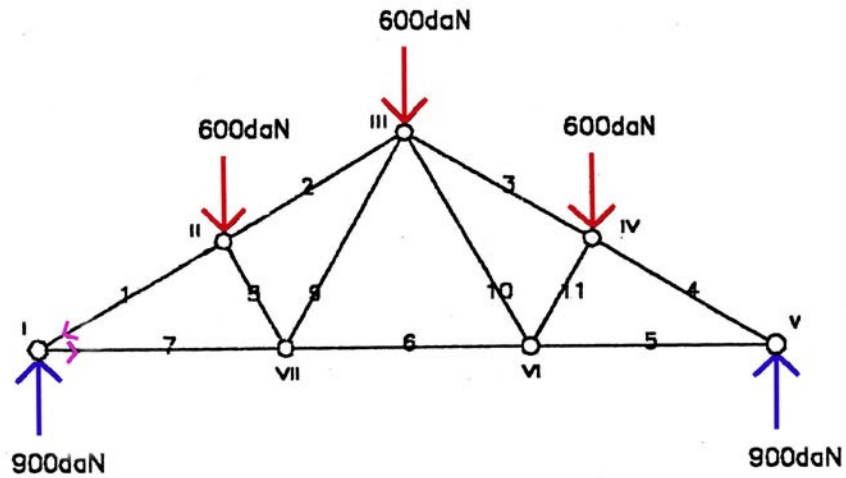
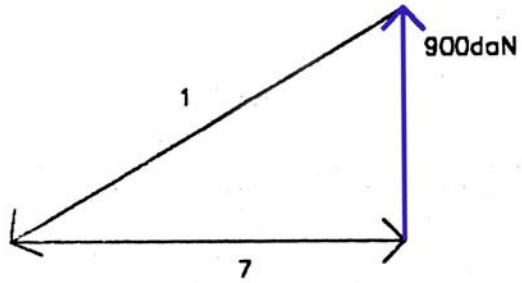
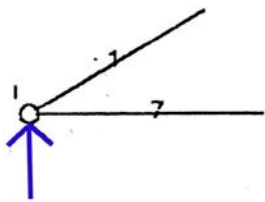


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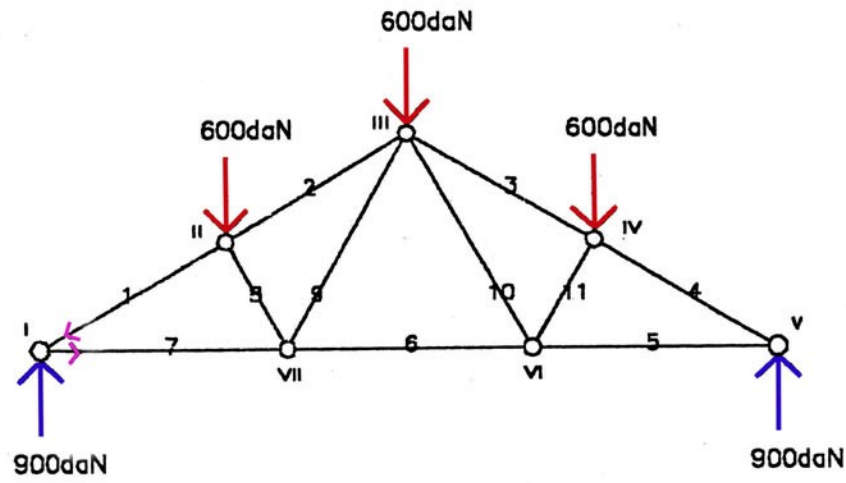
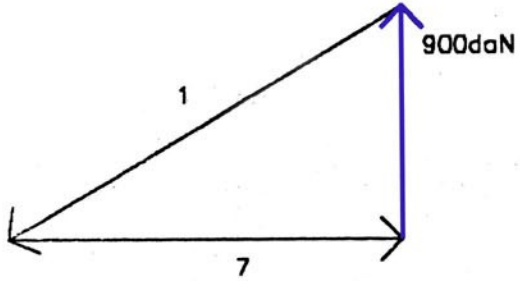
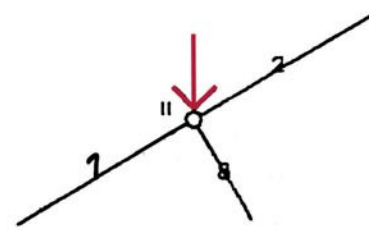
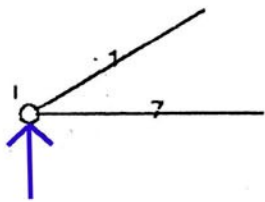


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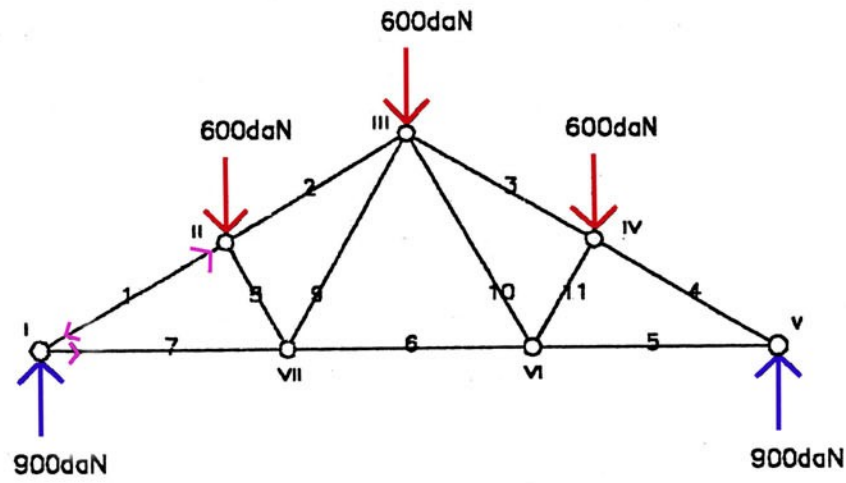
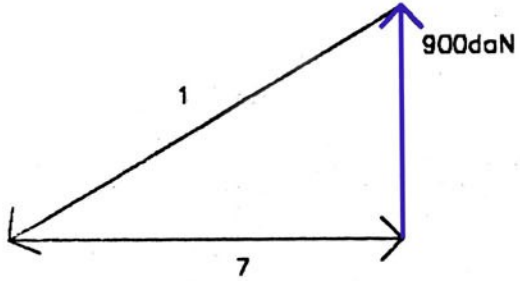
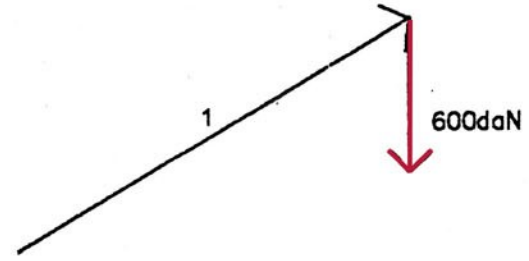
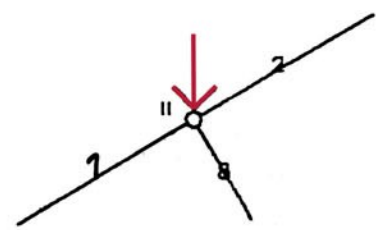
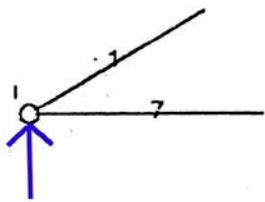




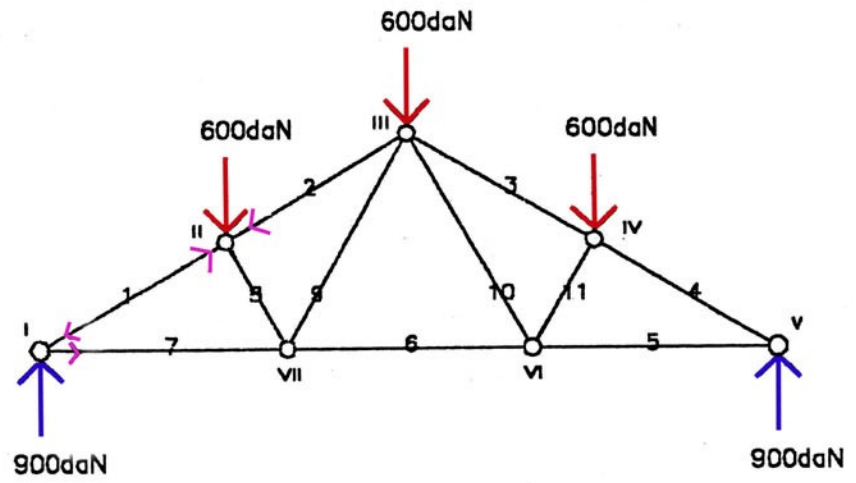
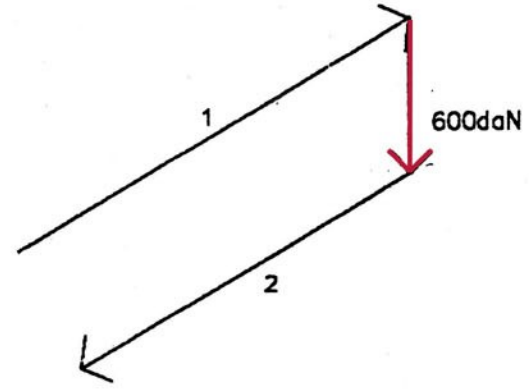
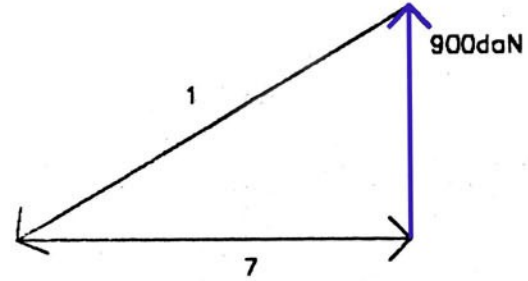
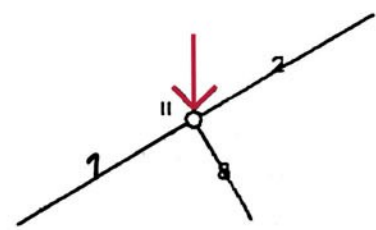
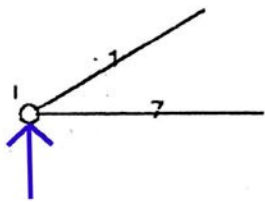
# MÉTODO DE LOS NUDOS



# MÉTODO DE LOS NUDOS

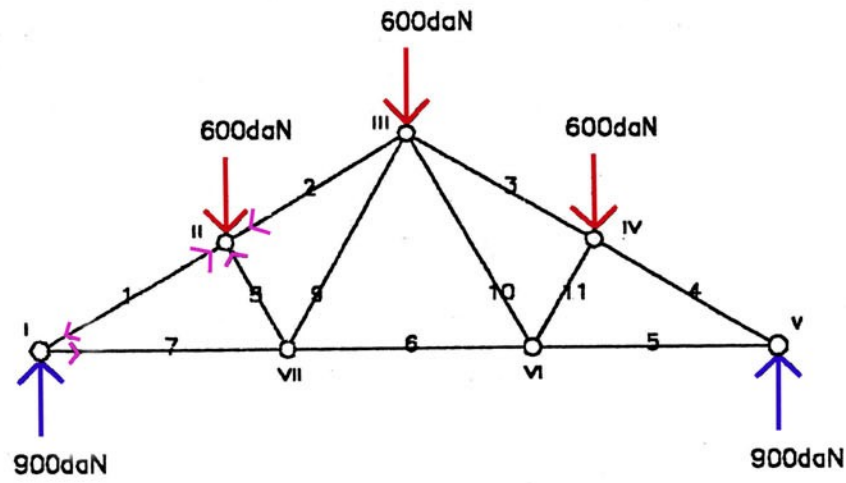
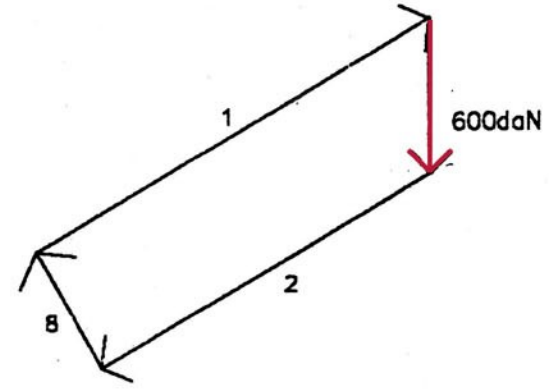
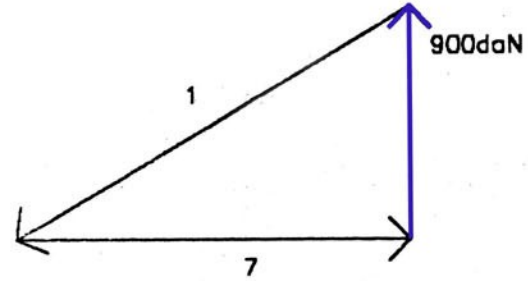
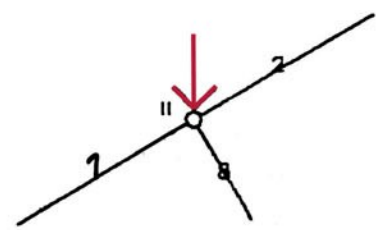
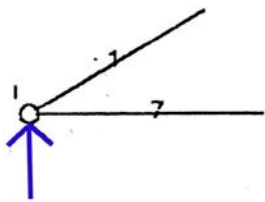


