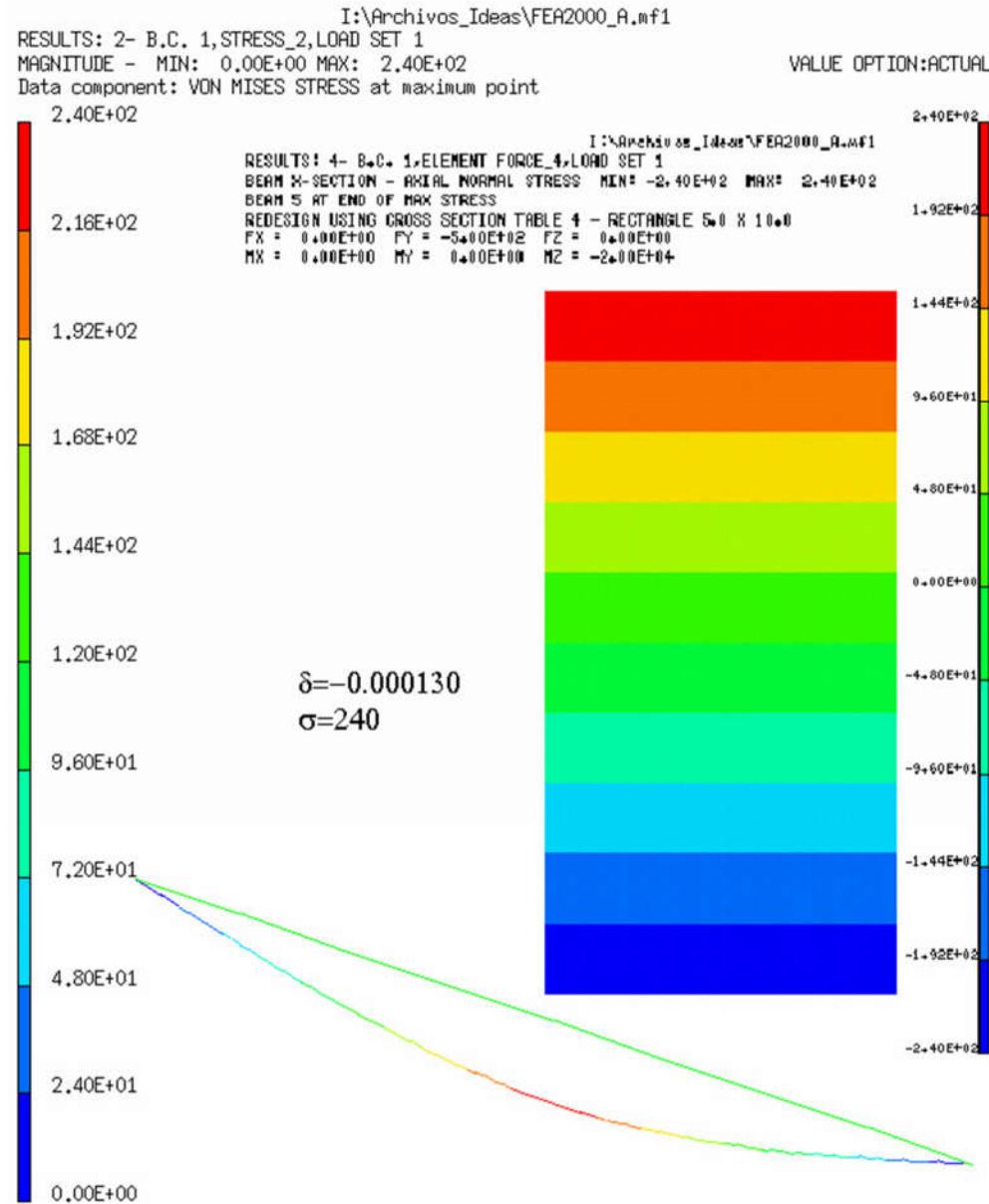
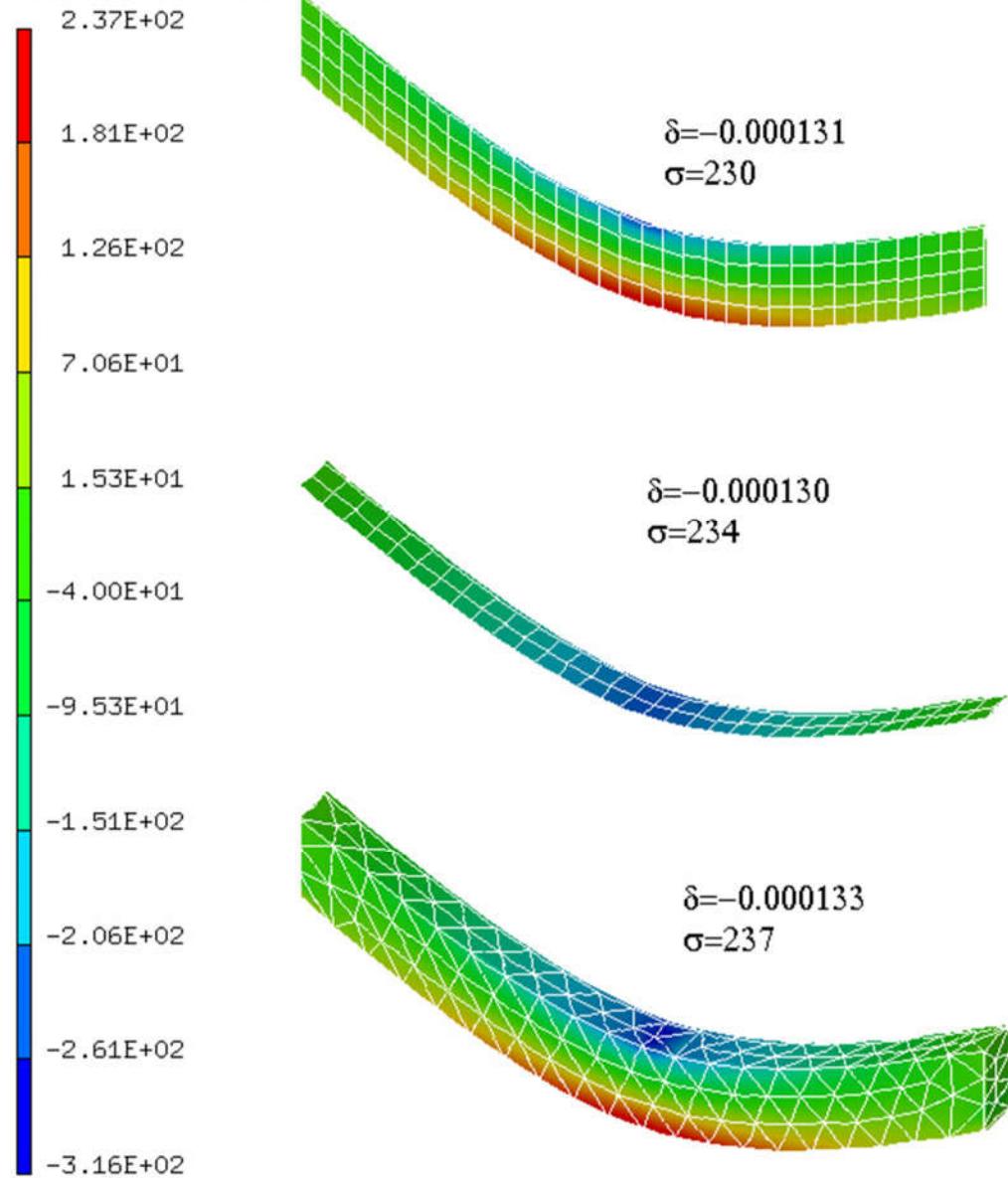


Comparación Elementos

Resultados $\delta = -0.000124\text{mm}$ / $\sigma = 240\text{mN/mm}^2$



RESULTS: 2- B.C. 1,STRESS_2,LOAD SET 1
STRESS - X MIN:-3.16E+02 MAX: 2.37E+02
DEFORMATION: 1- B.C. 1,DISPLACEMENT_1,LOAD SET 1
DISPLACEMENT - Y MIN:-1.33E-04 MAX: 0.00E+00
FRAME OF REF: PART



Tipos de Elementos

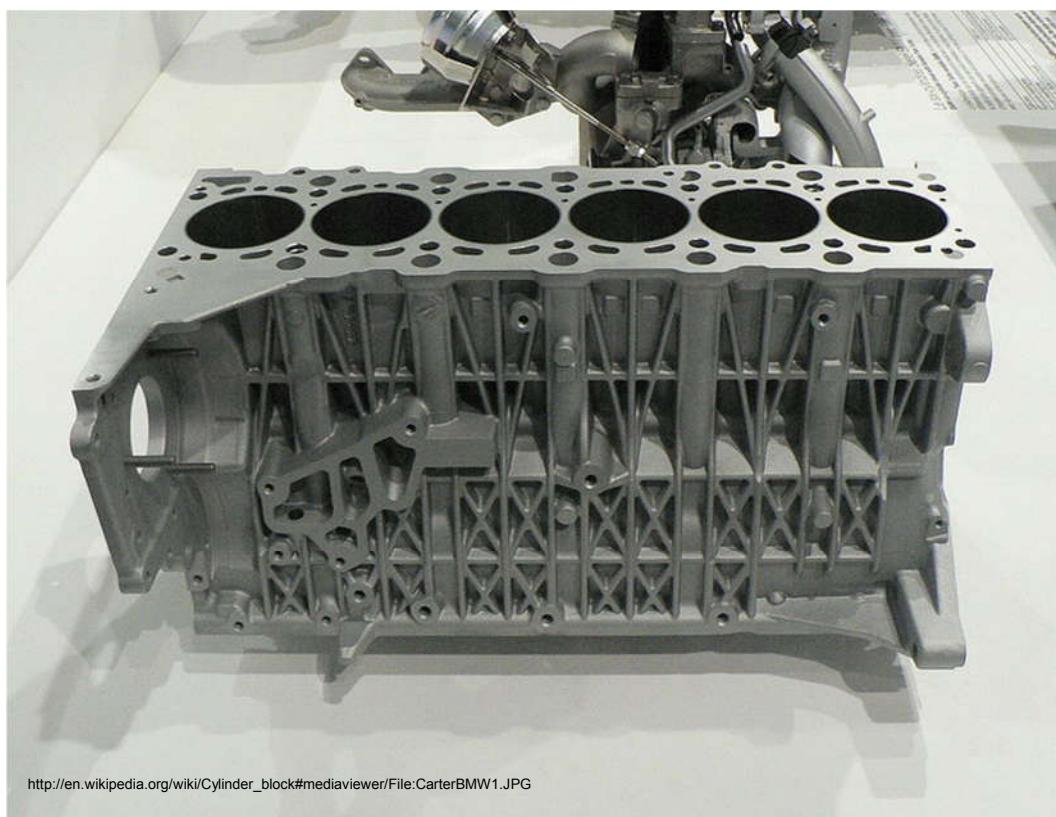
Cargas,
BC,
se complican.

Se suponen
más cosas

	Topology linear	Topology parabolic	Modeled Stiffness Trans. Rot.		Required Properties	Best Application
3D solid			3		material	general 3D structures (those that appear solid)
axis symmetric solids			2		material	general 3D structures that are symmetric about an axis
2D shell			3	3	material thickness non-structural mass formulation option	thin structures (>10:1 length/thickness) where bending is important
plane stress/ strain			2		material thickness	structures where only in-plane behavior is important
axis symmetric shells			2	1	material thickness	thin structures that are symmetric about an axis
1D rod			3		material non-structural mass cross section	axial deformation and rigid body motion of space frames
1D beam			3	3	material non-structural mass cross section orientation end offset end shortening release warping restraint factor	general space frame components and stiffeners for shell structures

La masa no estructural es para aumentar la
masa que no afecta la rigidez. Ej, mugre, cabes.
Difiere de carga ya que cuando hay aceleraciones
la carga es invariante pero la masa afecta en al dirección de la aceleración.

