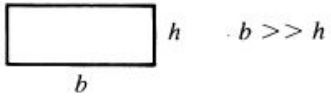
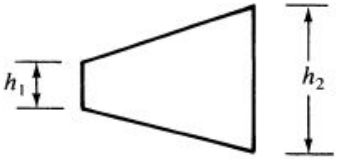
Recomendaciones y técnicas de y mallado

Características geométricas indeseables



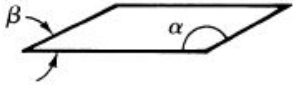
$b >> h$

(a) Large aspect ratio



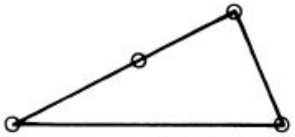
$h_2 >> h_1$

(b) Approaching a triangular shape

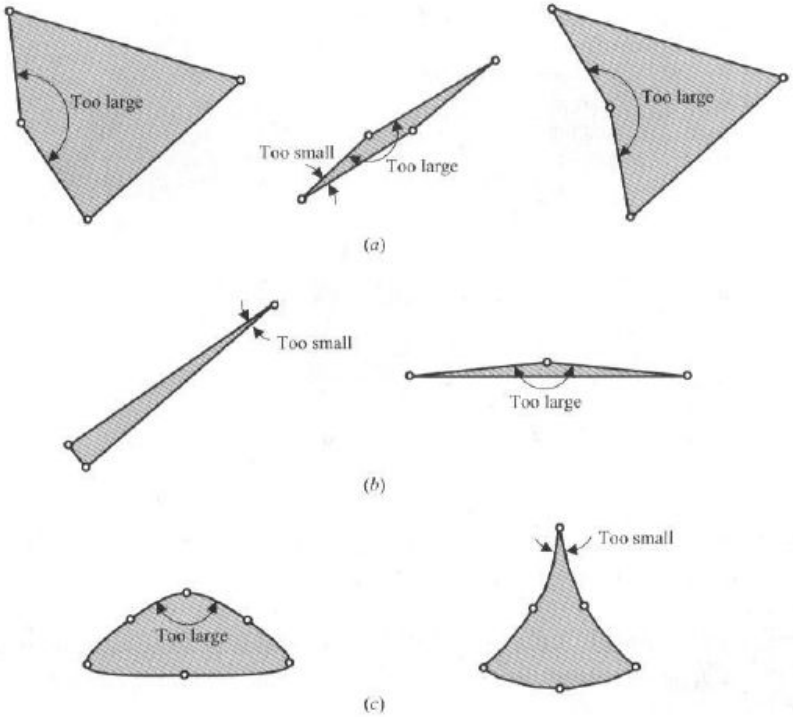


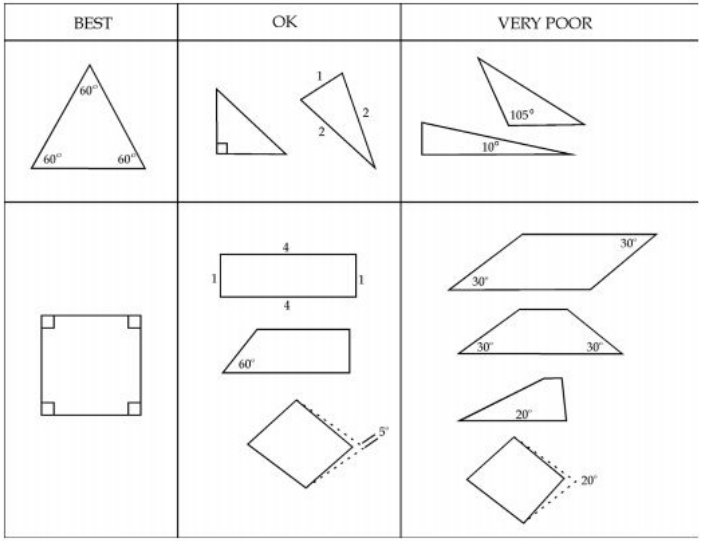
$\alpha >> \beta$

(c) Very large and very small corner angles



(d) Triangular quadrilateral





Recomendaciones y técnicas de y mallado

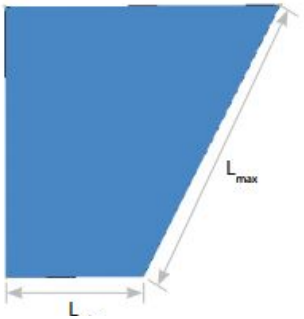
Parámetros de control (Varían de acuerdo al programa usado):

Ideal shape for quad elements – Square 

Ideal shape for triangular elements – Equilateral triangle 

Aspect = maximum element edge length / minimum element edge length

Ideal value = 1 (Acceptable < 5).