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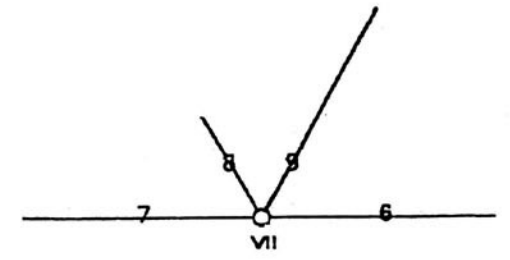
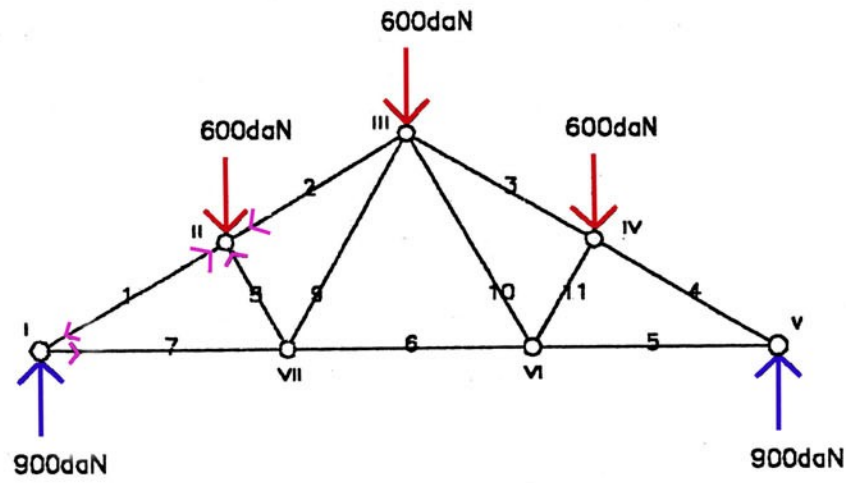
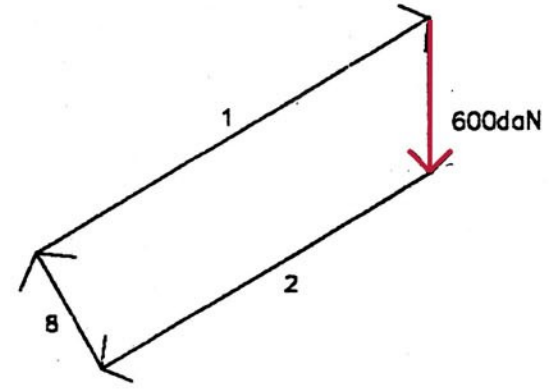
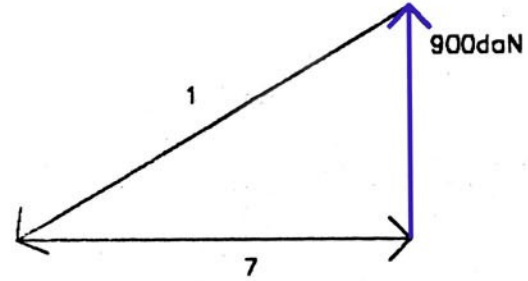
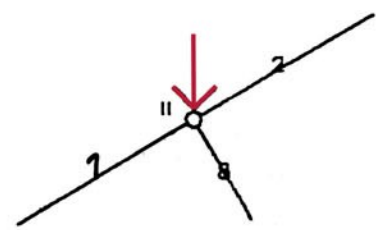
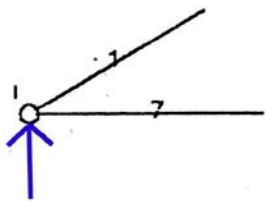


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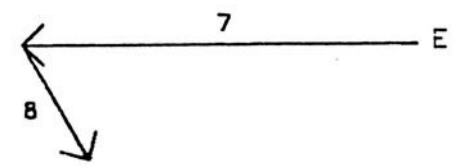
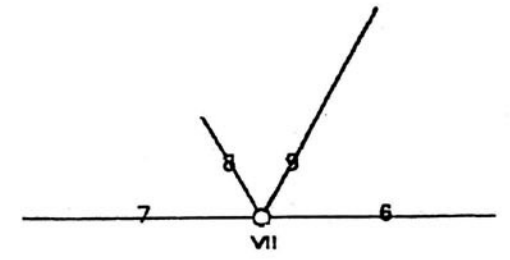
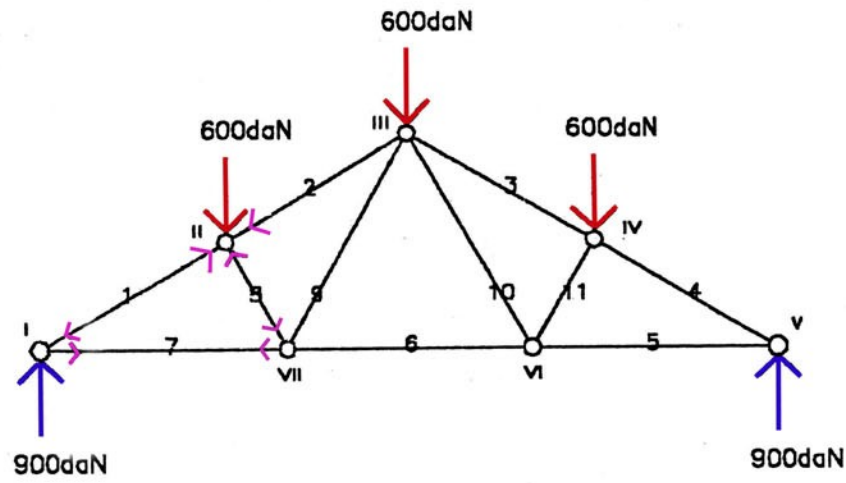
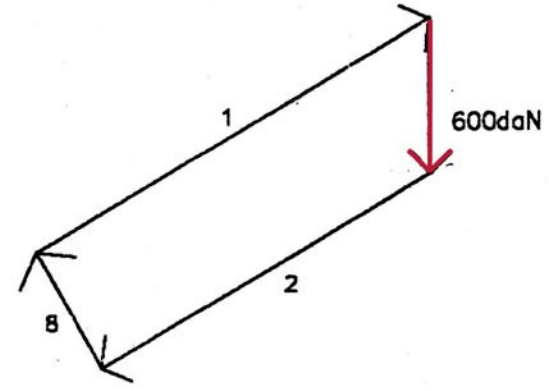
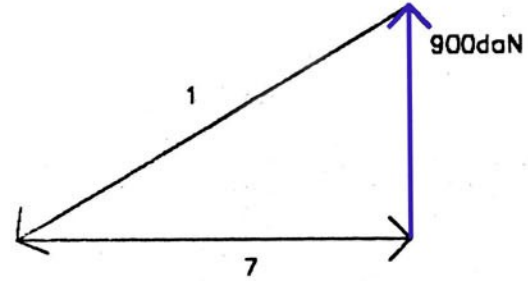
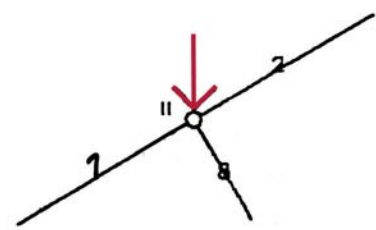
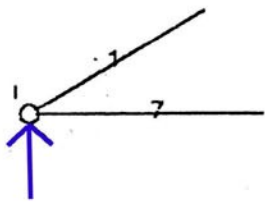




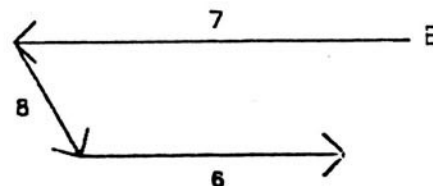
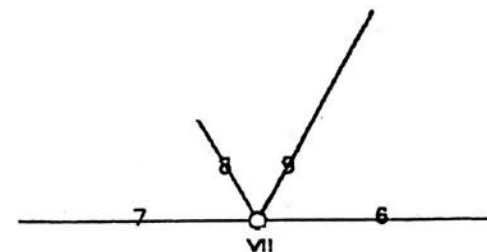
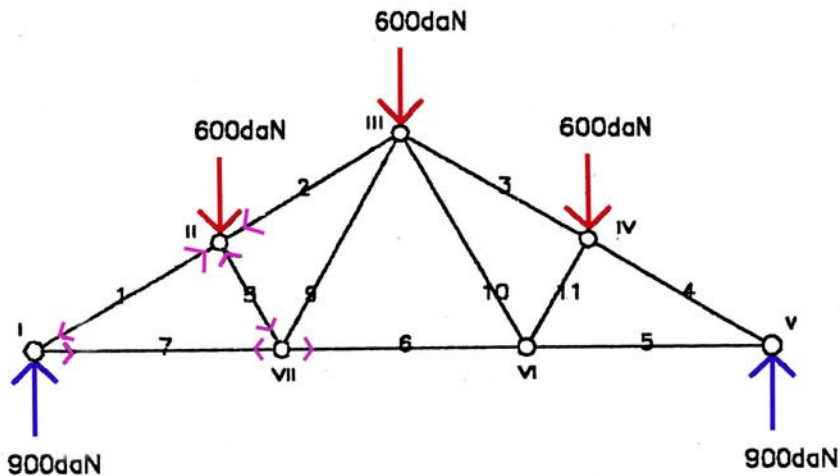
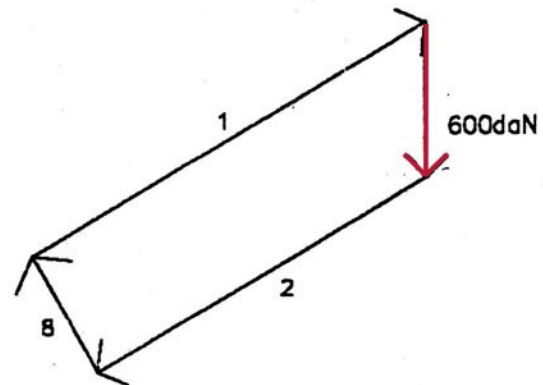
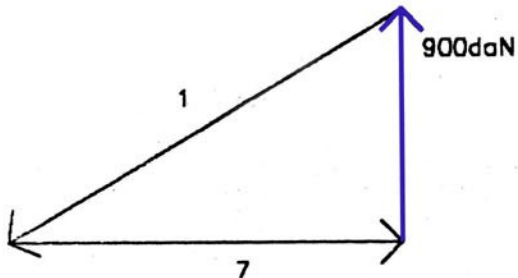
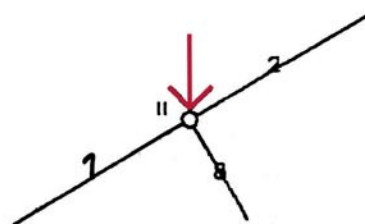
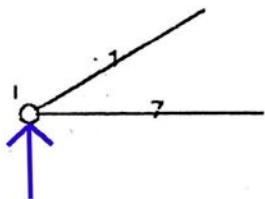
# MÉTODO DE LOS NUDOS