Tipos de Elementos



http://en.wikipedia.org/wiki/Cylinder_block#mediaviewer/File:CarterBMW1.JPG



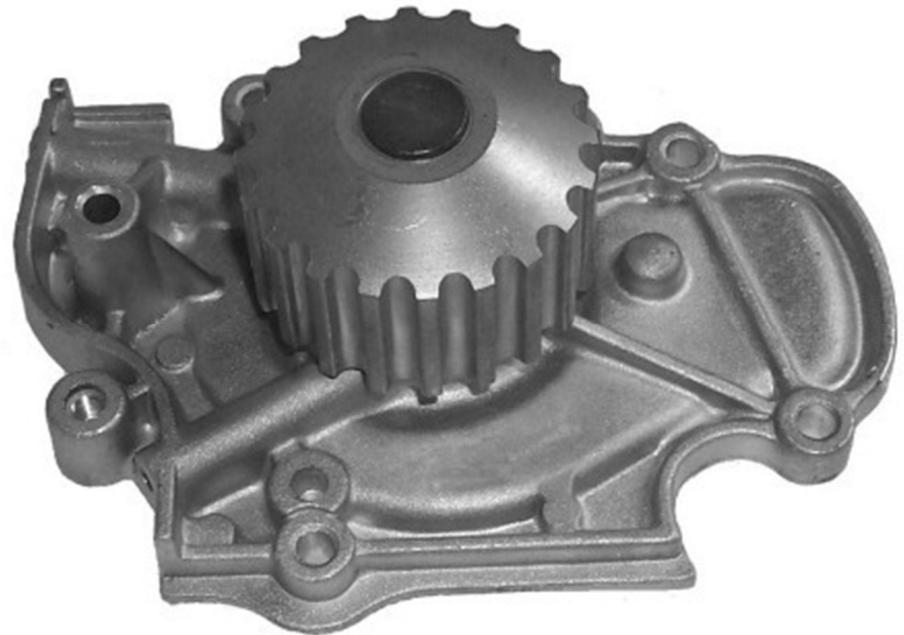
<http://www.combatreform.org/gliders.htm>



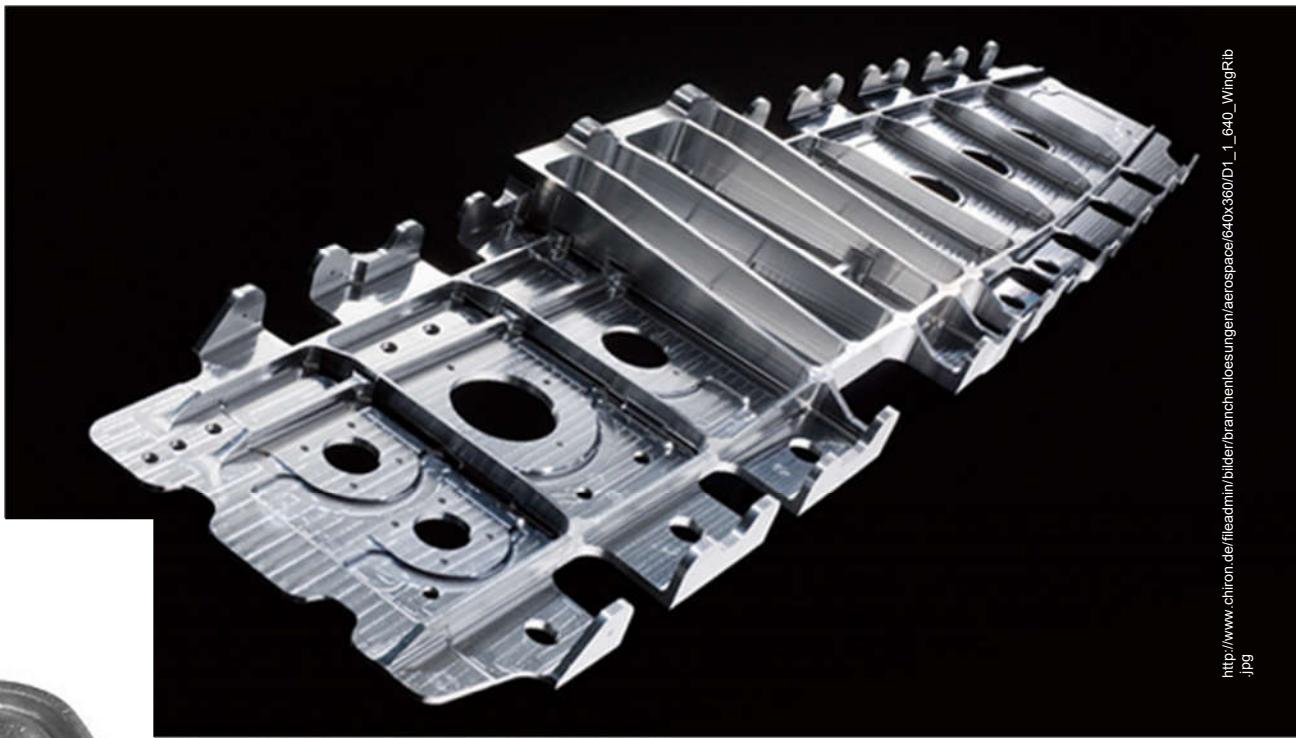
Air-Britain Photographic Images Collection

© David Reeves

Tipos de Elementos



<http://www.mechanicalengineeringblog.com/tag/sand-casting/>



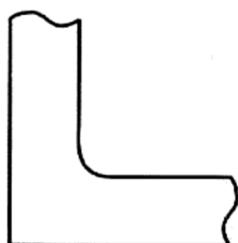
http://www.chiron.de/fileadmin/thilder/branchenbesetzungen/aerospace/640x360/D1_1_640_WingRib.jpg



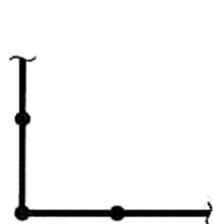
<http://www.wheelabratorgroup.com/en/images/A330%20wing%20ribs2%20300%20x200.png>

Uniones

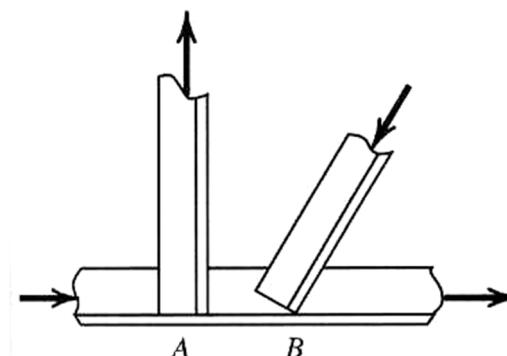
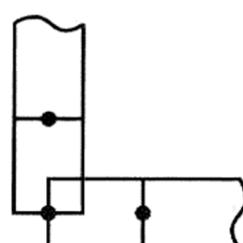
Actual



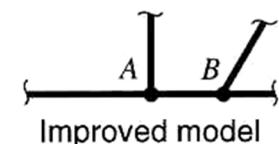
Beam elements



Implied geometry



Poor model

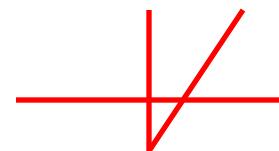


Improved model

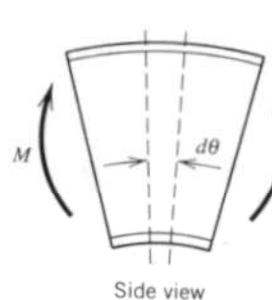
Mejora



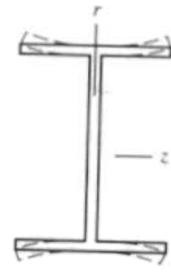
Se conecta una viga con rigid links para que toda la cara A siga a los elementos viga.



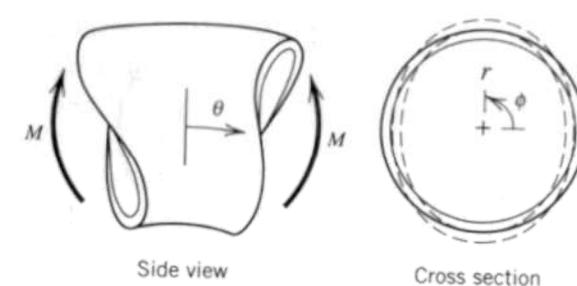
Ovalización



Side view



Cross section



Cross section

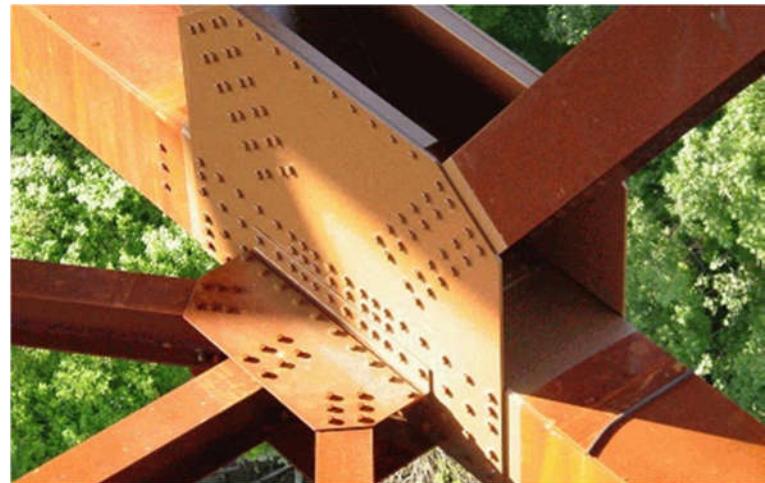
Pipe bend

(a)

200

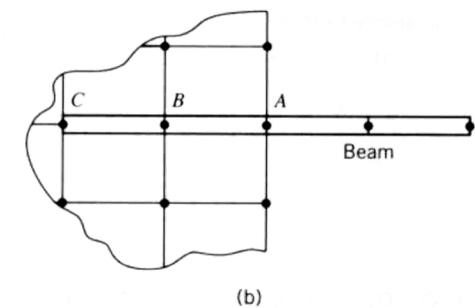
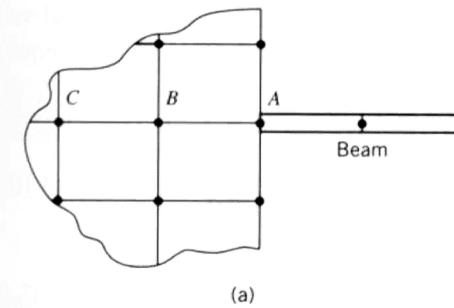
(b)

Uniones



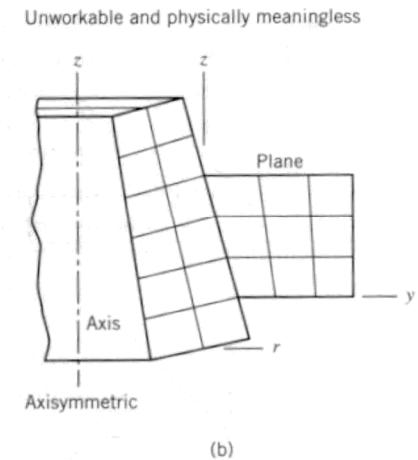
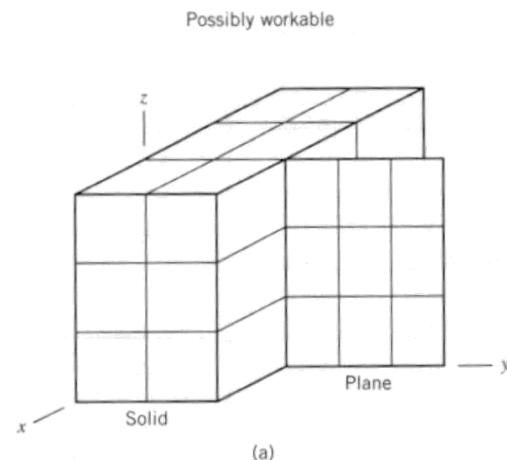
<http://wallpapers4screen.com/cities/raised-bridge-iron-bridges-riveted-bridge-the-design-of-the-bridge-17624>

Uniones



<http://wallpapers4screen.com/cities/raised-bridge-iron-bridges-riveted-bridge-the-design-of-the-bridge-17624>

Ensamblado



Criterios de Falla

Tensión Equivalente - Von Mises

$$J_2 = \frac{1}{2} s_{ij} s_{ij} = \frac{1}{3} \sigma_{vm}^2 \Rightarrow \sigma_{vm} = \sqrt{\frac{3}{2} s_{ij} s_{ij}}$$