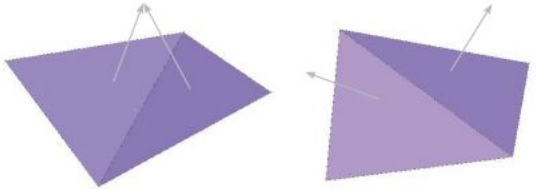


Warp angle: warp angle is the out of plane angle

Ideal value = 0^0 (Acceptable < 10^0).

Warp angle is not applicable for triangular elements.

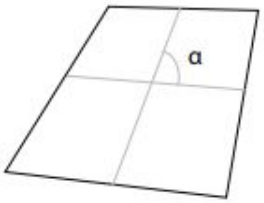
It is defined as the angle between the normals to two planes formed by splitting the quad element along the diagonals. The maximum angle of the two possible angles is reported as the warp angle.



Skew :

Ideal value = 0 (Acceptable < 45^0)

Skew for quadrilateral element = 90^0 minus the minimum angle between the two lines joining the opposite mid-sides of the element (α).



Jacobian:

Ideal value = 1.0 (Acceptable > 0.6)

Recomendaciones y técnicas de y mallado

Parámetros de control (Varían de acuerdo al programa usado):

Distortion :

Ideal value = 1.0 (Acceptable > 0.6)

Distortion is defined as - | Jacobian | * $Area_{LCS}$ / $Area_{GCS}$

LCS – Local Coordinate system

GCS – Global Coordinate system

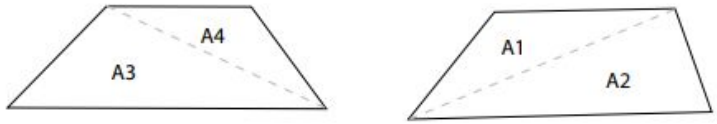
Stretch:

Ideal value: 1.0 (Acceptable > 0.2)

For quadrilateral elements stretch = L_{min} * √ 2 / d_{max}

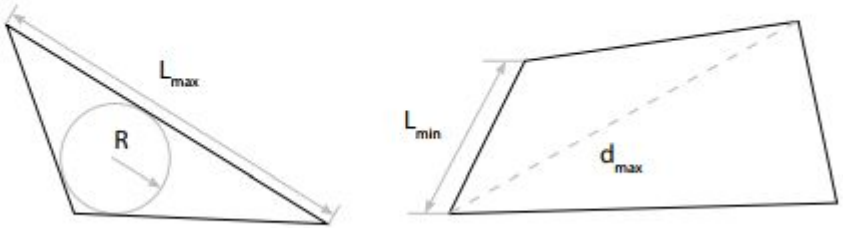
Taper:

Ideal value = 0 (Acceptable < 0.5)



Taper = $\Sigma | (A_i - A_{avg}) / A_{avg} |$

$A_{avg} = (A_1 + A_2 + A_3 + A_4) / 4$



Minimum element length

Stretch for triangular element = R * √ 12 / L_{max}

Included angles :

Chord deviation :

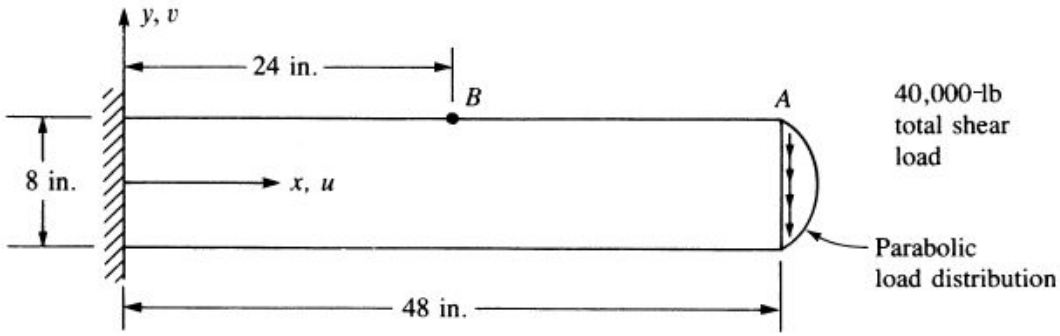
Skew is based on the overall shape of the element and it does not take into account the individual angles of a quadrilateral or triangular element. Included or interior angle check is applied for individual angles.