# MÉTODO DE LOS NUDOS

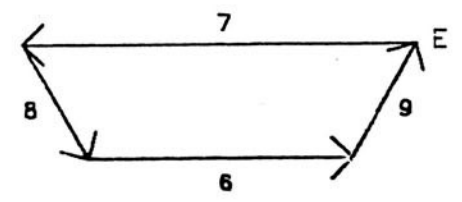
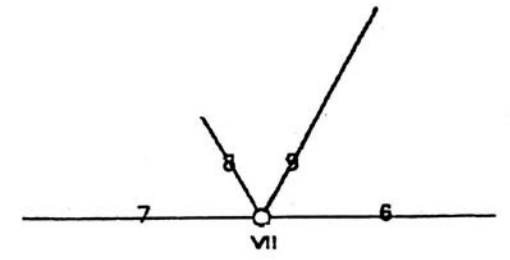
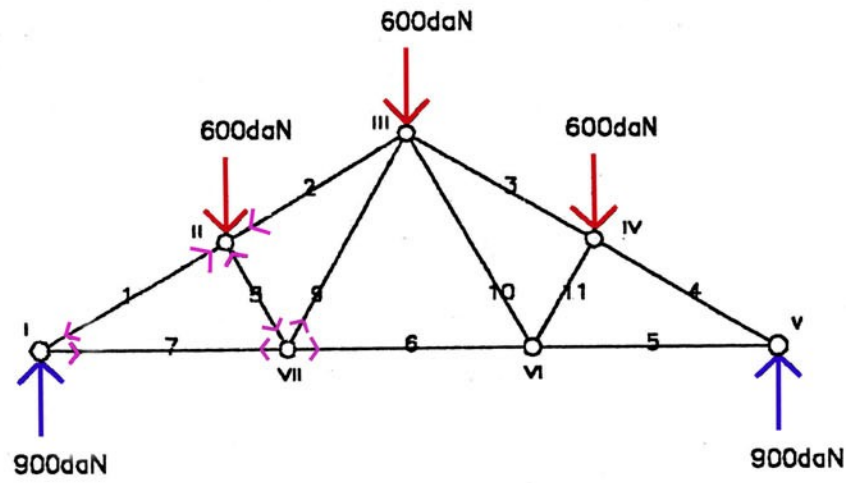
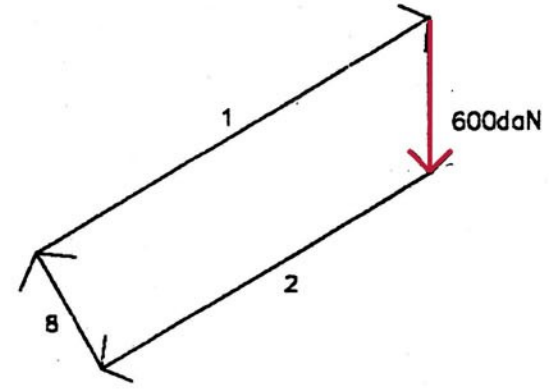
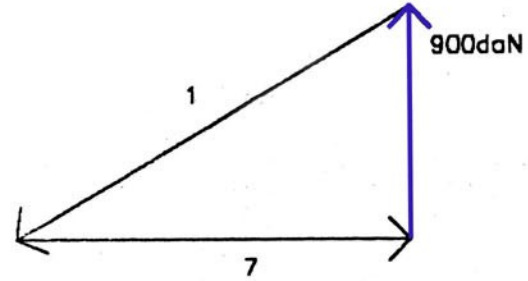
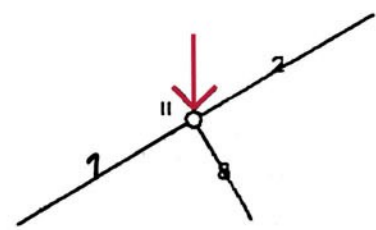
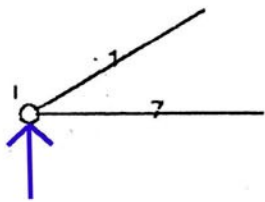


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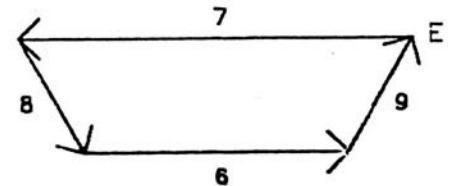
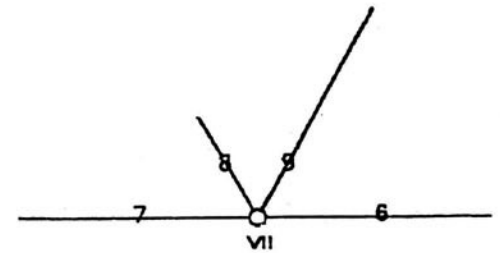
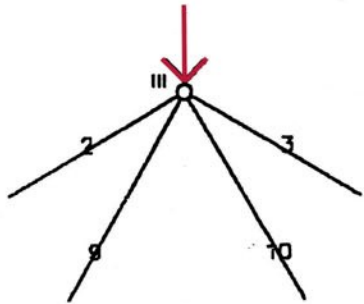
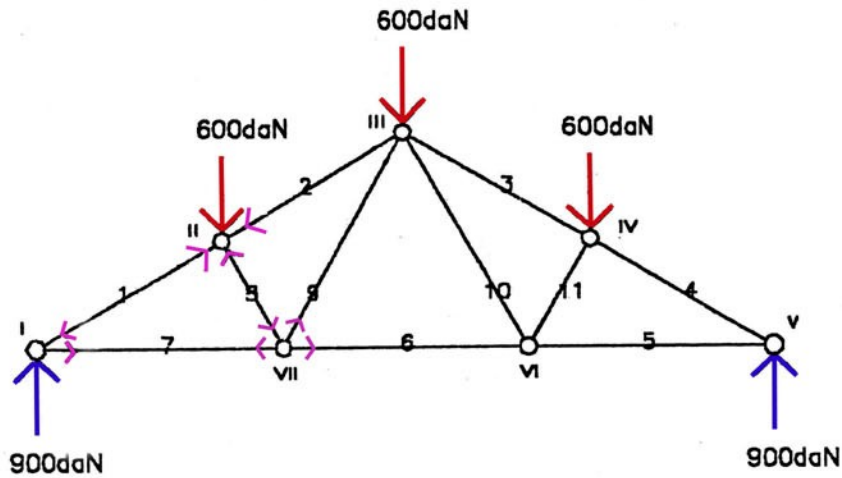
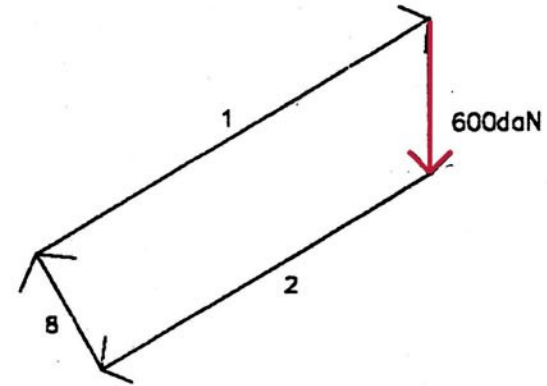
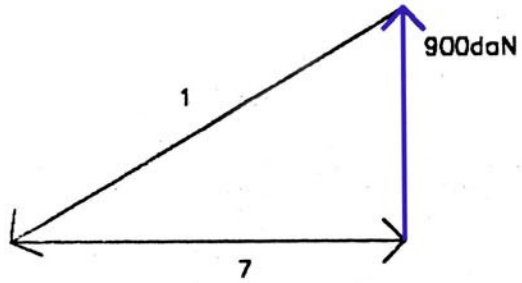
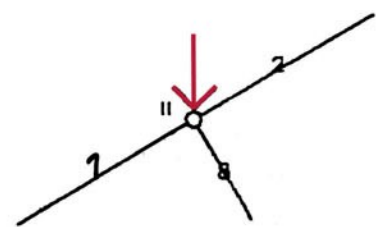
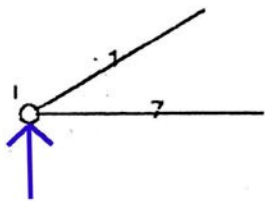


# MÉTODO DE LOS NUDOS

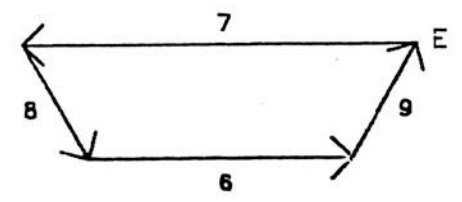
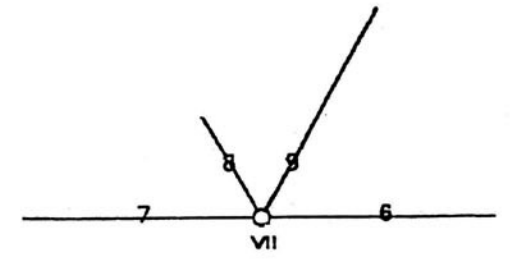
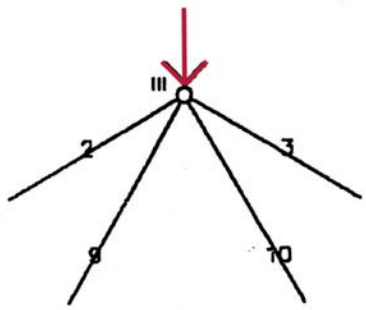
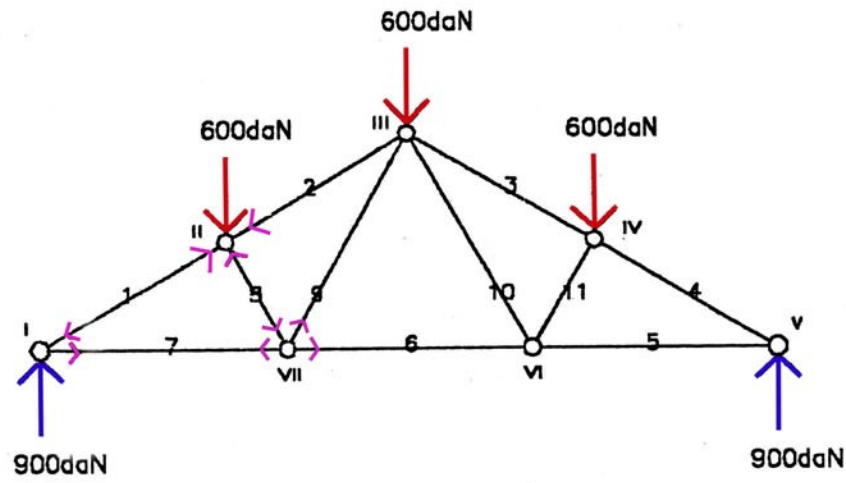
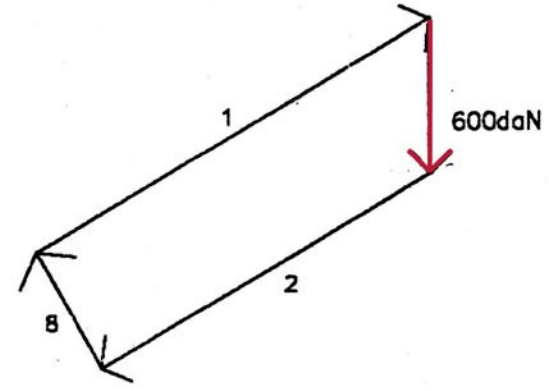
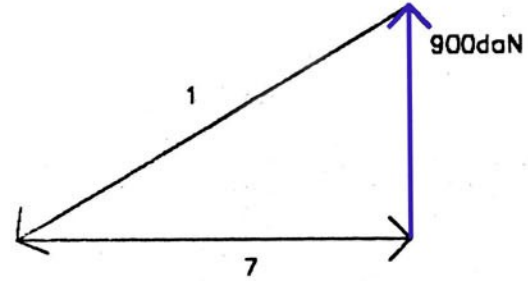
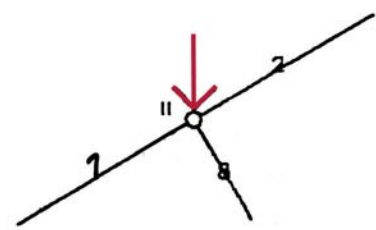
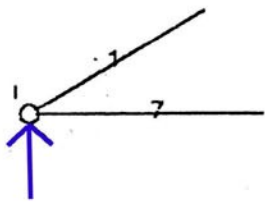