Tresca

$$\frac{\sigma_I - \sigma_{III}}{2 \tau_{yield}} \geq 1$$

Tsai-Wu - Materiales anisotrópicos

$$F_i \sigma_i + F_{ij} \sigma_i \sigma_j \leq 1$$

Mohr Coulomb - Materiales Frágiles

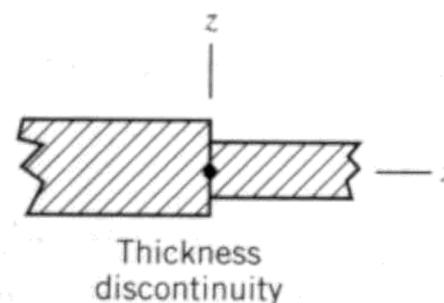
$$m = \frac{\sigma_{yc}}{\sigma_{yt}}; \quad K = \frac{m-1}{m+1}$$

$$\frac{m+1}{2} \max(|\sigma_I - \sigma_{II}| + K(\sigma_I + \sigma_{II}), |\sigma_I - \sigma_{III}| + K(\sigma_I + \sigma_{III}), |\sigma_{II} - \sigma_{III}| + K(\sigma_{II} + \sigma_{III})) = \sigma_{uc}$$

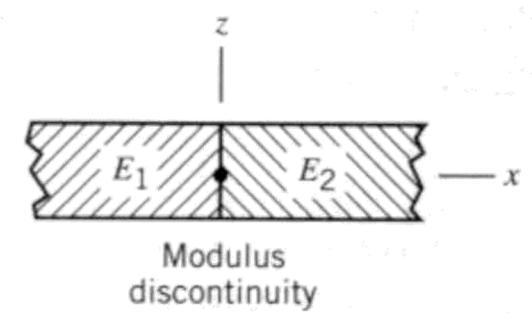
Discontinuidades de Tensión

Tensiones Promediadas

Image source: <http://www.mechanicsexplained.com/2012/07/03/discontinuity-in-thickness-and-modulus/>

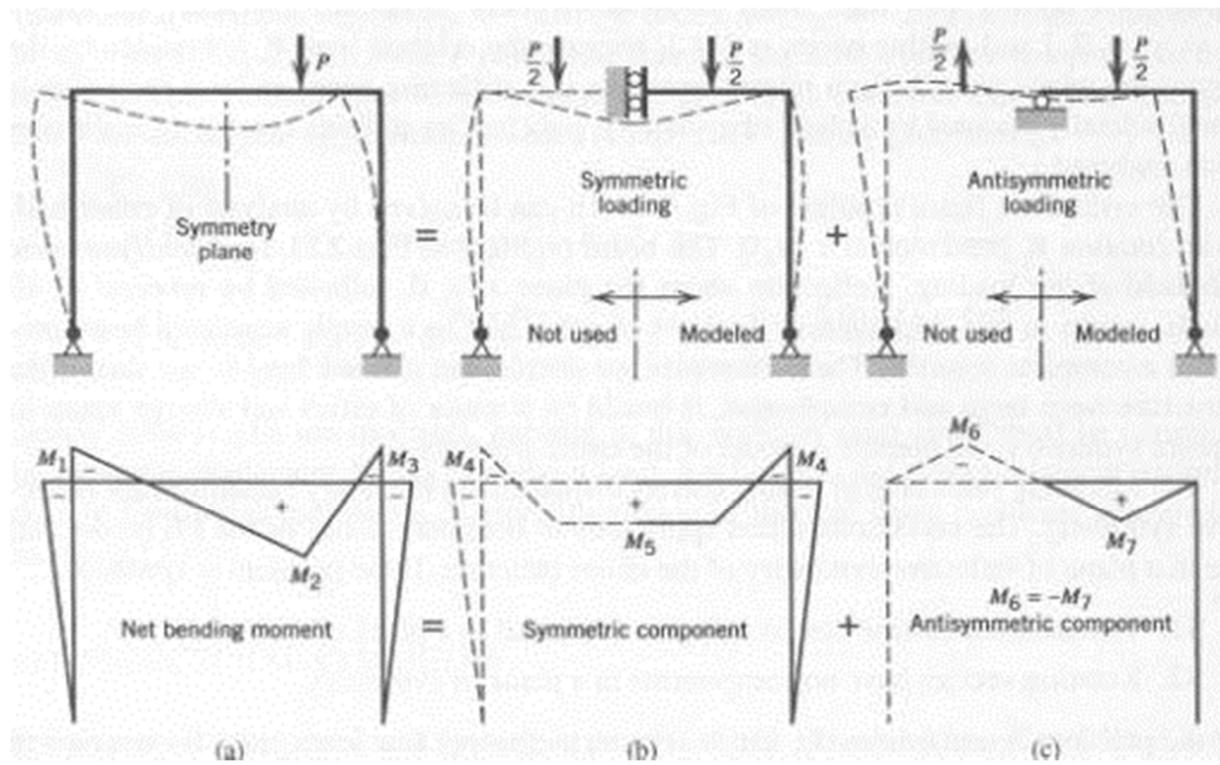
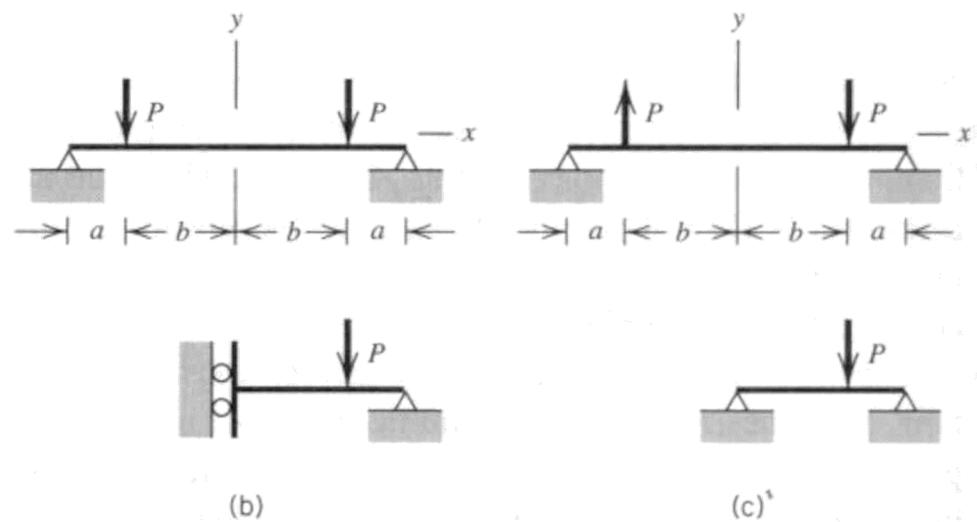
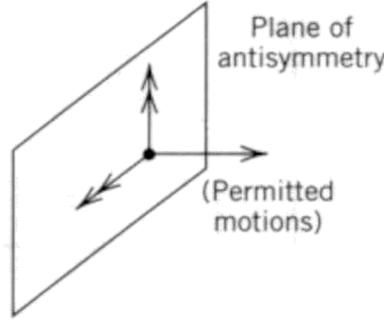
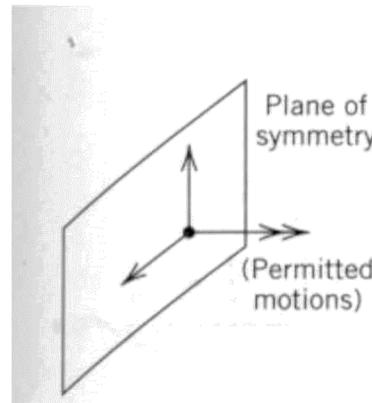


Discontinuidad de Geometría

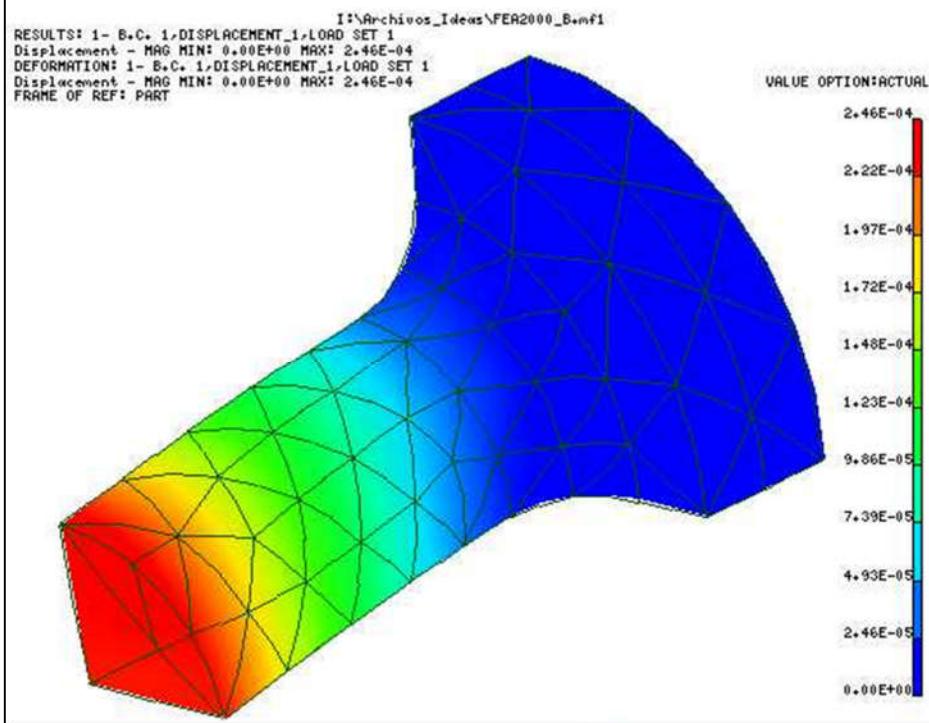
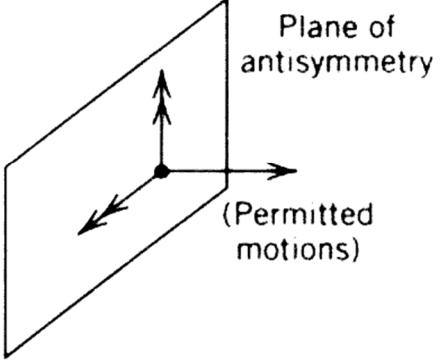
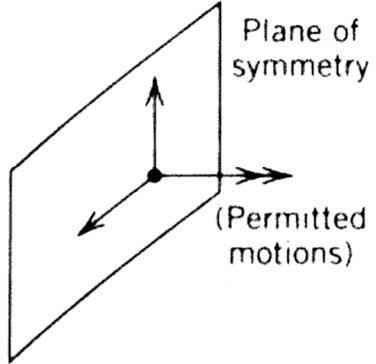


Discontinuidad de Material

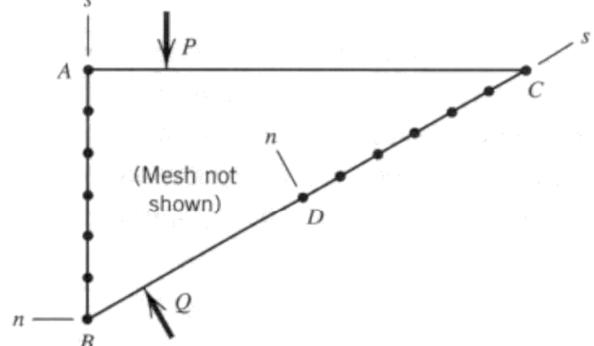
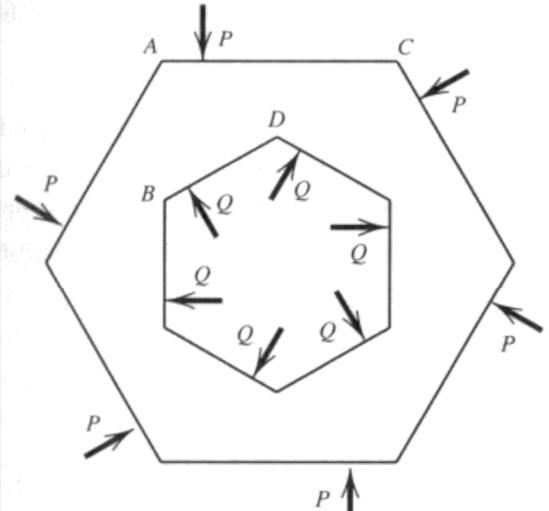
Simetrías