Quad Ideal value = 90^0. (Acceptable = $45^0 < \theta < 135^0$)

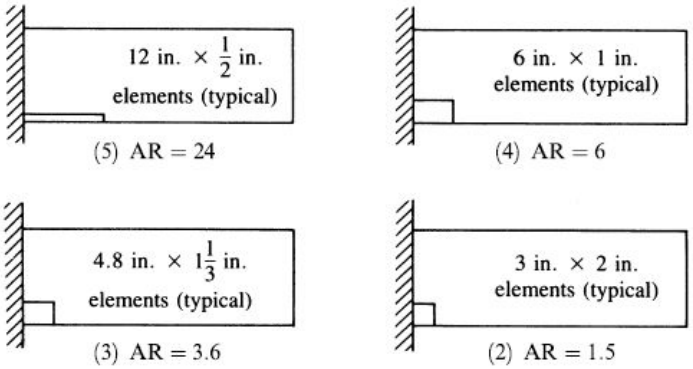
Tria: Ideal value = 60^0 (Acceptable = $20^0 < \theta < 120^0$)

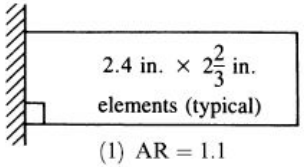
Recomendaciones y técnicas de y mallado

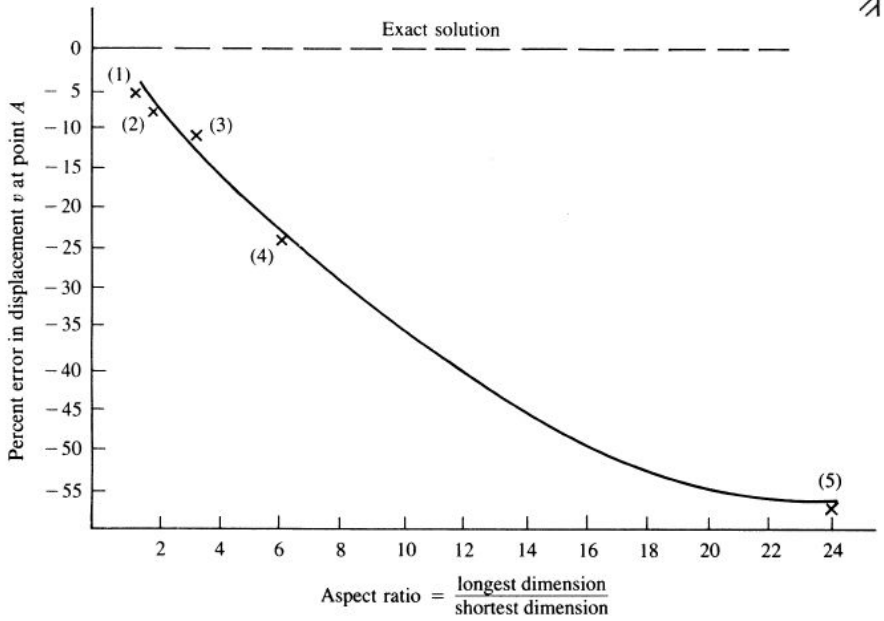
Aspect ratio



$E = 30 \times 10^6$ psi
$v = 0.3$
$t = 1.0$ in.