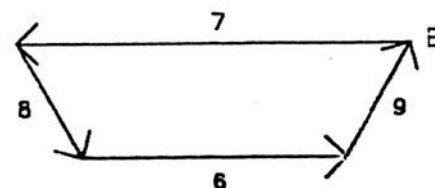
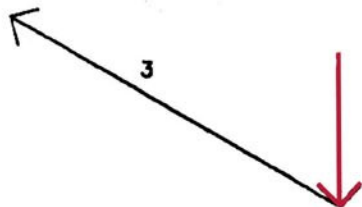
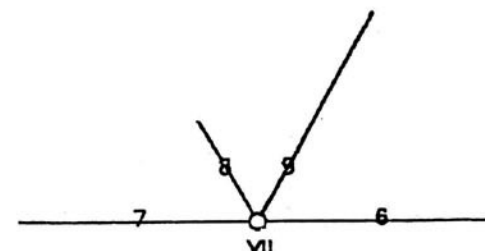
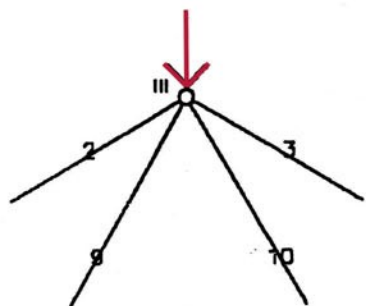
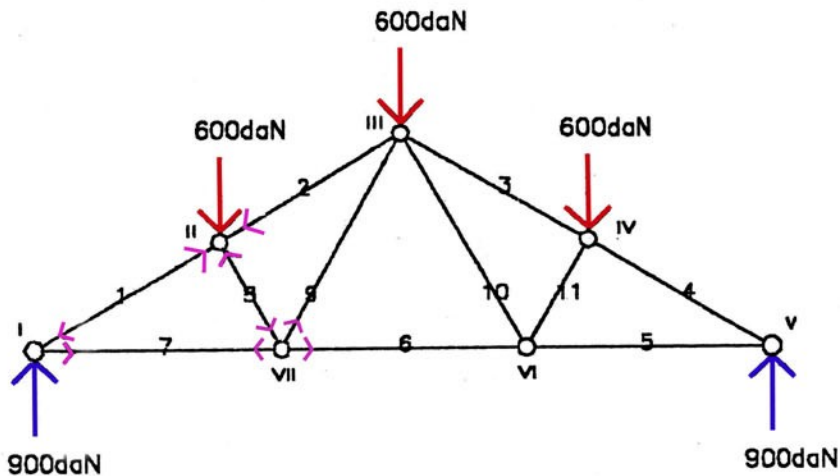
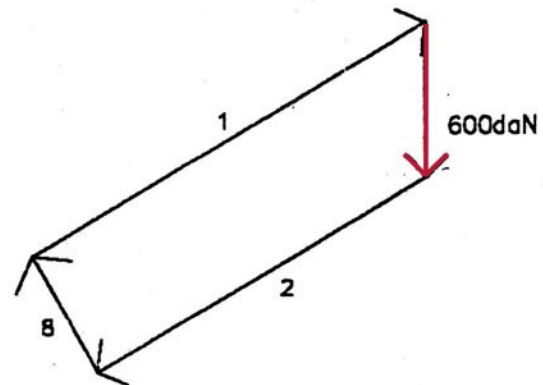
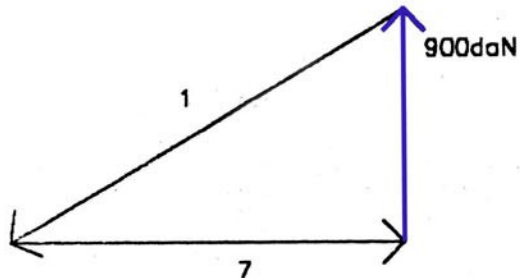
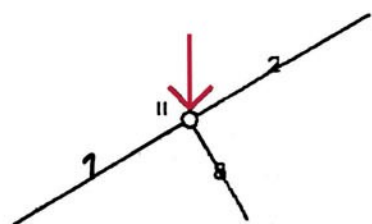
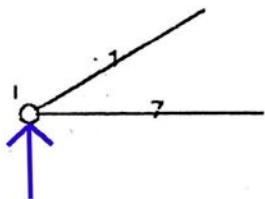
# MÉTODO DE LOS NUDOS



# MÉTODO DE LOS NUDOS

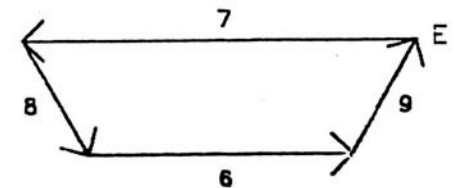
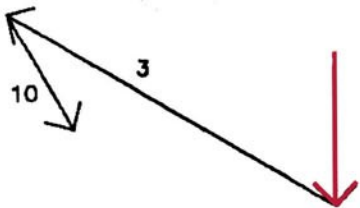
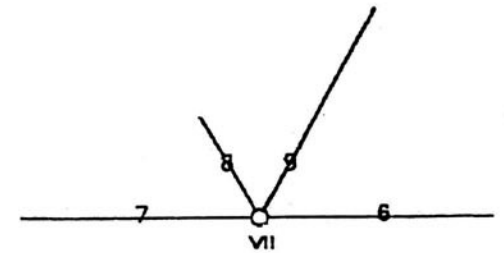
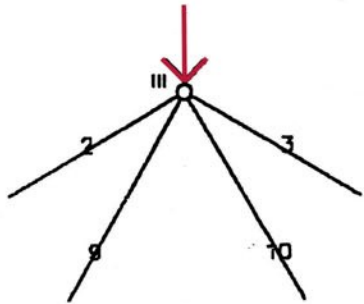
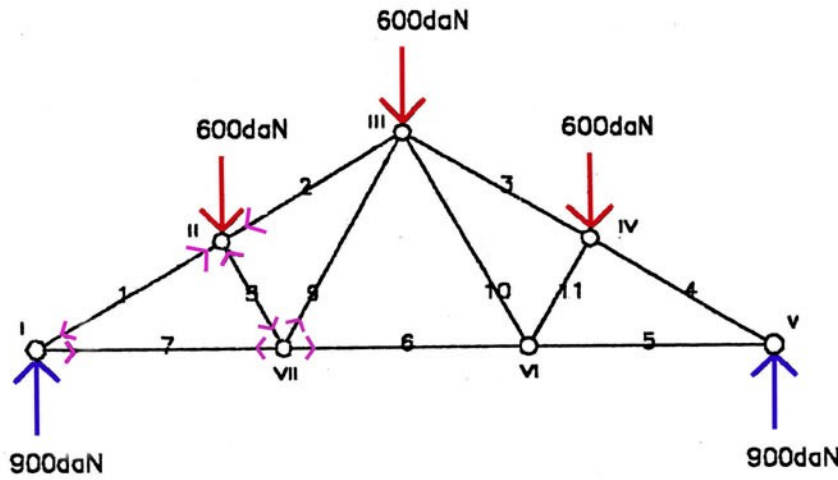
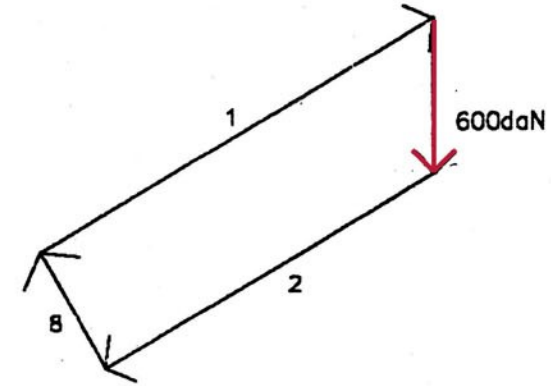
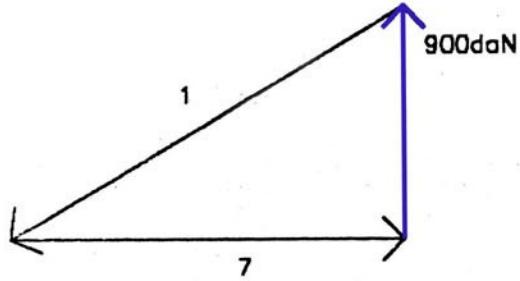
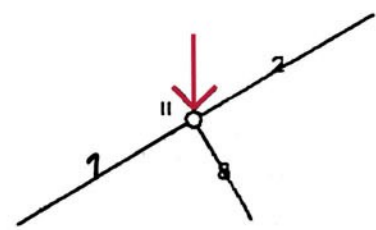
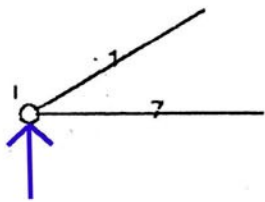


# MÉTODO DE LOS NUDOS

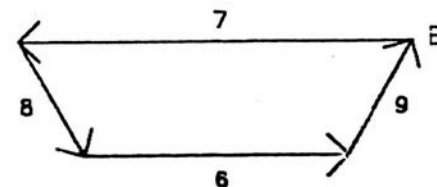
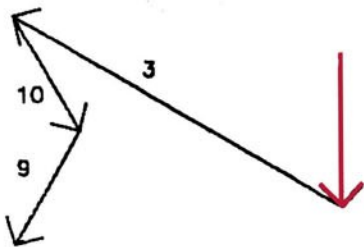
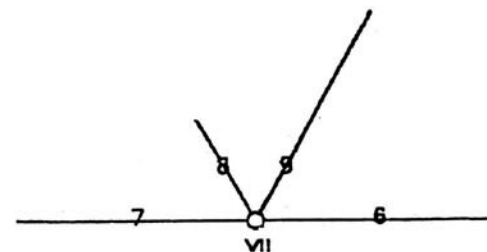
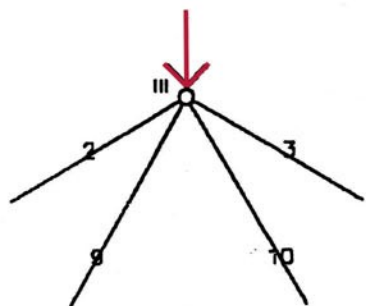
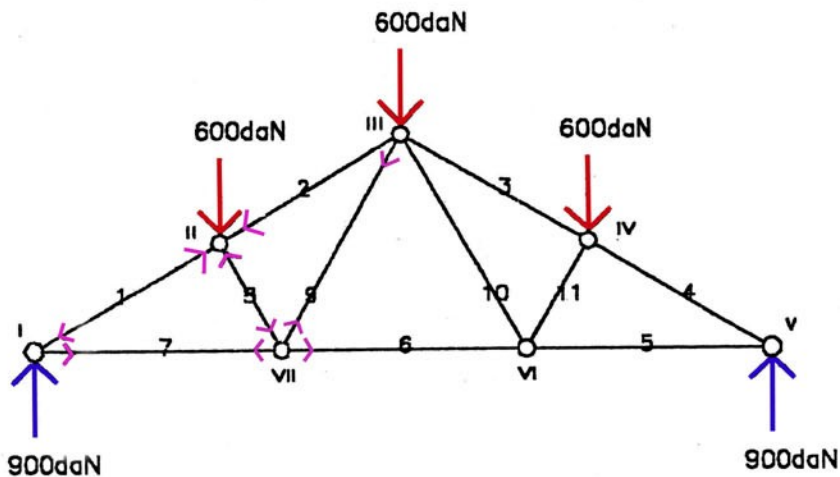
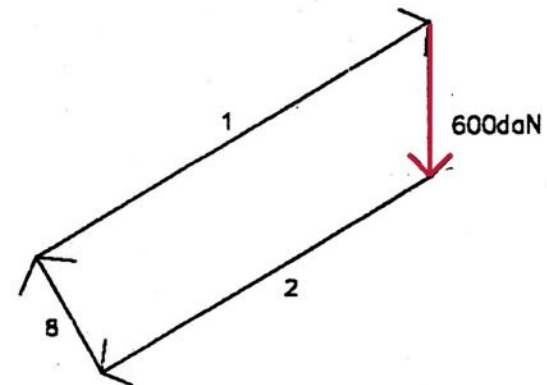
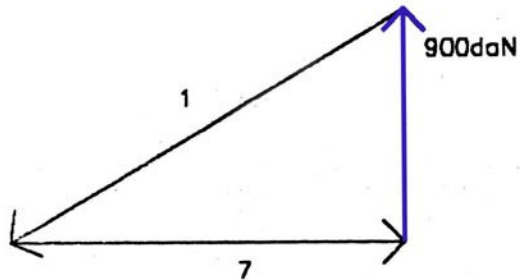
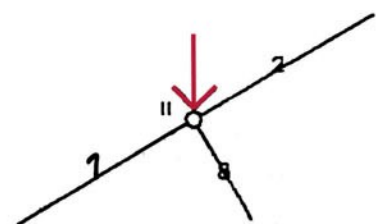
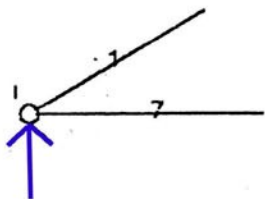