Simetrías

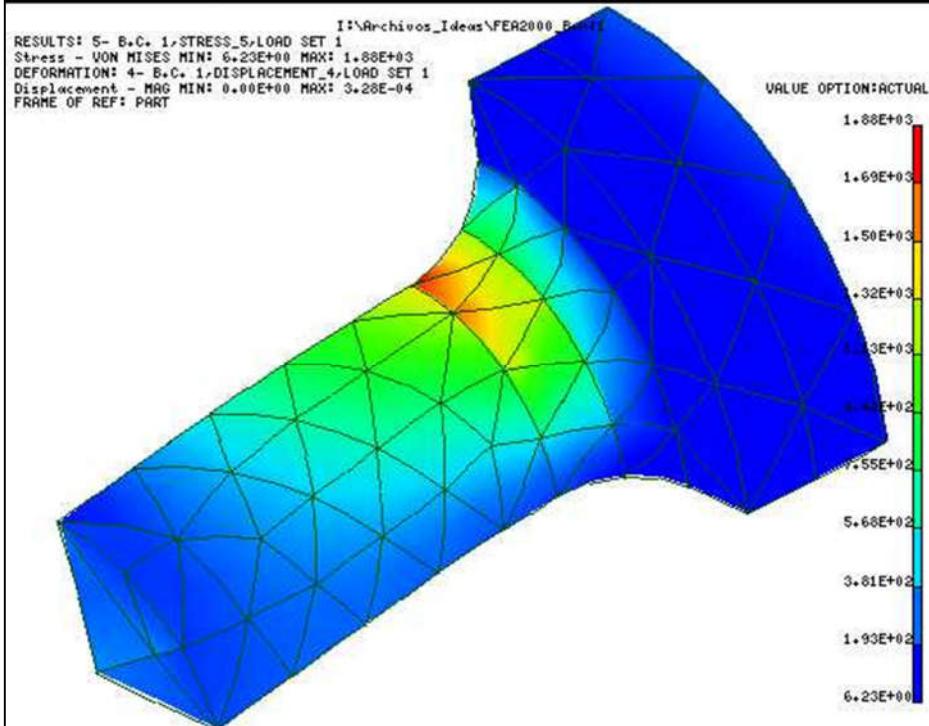


Cíclica

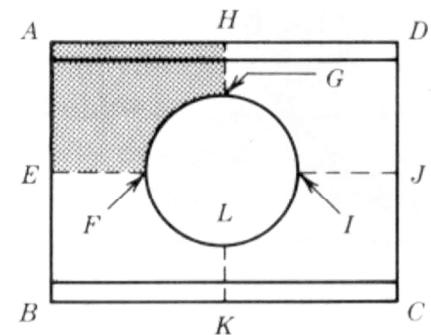
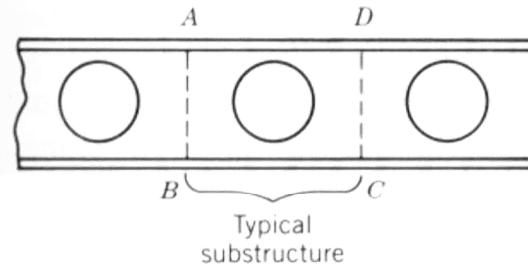


(a)

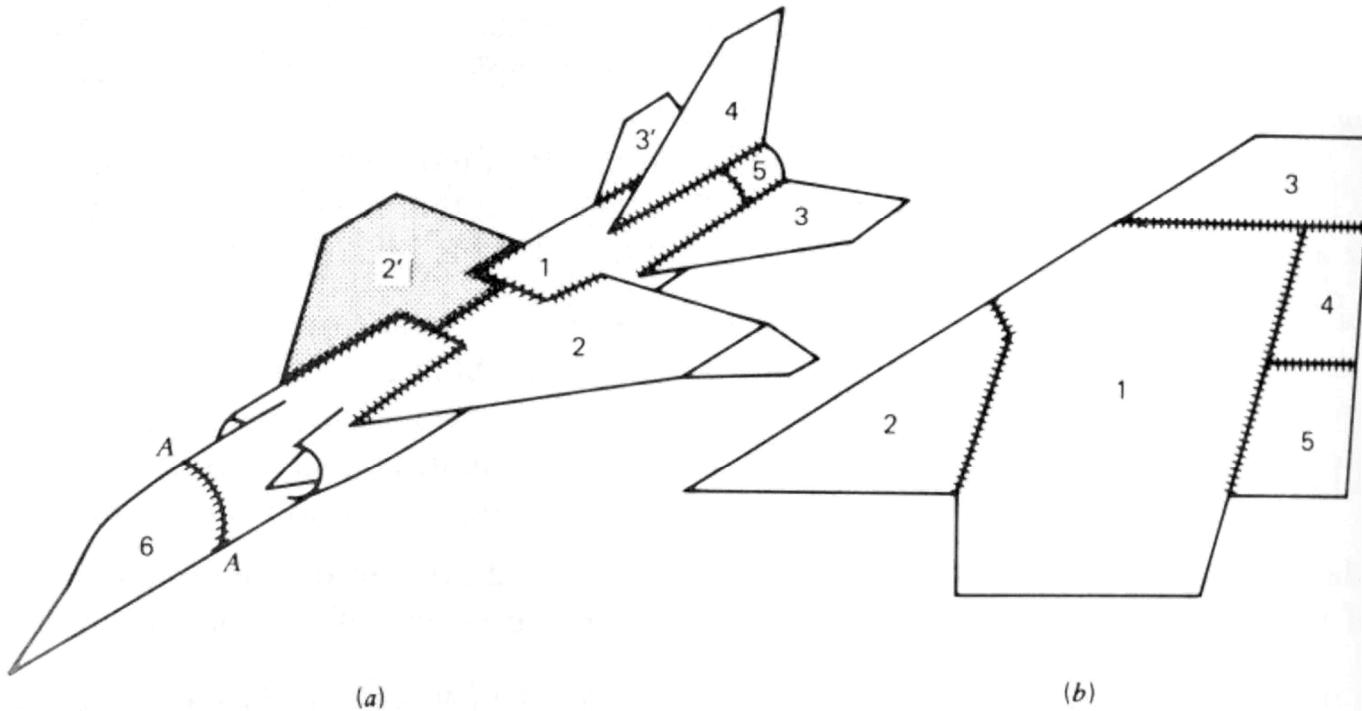
(b)



Subestructuras



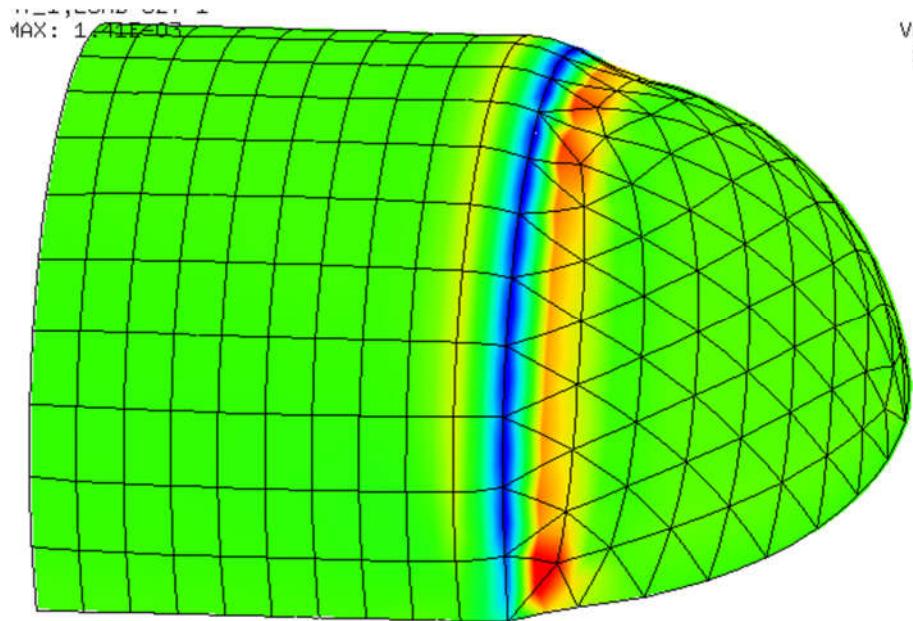
$$\left. \begin{array}{l} K_s \cdot D_s = R_s \Rightarrow K_a \cdot D_a = R_a \\ \downarrow \\ \sum K_a D_a = K_A \cdot D_A = R_A \end{array} \right\} K_s \cdot D_s = R_s \quad (a)$$



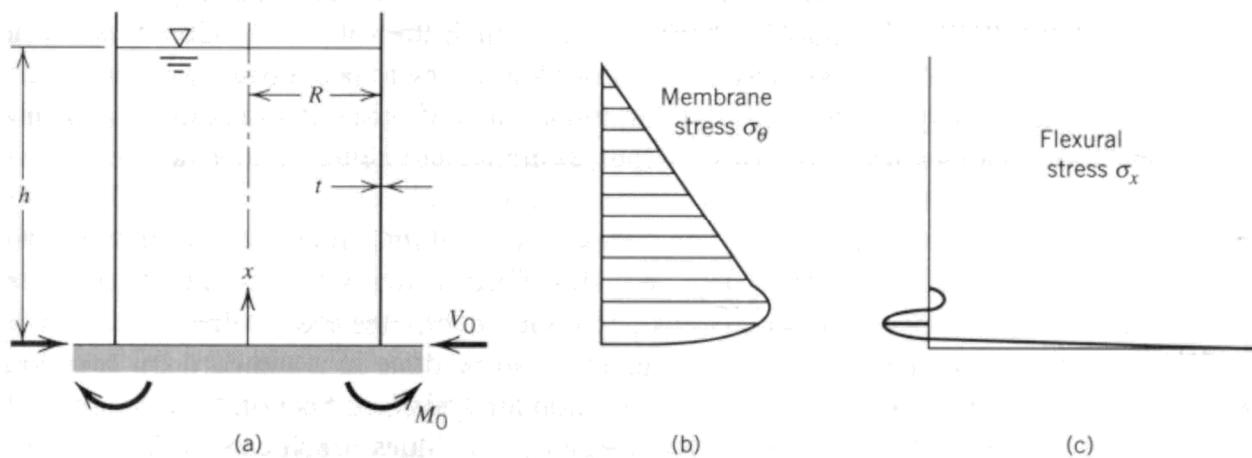
Recipientes



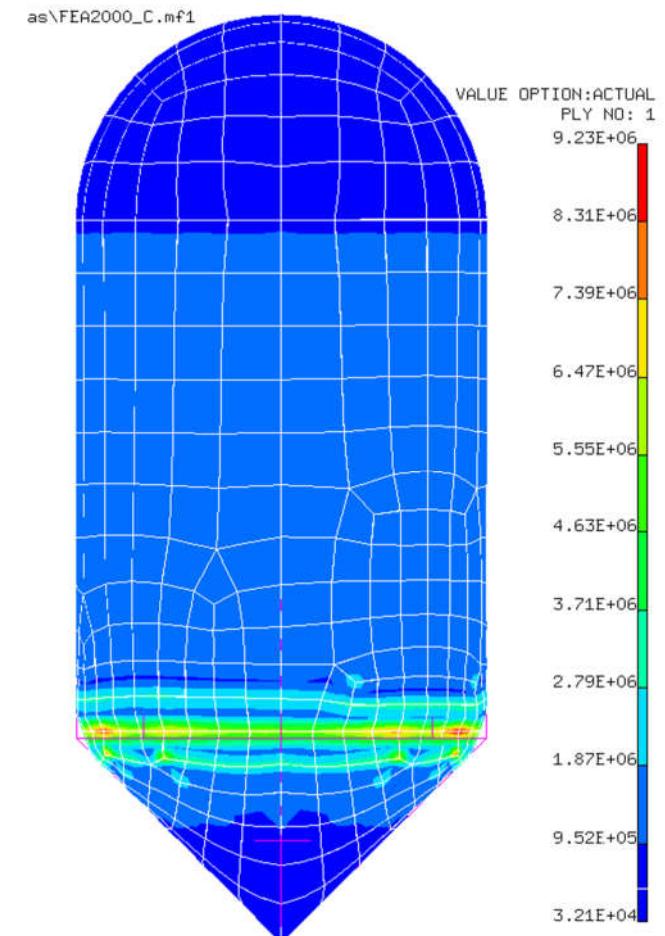
Compatibilidad de deformaciones



Tanques

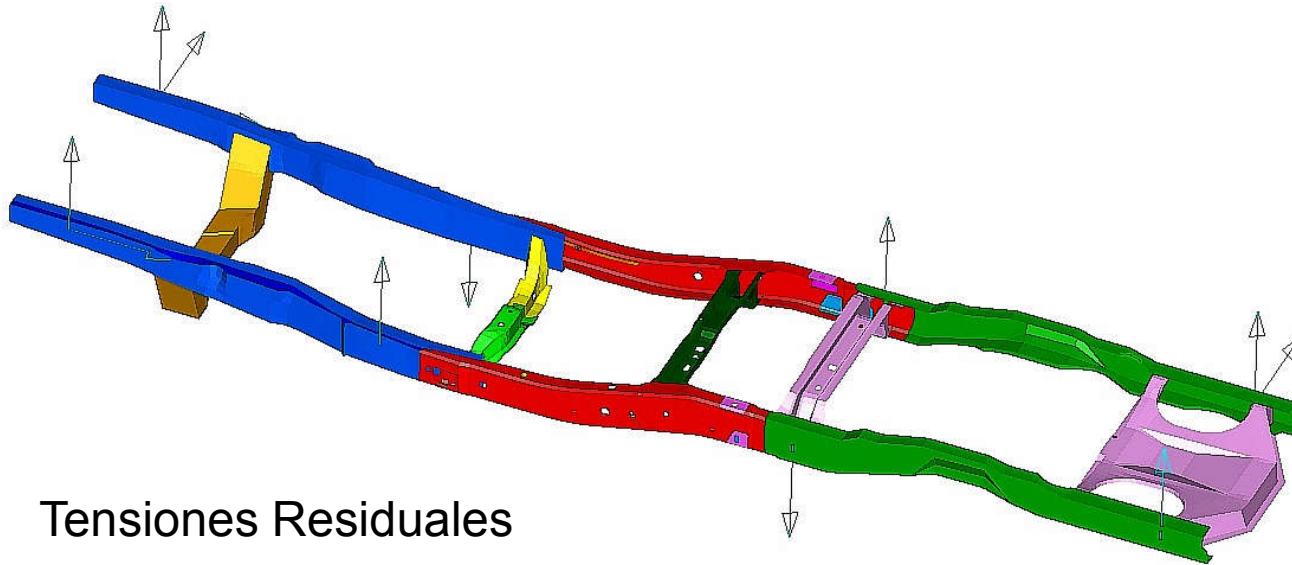


Recipientes a Presión

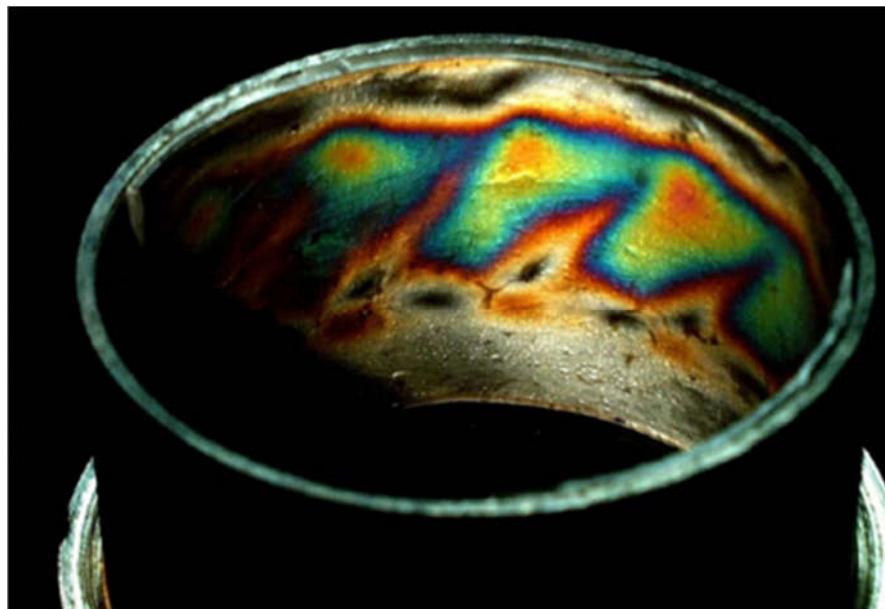


Secciones

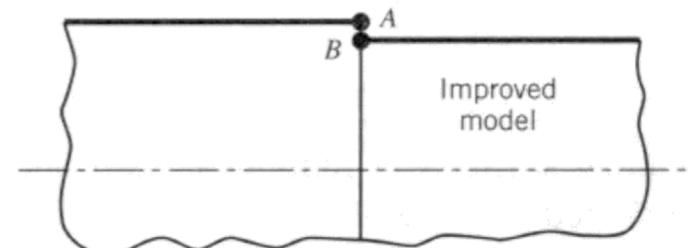
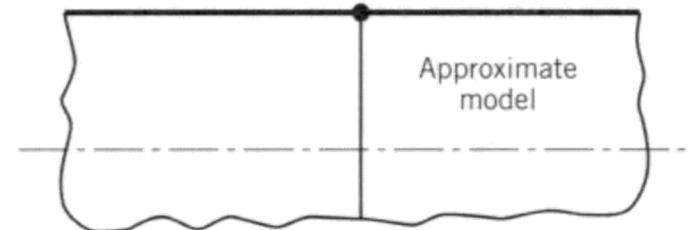
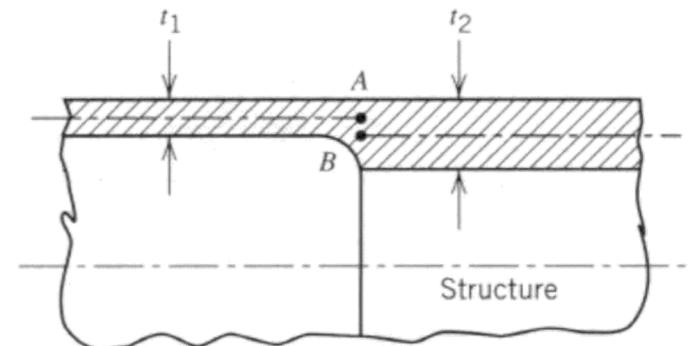
Chapas



Tensiones Residuales



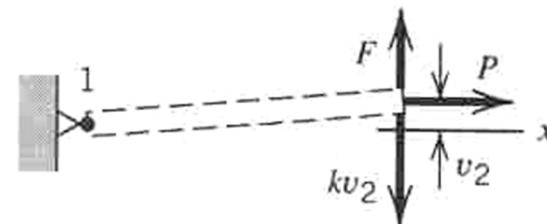
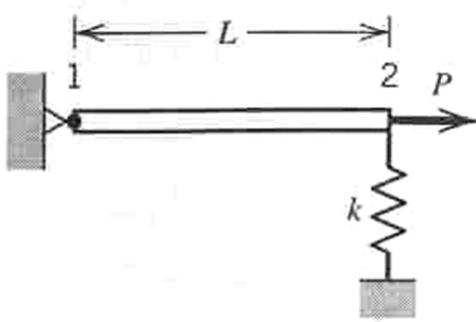
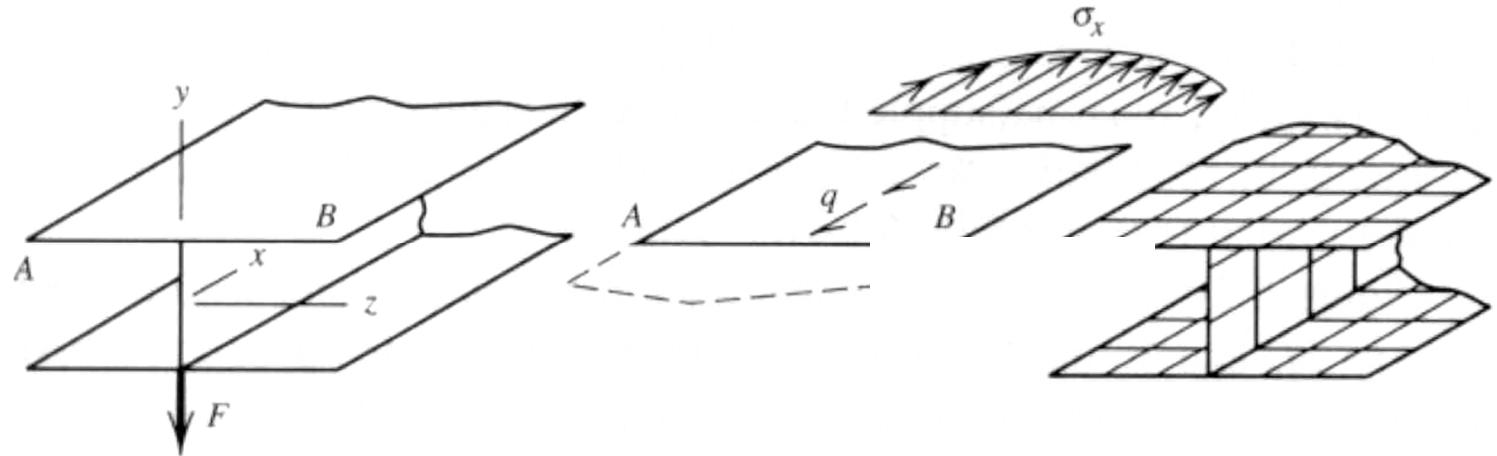
<http://www.vishaypg.com/micro-measurements/photo-stress-plus/category/case-studies/?subCategory=stress-analysis>



(b)