# MÉTODO DE LOS NUDOS

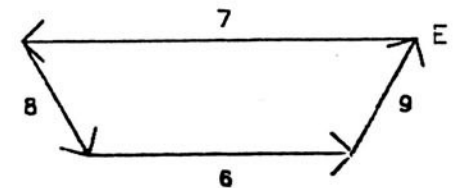
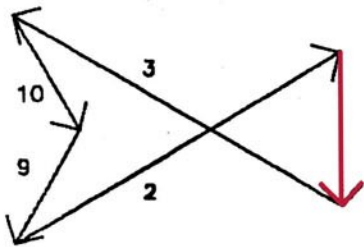
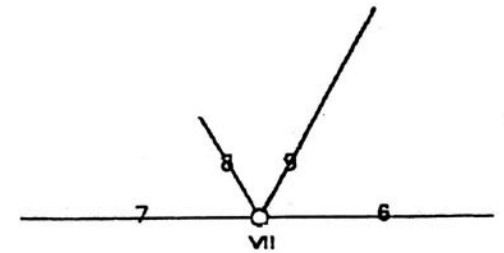
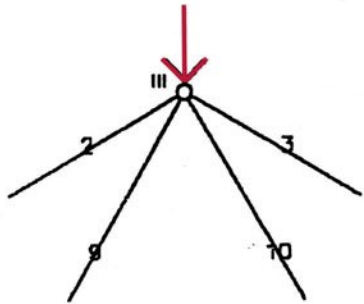
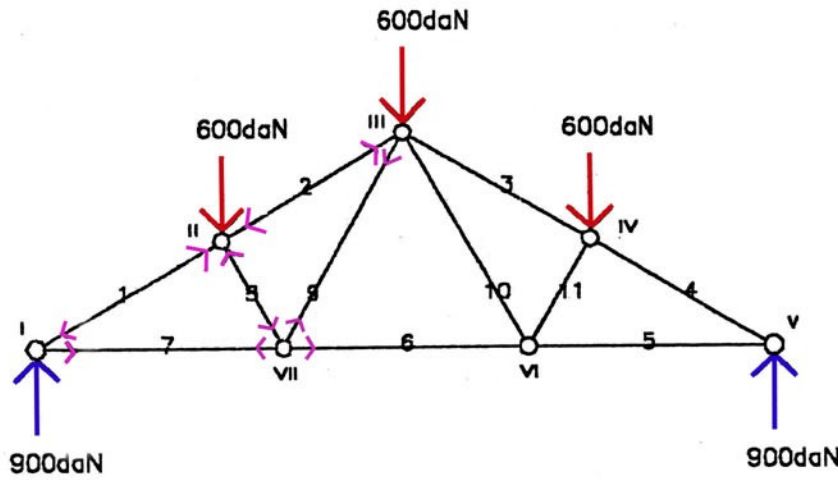
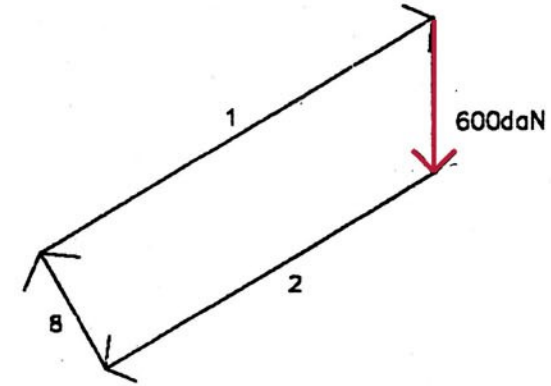
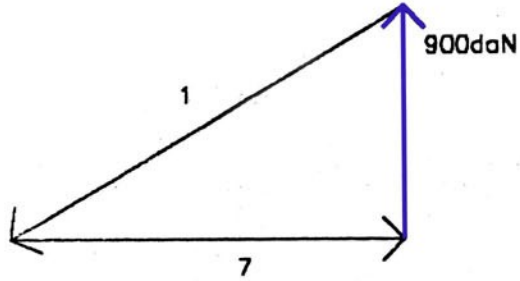
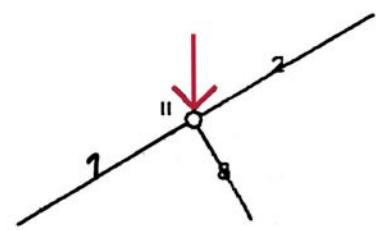
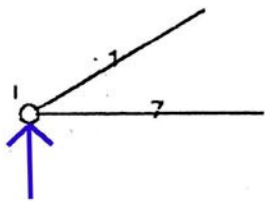




# MÉTODO DE LOS NUDOS



# MÉTODO DE LOS NUDOS

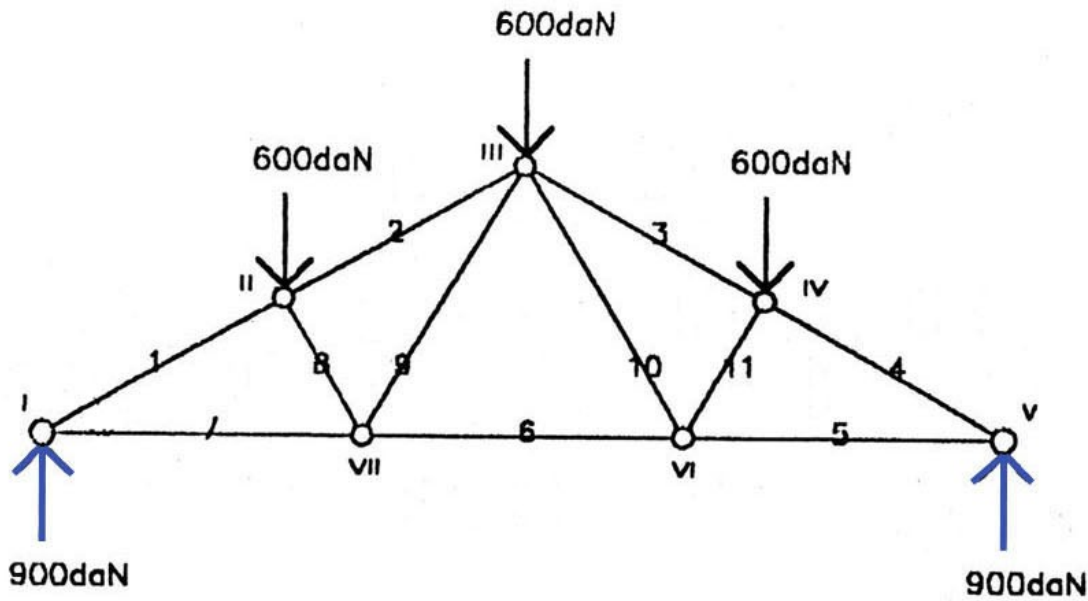


# MÉTODO DE LOS NUDOS

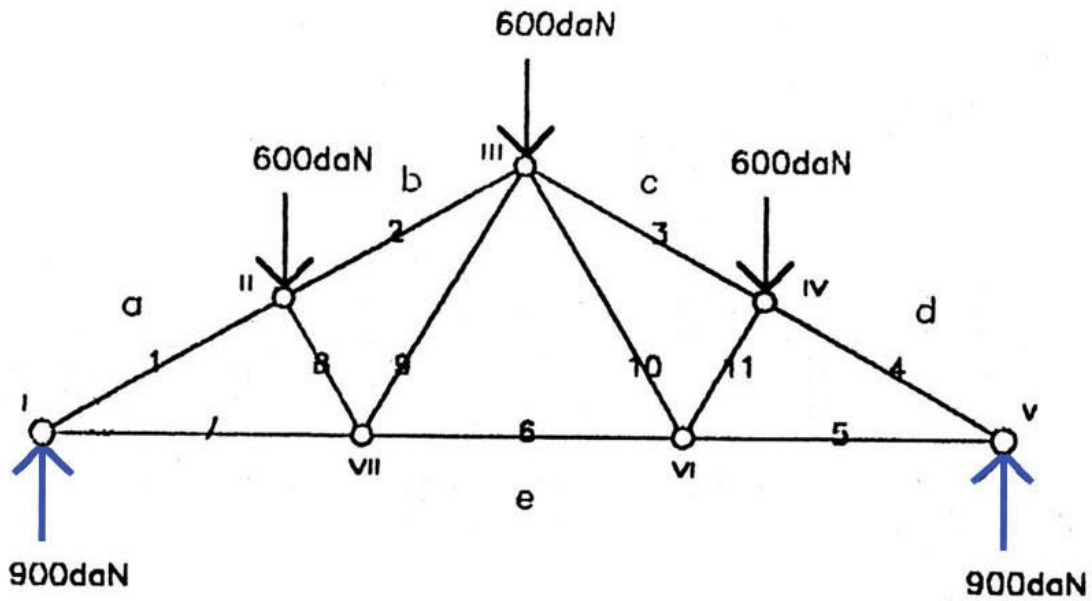
# **MÉTODO DE CREMONA**



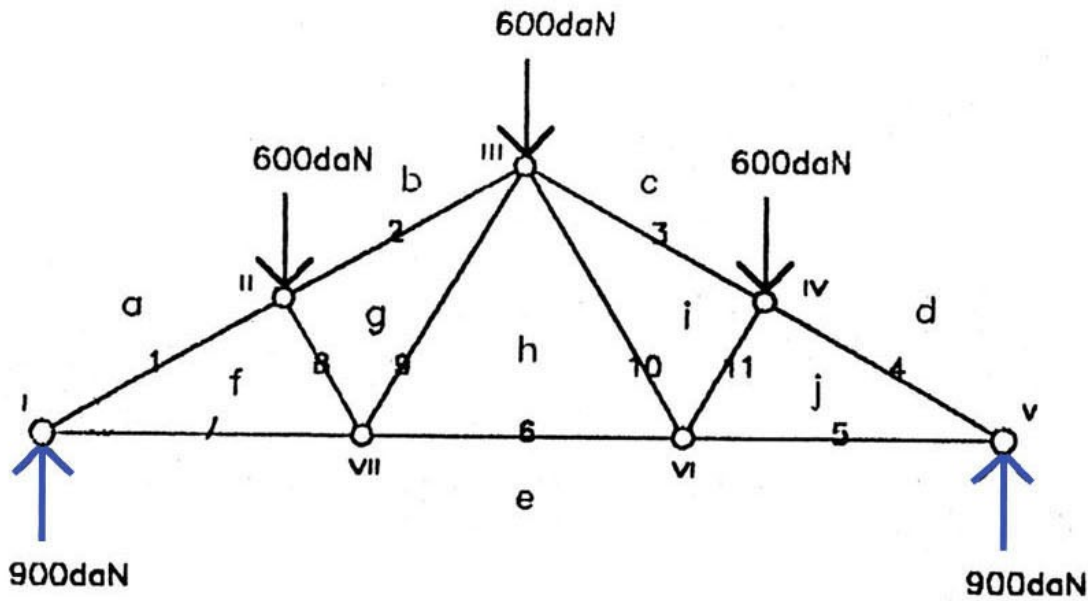
# MÉTODO DE CREMONA



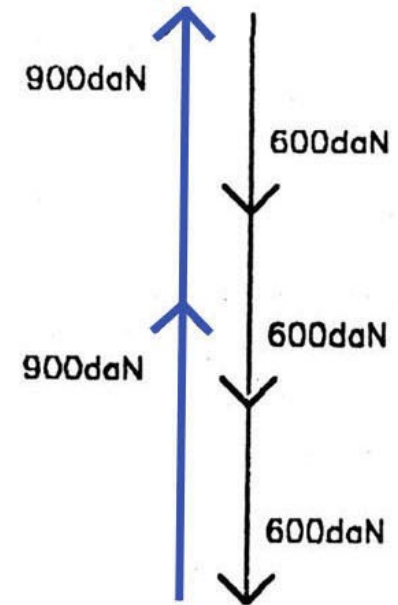
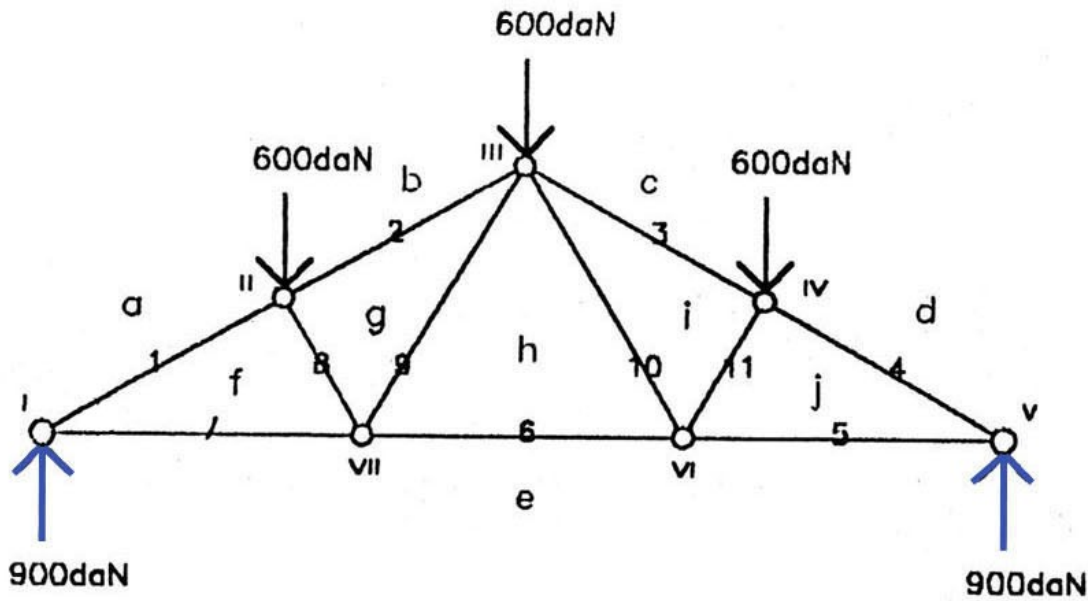
# MÉTODO DE CREMONA