Concentración de Tensiones - Rigidización

Stress Stiffening



$$kv_2 + \underbrace{\frac{P}{L}}_{k_\sigma} v_2 = F$$

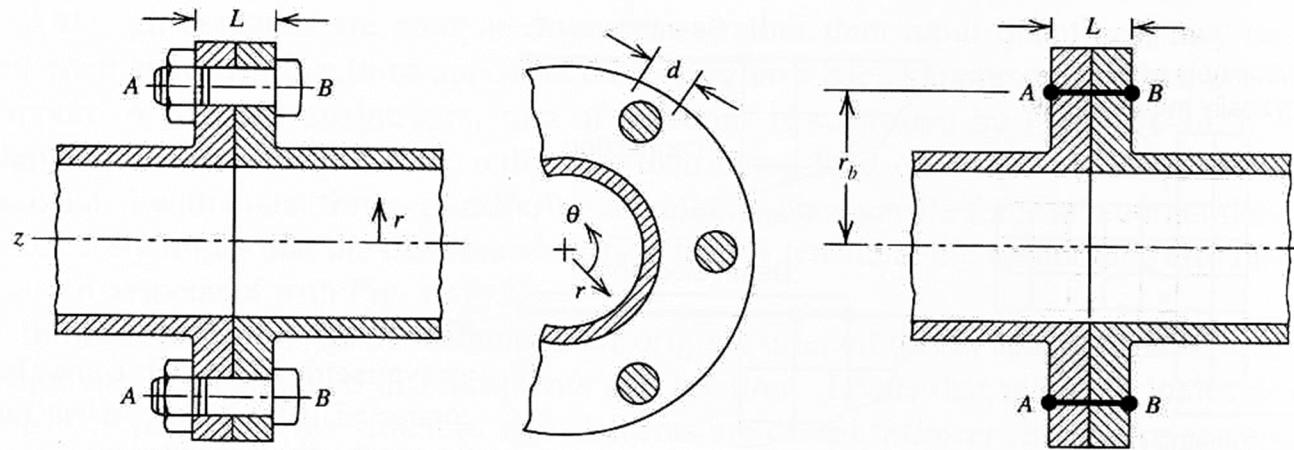
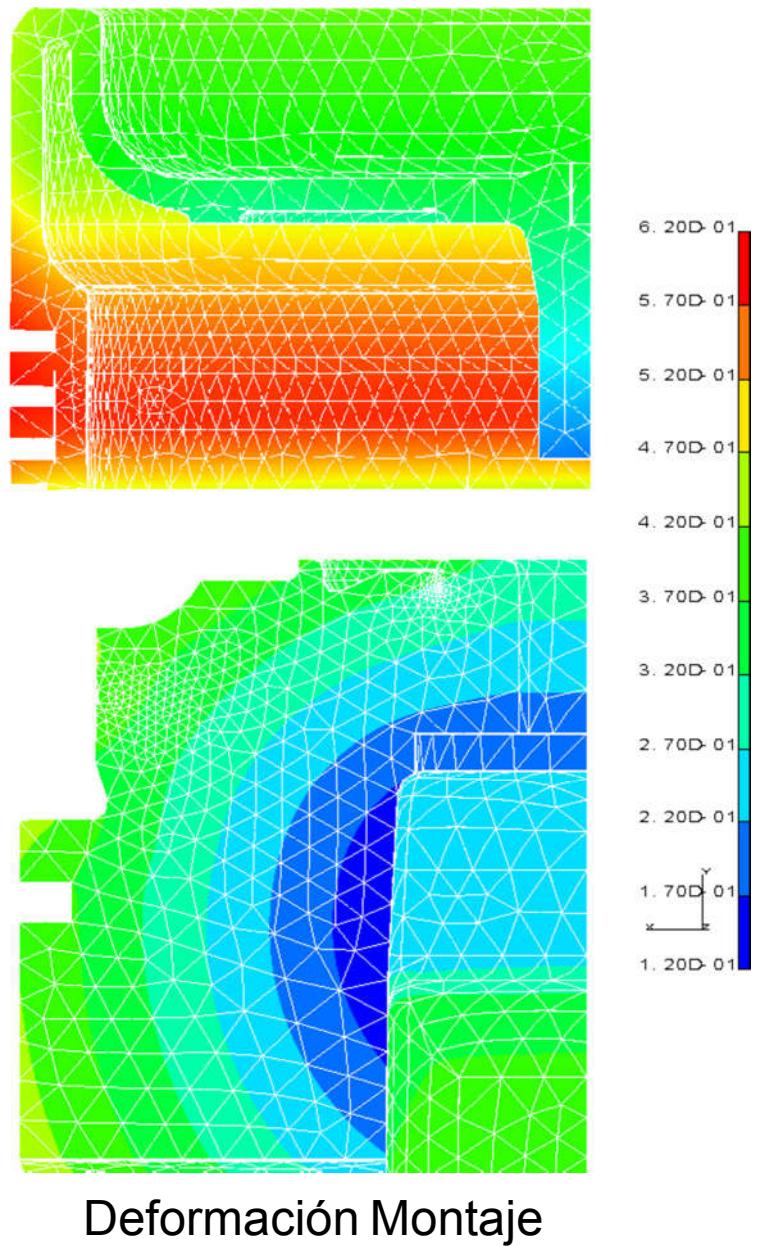
$$k_\sigma(P) = \frac{P}{L} \Rightarrow (k + k_\sigma)v_2 = F$$

$$\text{Pandeo } P = -kL \Rightarrow \underbrace{(k + k_\sigma)}_0 v_2 = F = 0$$

$$\text{Rigidizacion } (K + K_\sigma(R))D = R$$

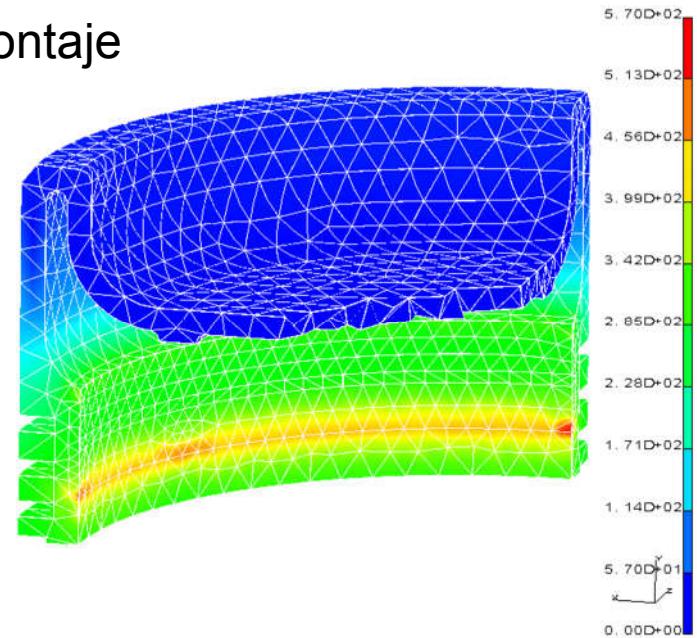
Pretensión

Deformaciones Iniciales

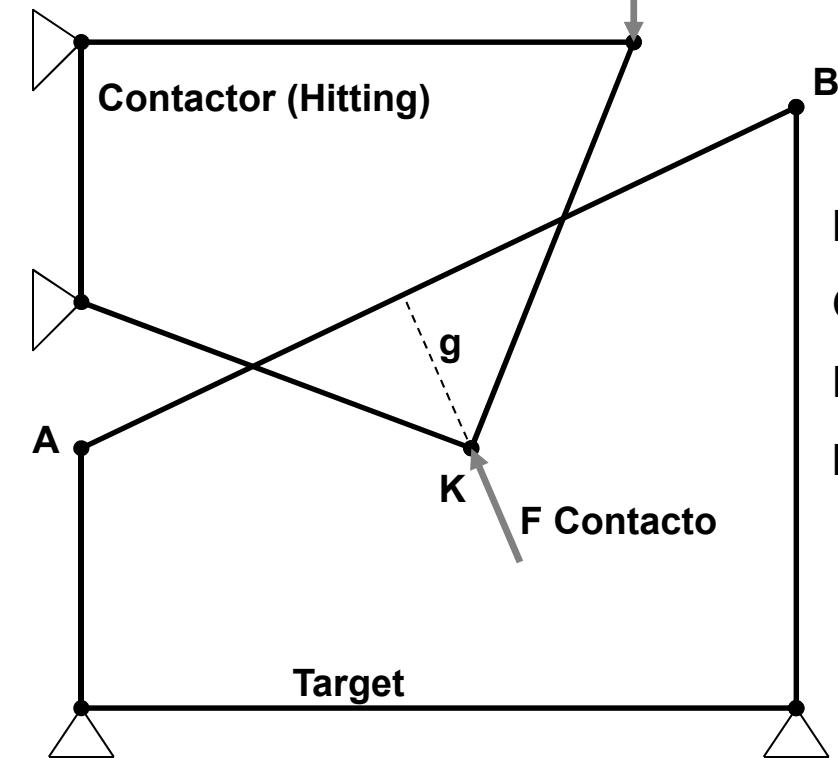
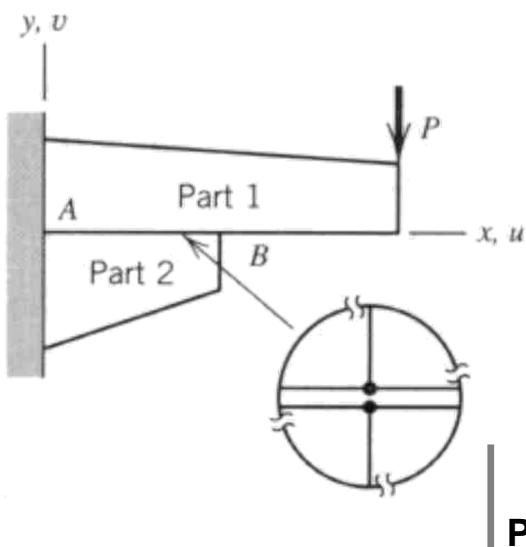


$$\begin{Bmatrix} \sigma_x \\ \sigma_y \\ \tau_{xy} \end{Bmatrix} = \frac{E}{1-\nu^2} \begin{bmatrix} 1 & \nu & 0 \\ \nu & 1 & 0 \\ 0 & 0 & \frac{1-\nu}{2} \end{bmatrix} \begin{Bmatrix} [B]\{d\} - \alpha T \\ \alpha T \\ 0 \end{Bmatrix}$$

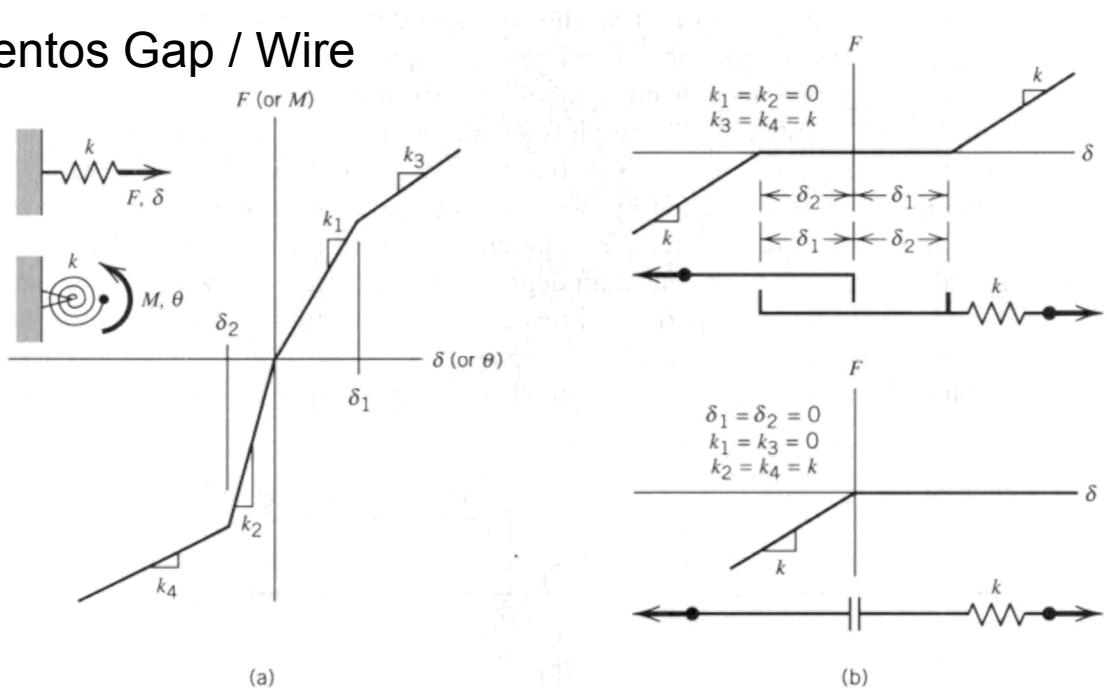
Tensiones Montaje



Contacto



Elementos Gap / Wire

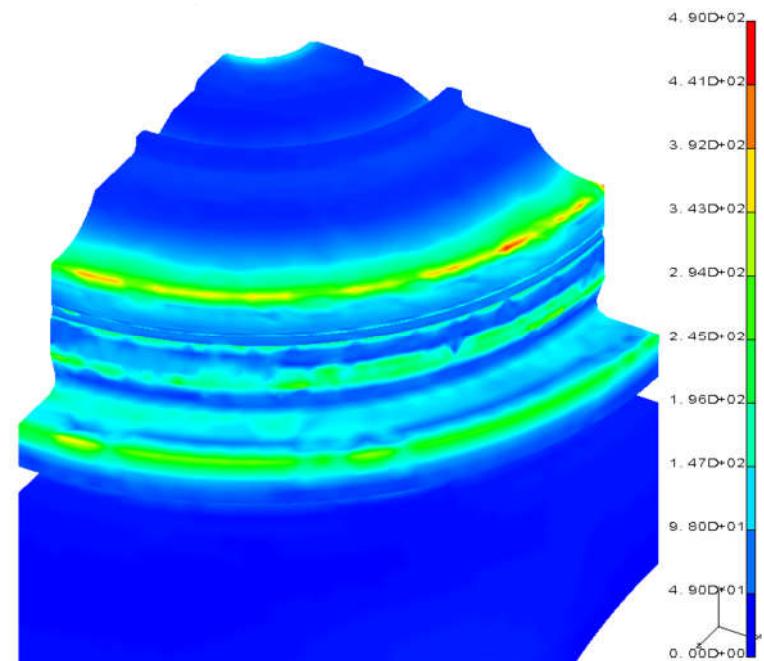


Restricciones:

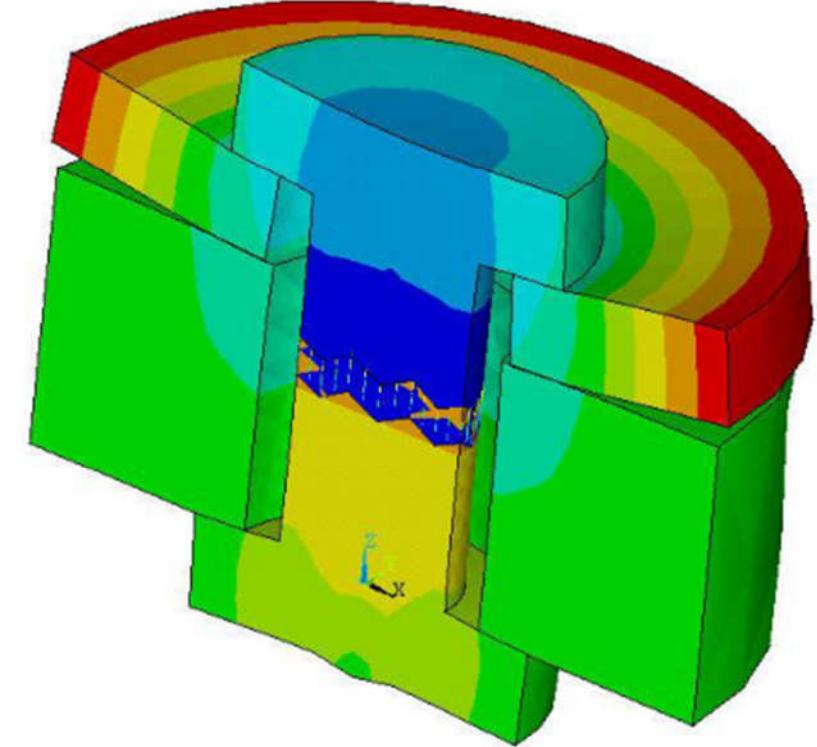
Gap: $g \geq 0$

Fuerza Contacto: $\lambda \geq 0$

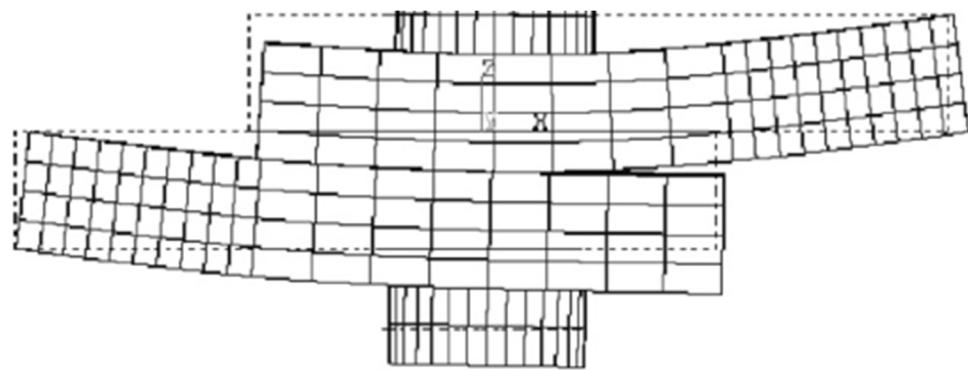
Kunn-Tucker: $g \lambda = 0$



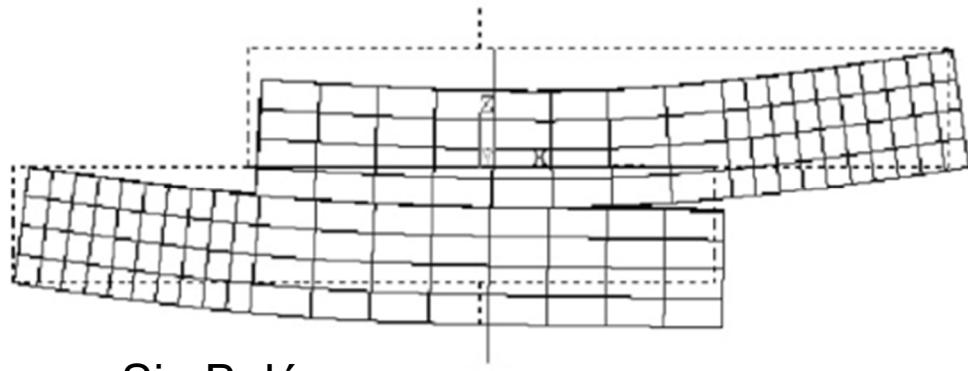
Uniones Aburonadas - Resultados



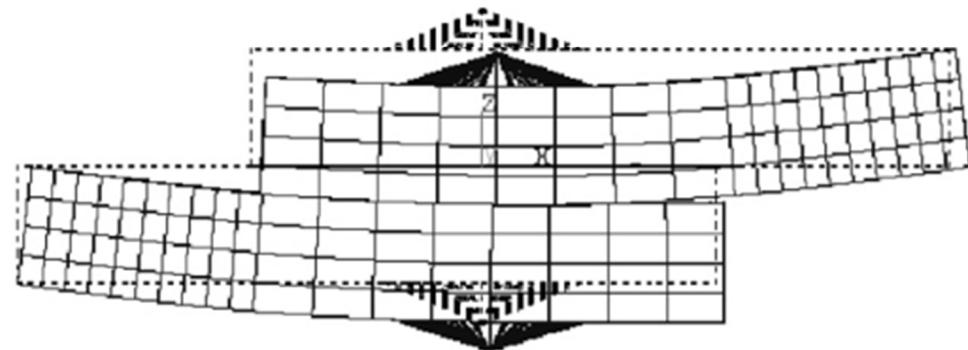
```
ANSYS 5.7.1
FEB 22 2002
19:53:35
NODAL SOLUTION
STEP=1
SUB -1
TIME=1
UZ      (AVG)
RSYS=0
PowerGraphics
EFACET=1
AVRES=Mat
DMX -.901E-04
SMN --.533E-04
SMX +.583E-04
SMY -.533E-04
SMZ -.409E-04
SXY -.285E-04
SXZ -.161E-04
SYZ -.368E-05
SXW .871E-05
SYW .211E-04
SZW .335E-04
SXYW .459E-04
SMZW .583E-04
```



Bulón con elementos sólidos

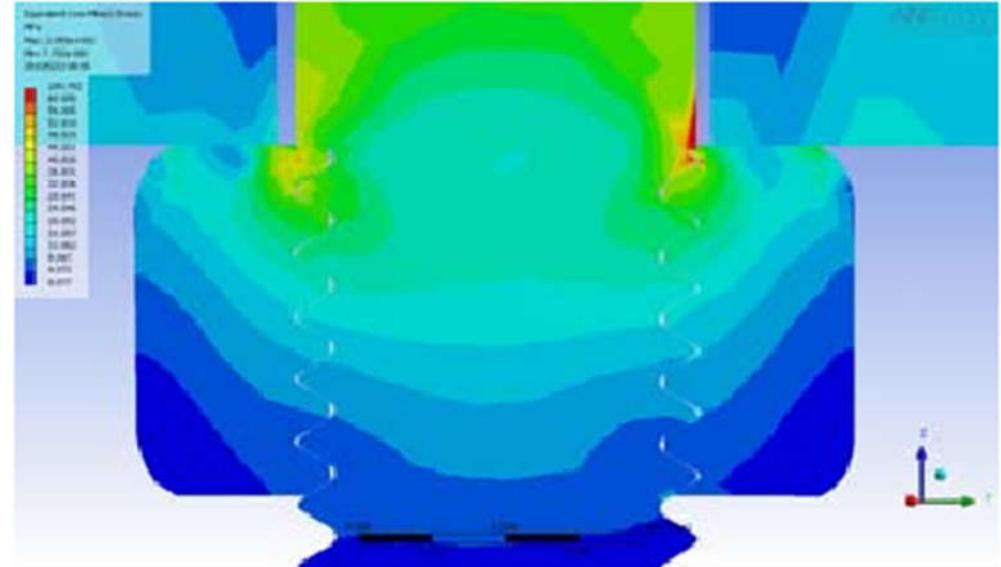
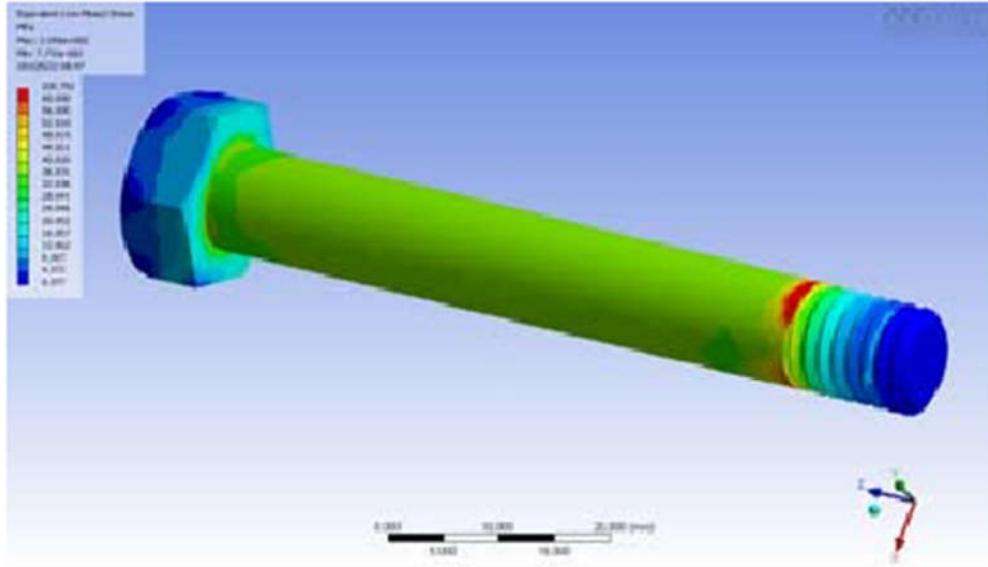


Sin Bulón



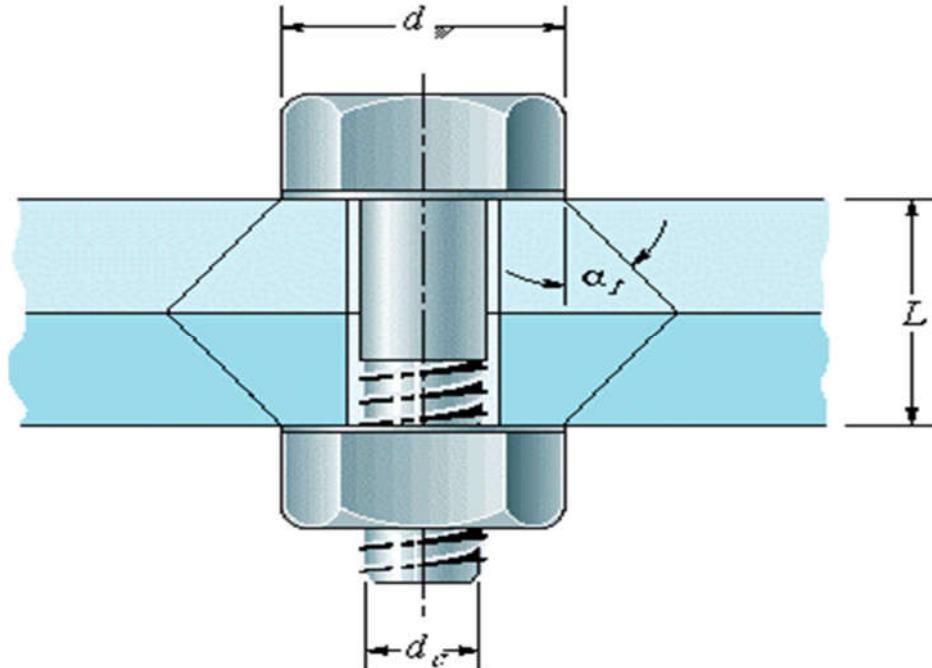
Bulón como elemento viga

Uniones Abulonadas – Tensiones en roscas



Criterios de Diseño

- Bulón
 - Tensión
 - Corte
 - Tensión y Corte
 - Tensión, Corte y Flexión
- Rosca