# MÉTODO DE CREMONA

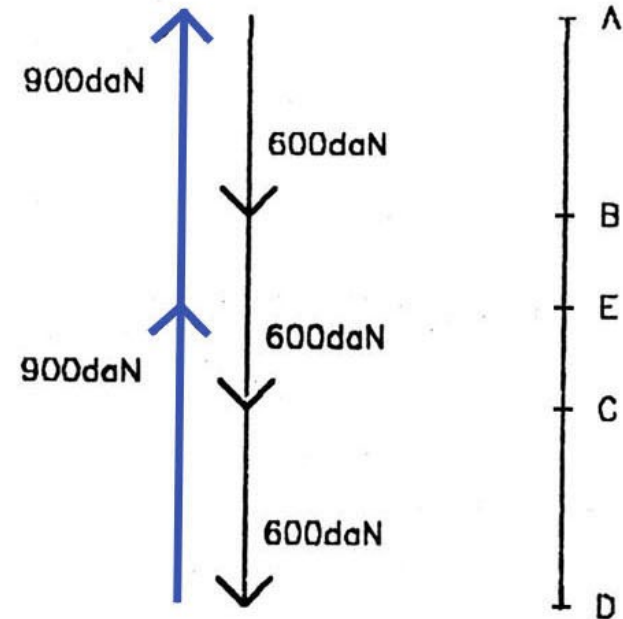
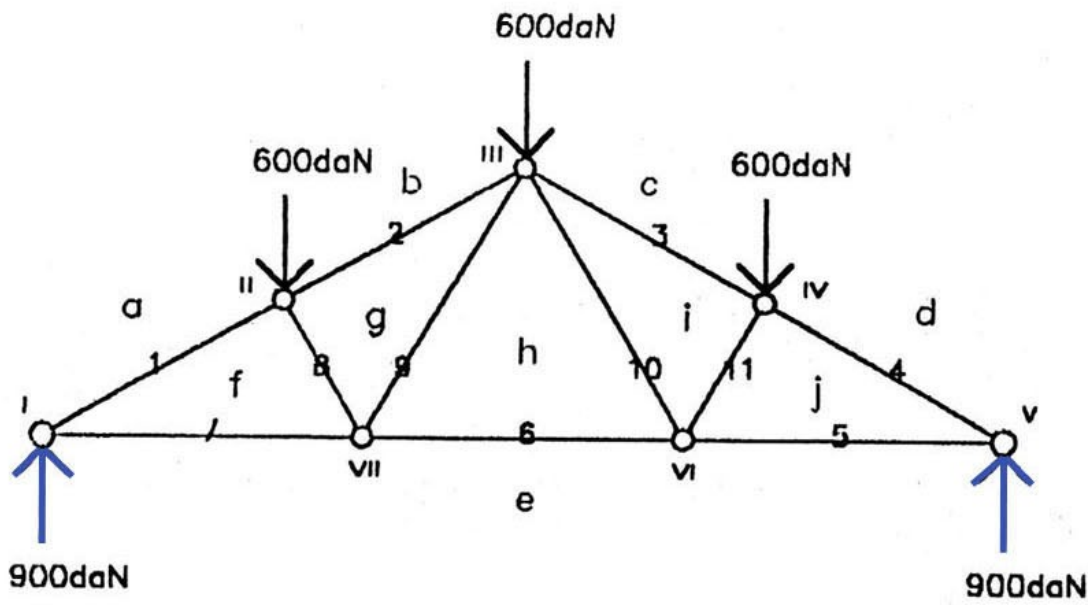


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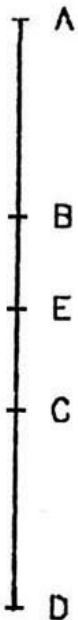
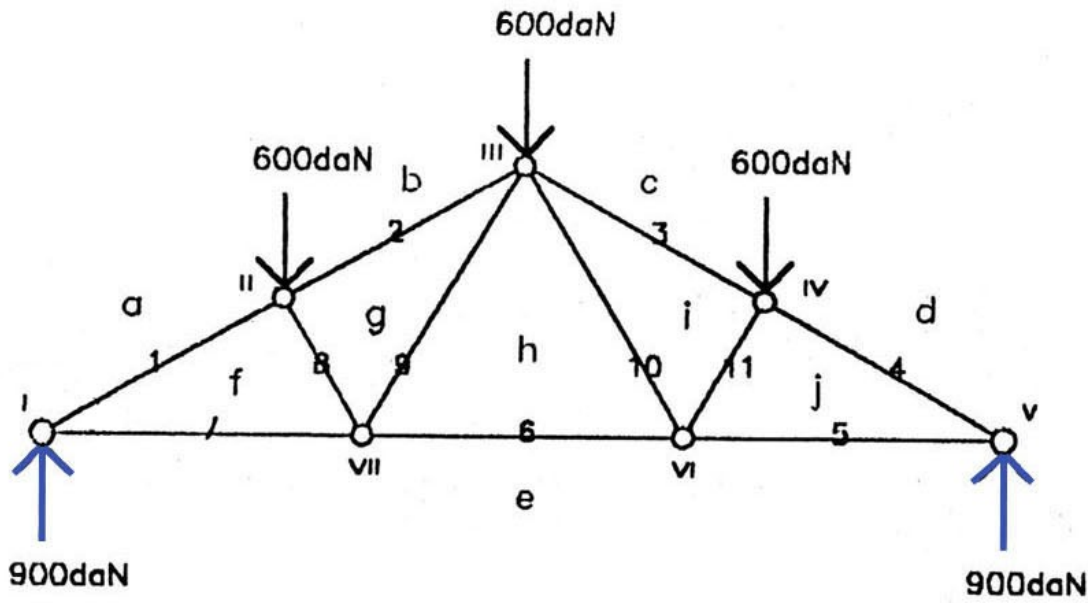




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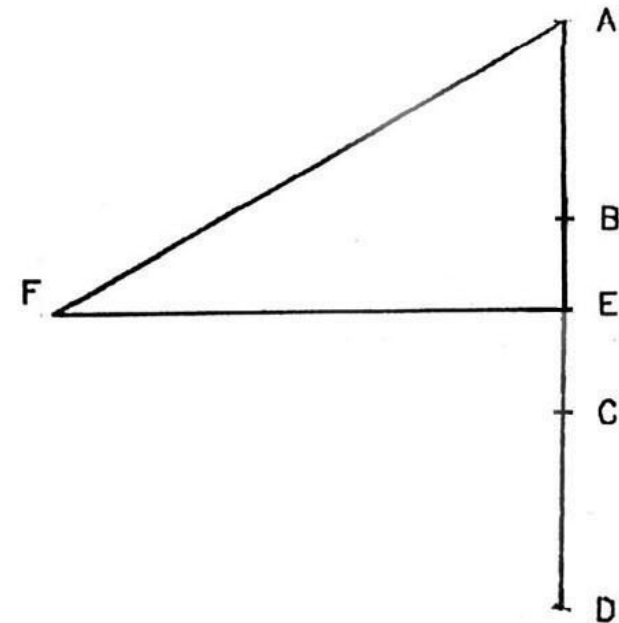
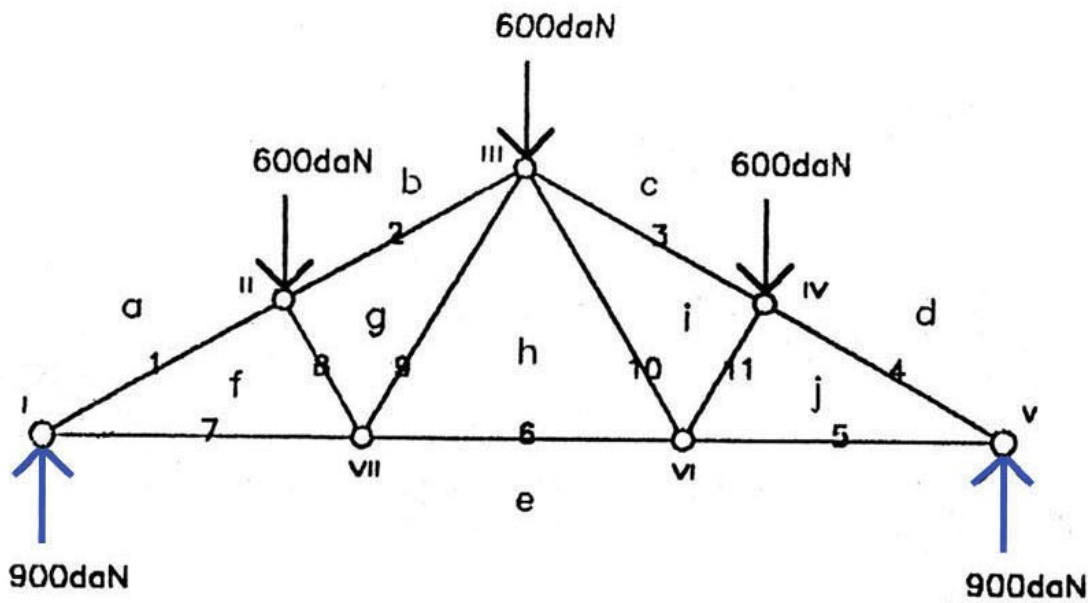
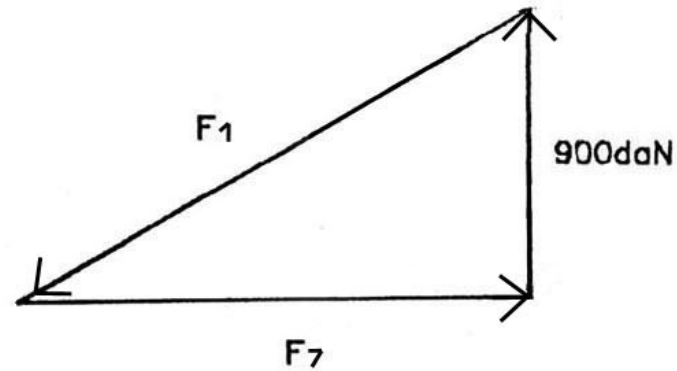