Caso de Estudio – Soporte de Tanques

Requerimientos

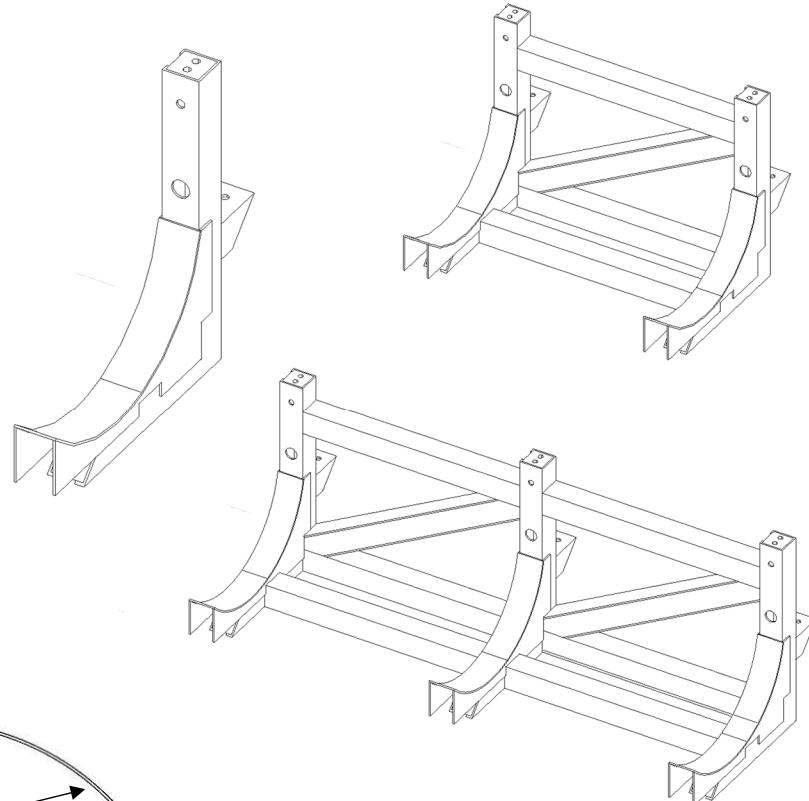
• Análisis cuasi-estático

- 1 g Vertical
- 8 g Vertical
- 8 g Lateral
- 20 g Frontal

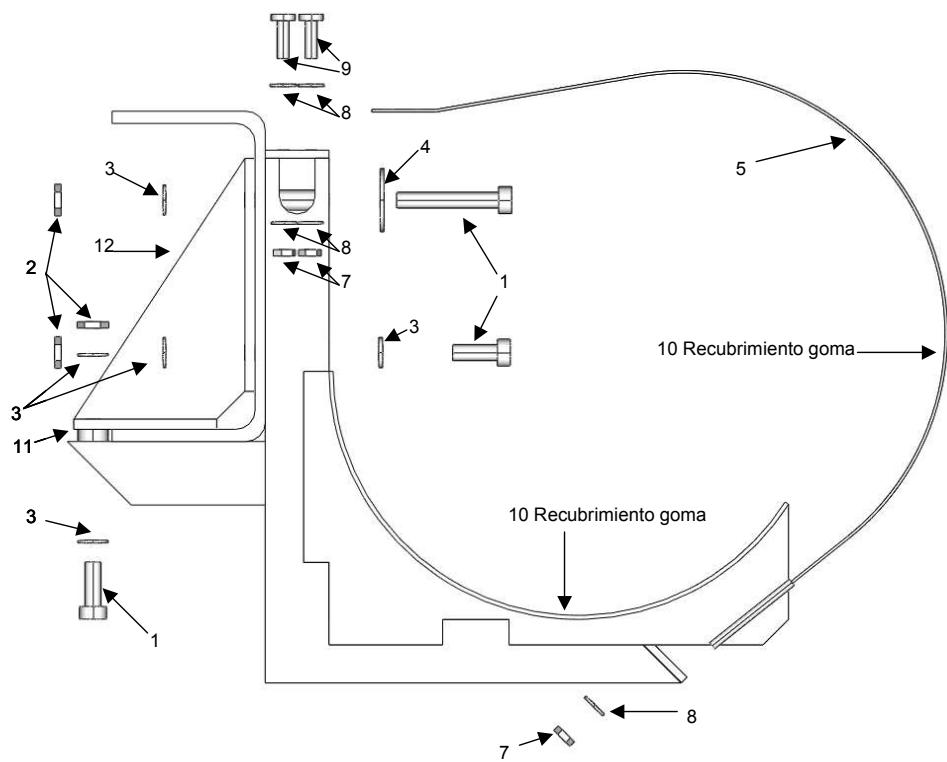
• Análisis fatiga

- 2 g Lateral

Diseño

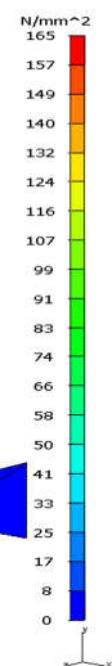
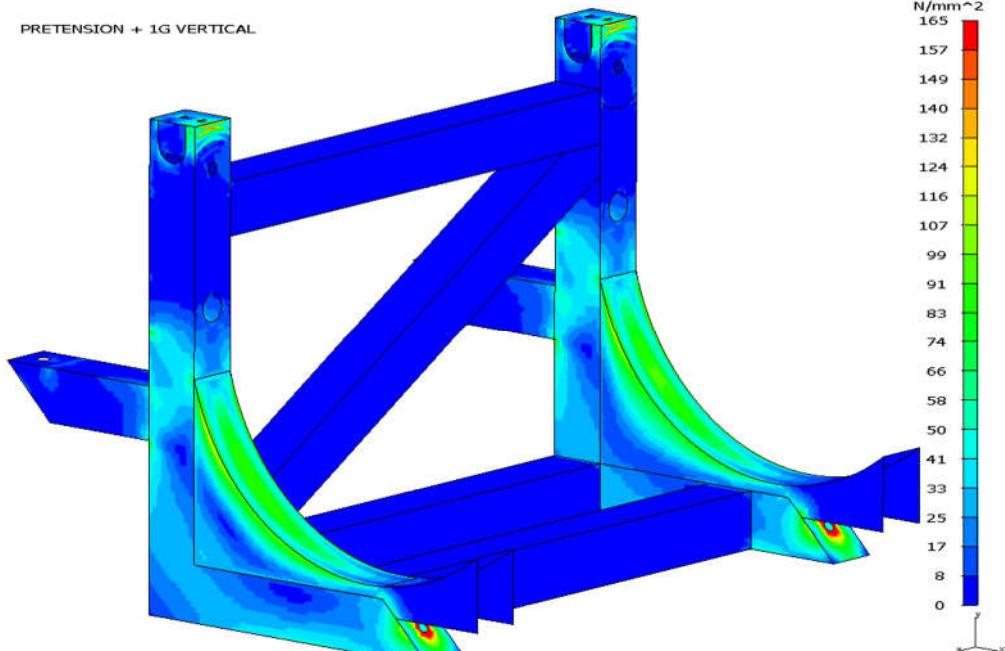


Montaje

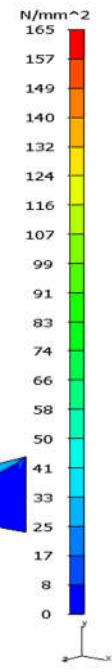
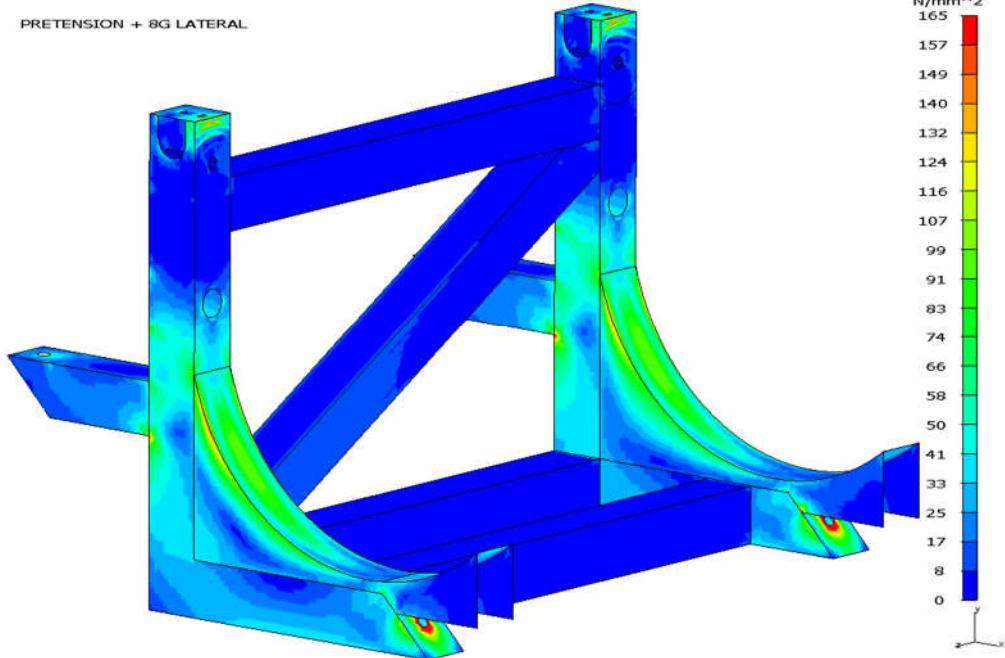


Caso de Estudio – Soporte de Tanques

PRETENSION + 1G VERTICAL

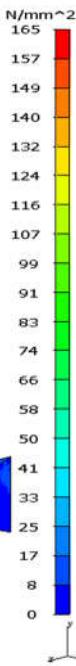
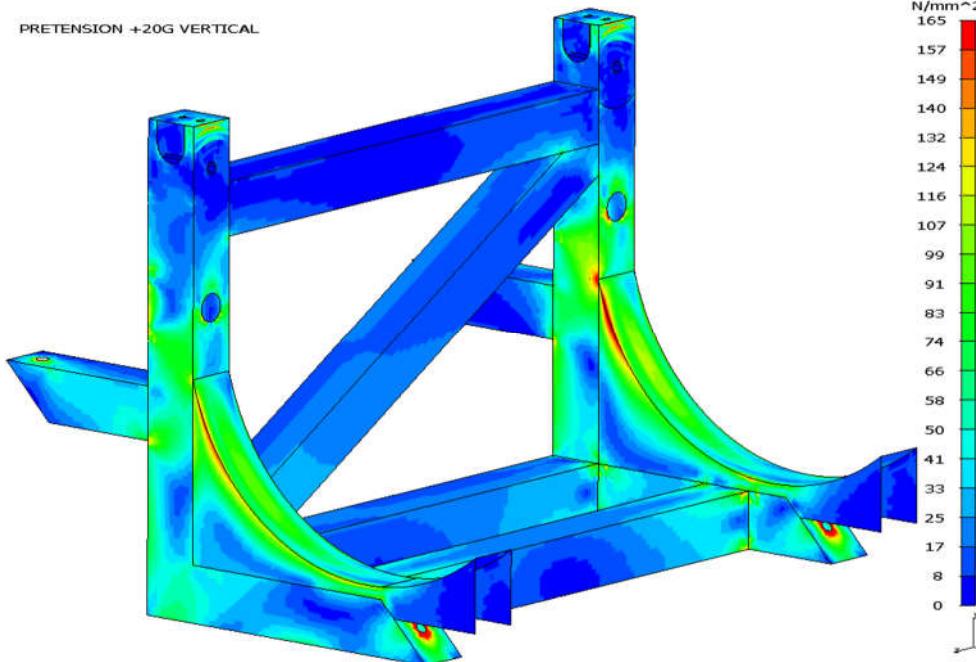


PRETENSION + 8G LATERAL



Carga	Desplazamiento Máximo [mm]	Tensión Equivalente [MPa]
1g vertical	0.54	131
8g vertical	0.15	250(*)
8g lateral	0.68	273(*)
20g frontal	1.32	400(?)

PRETENSION +20G VERTICAL



Combinación	Media [MPa]	Amplitud [MPa]	Soderber g [MPa]	Gerber [MPa]
Máximo según Soderberg	63.72	52.87	40.62	51.83
Máximo según Gerber	63.72	52.87	40.62	51.83

Modelado por Elementos Finitos

Tareas