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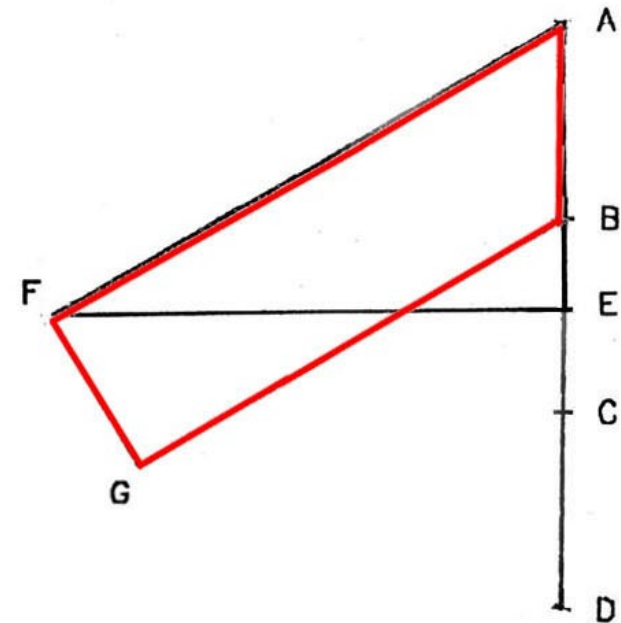
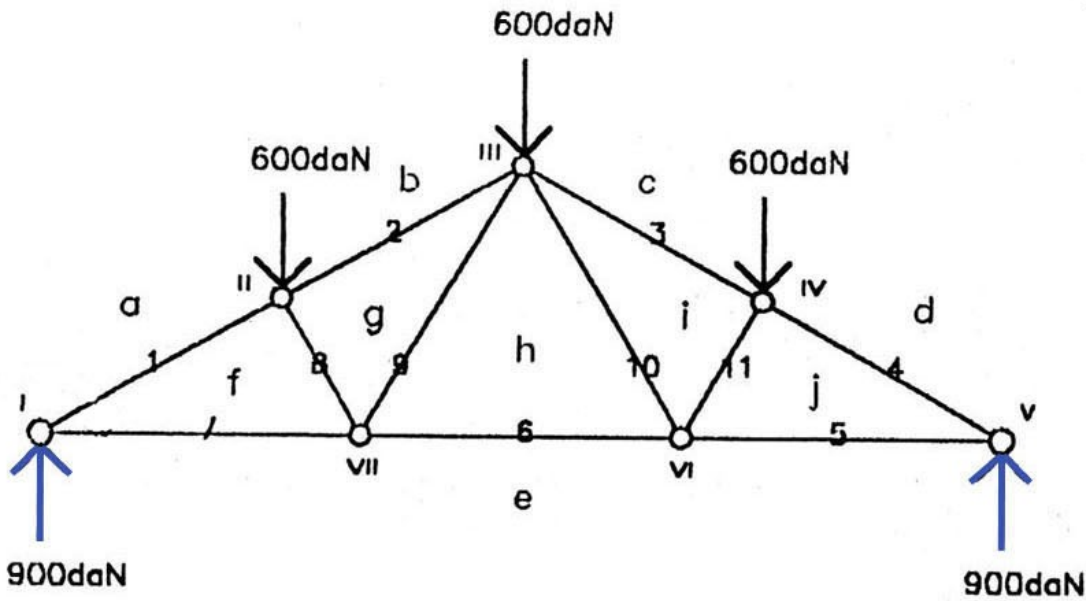
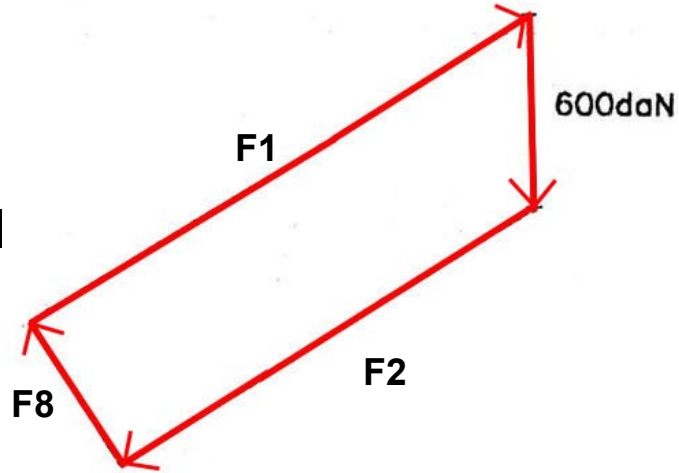
# MÉTODO DE CREMONA

NUDO I



# MÉTODO DE CREMONA

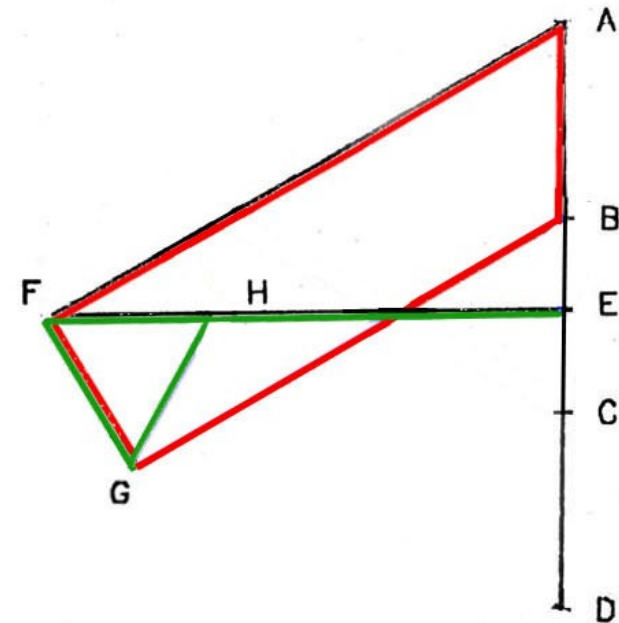
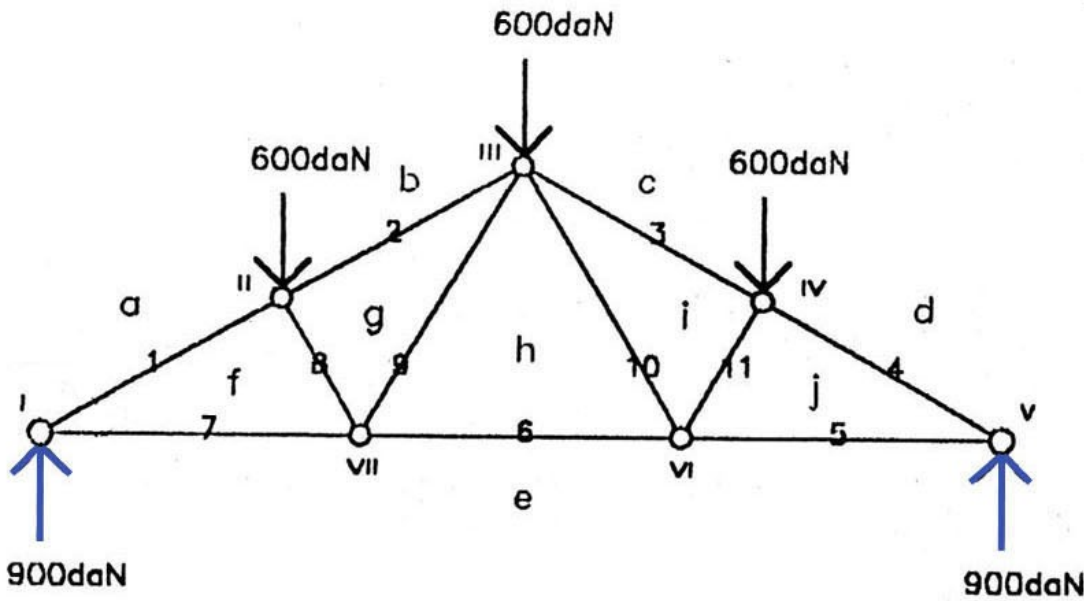
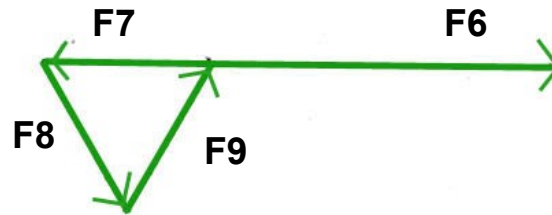
NUDO II





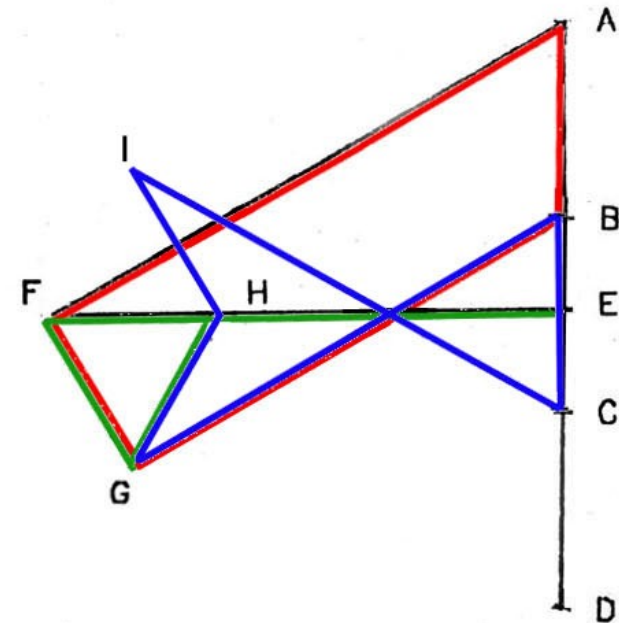
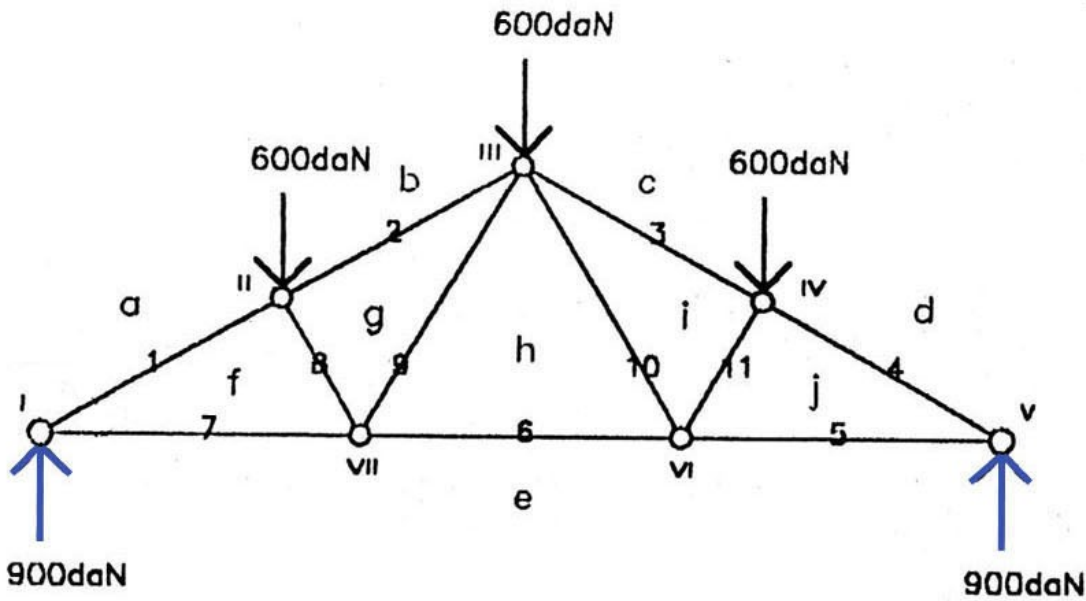
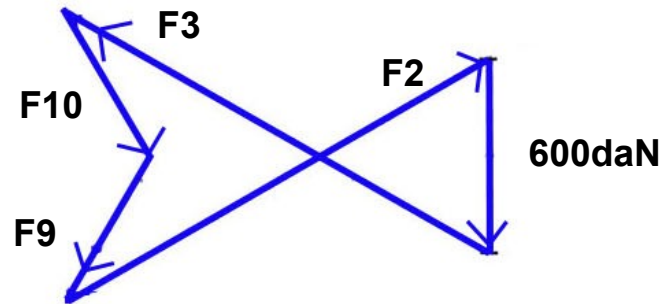
# MÉTODO DE CREMONA

NUDO VII



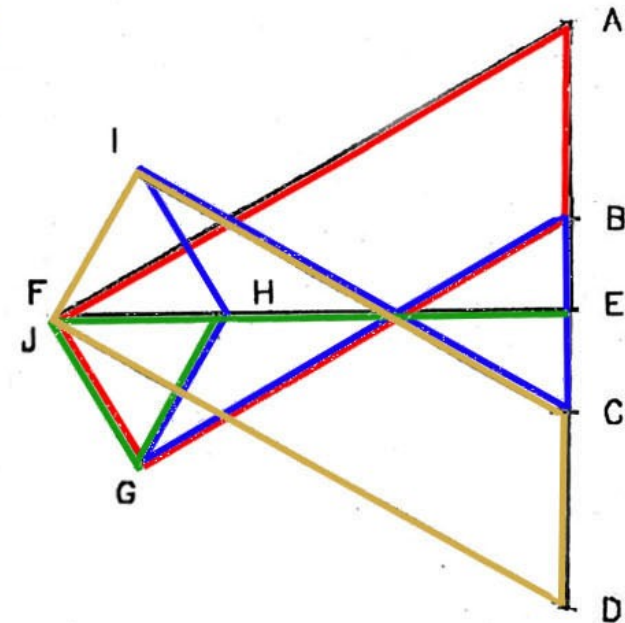
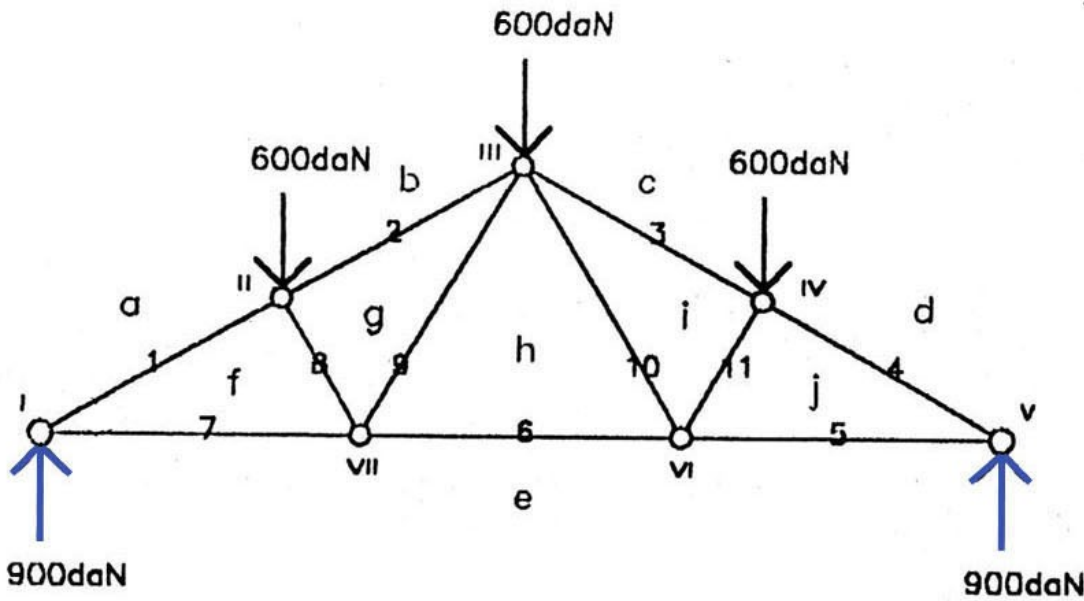
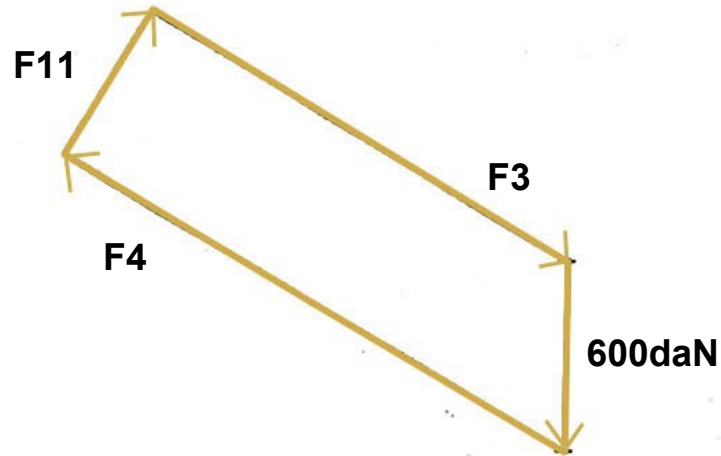
# MÉTODO DE CREMONA

NUDO III



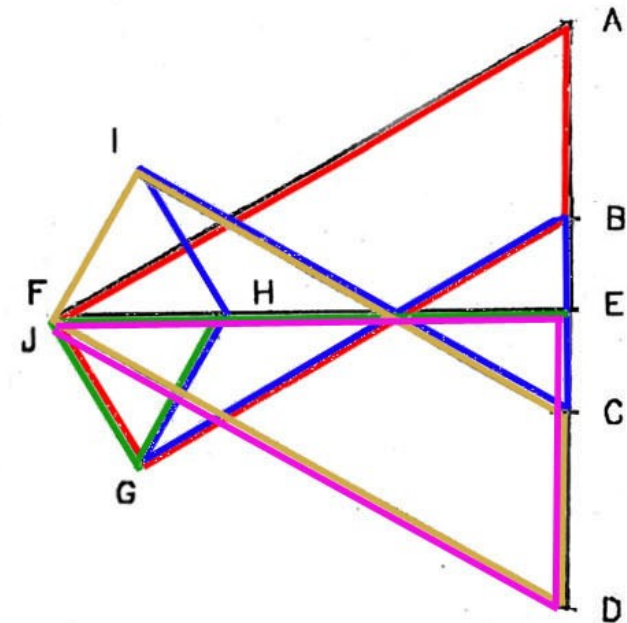
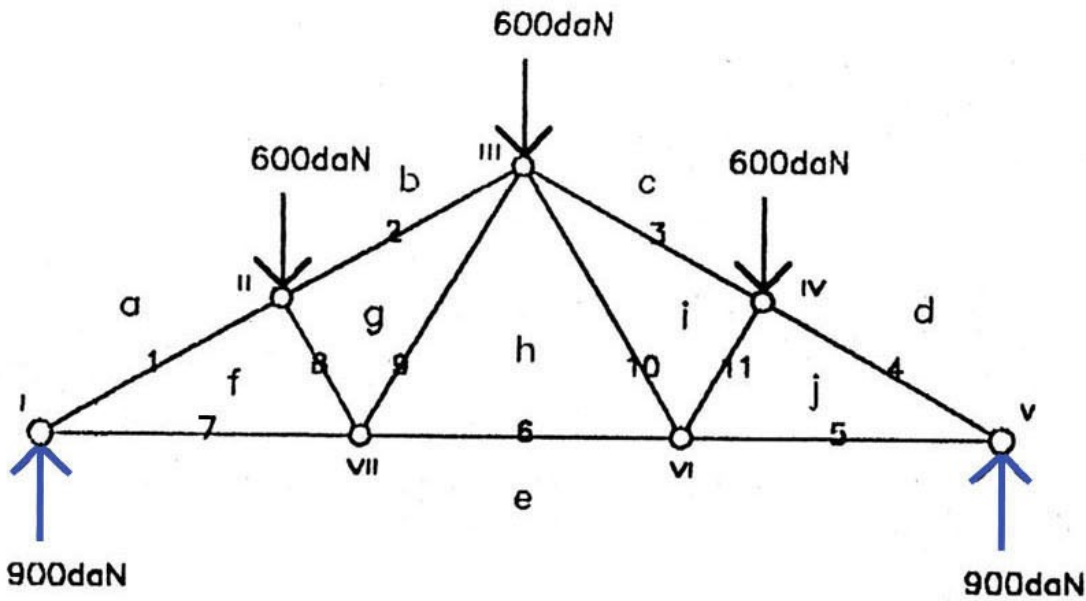
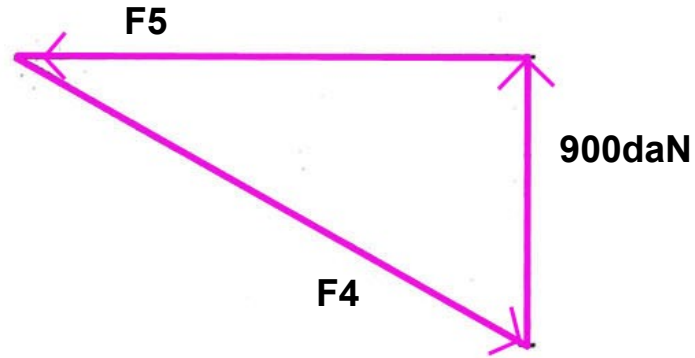
# MÉTODO DE CREMONA

NUDO IV



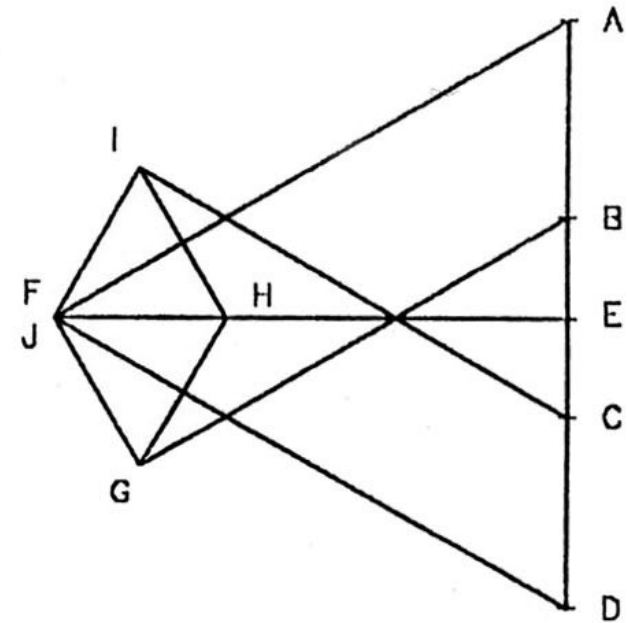
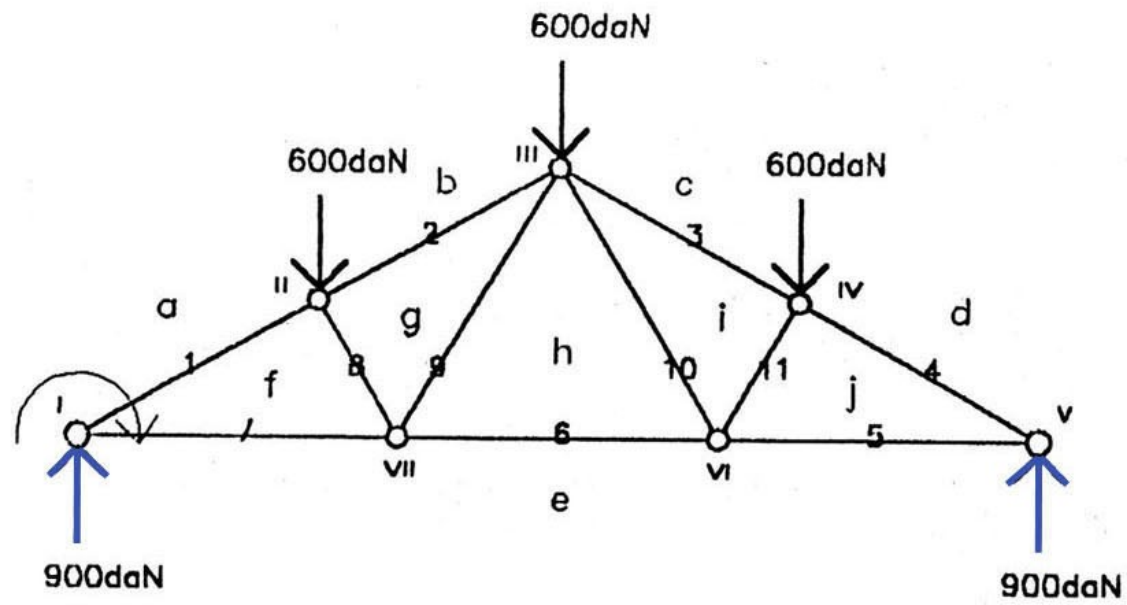
# MÉTODO DE CREMONA

NUDO V





# MÉTODO DE CREMONA



BARRA	COMPRESION	TRACCION	LONGITUD	SECCION	$\sigma_{real}$	$\sigma_d$ EULER
1	1800daN		260cm			
2	1500daN		290cm			
3	1500daN		290cm			
4	1800daN		260cm			
5		1558daN	300cm			
6		1039daN	300cm			
7		1558daN	300cm			
8	519daN		150cm			
9		519daN	260cm			
10		519daN	260cm			
11	519daN		150cm			

### TRACCIÓN

$$\sigma = \frac{F}{A} \leq f_d$$

$$A = \frac{F}{f_d}$$

### COMPRESIÓN

$$\left. \begin{aligned} \sigma = \frac{F}{A} < \sigma_d \text{ EULER} \leq f_d \\ \sigma_d \text{ EULER} = \frac{f_d}{\omega} \end{aligned} \right\} \frac{F}{A} < \frac{f_d}{\omega} \leq f_d$$

$$A = \frac{F}{f_d} \cdot \omega$$

$$\lambda = \frac{l_0}{i_{\min}} \quad l_0 = l_{\text{real}} \cdot \alpha$$