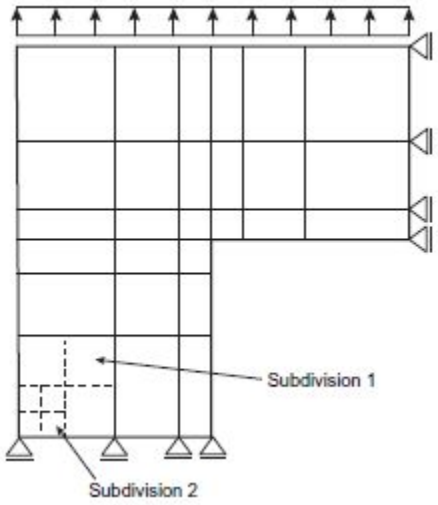


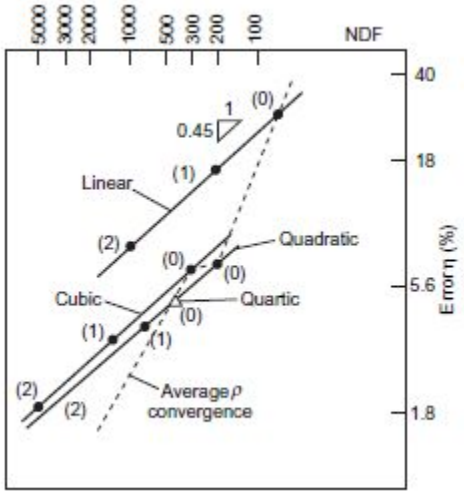


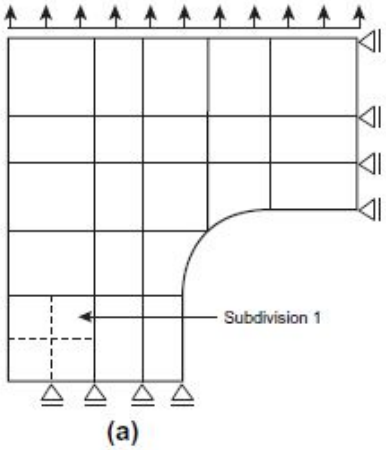


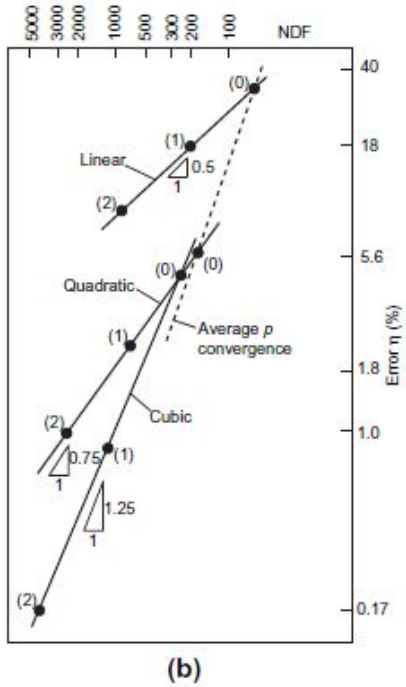
Recomendaciones y técnicas de y mallado

Convergencia en problemas con singularidades

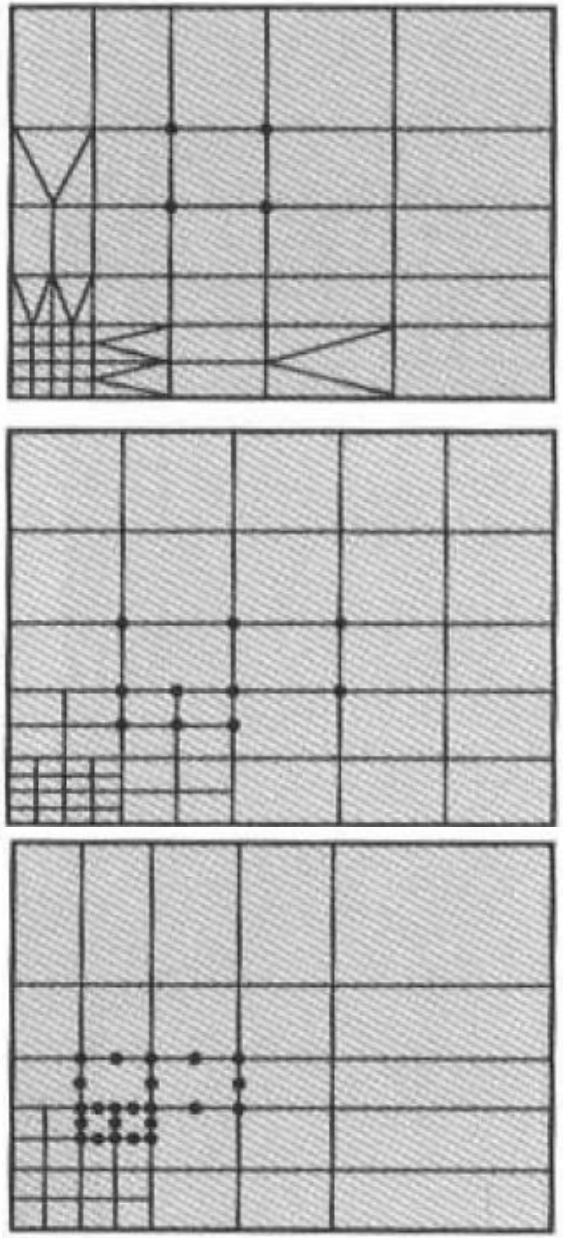




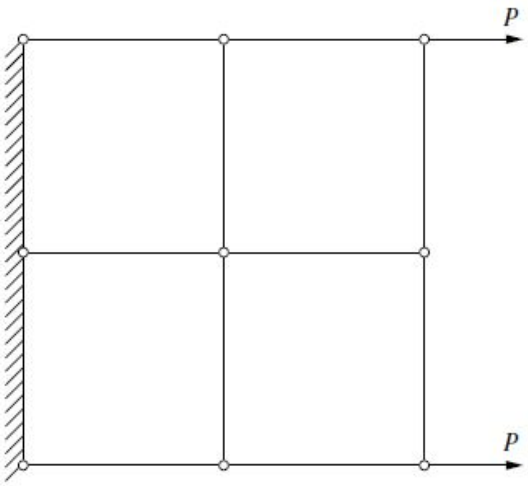




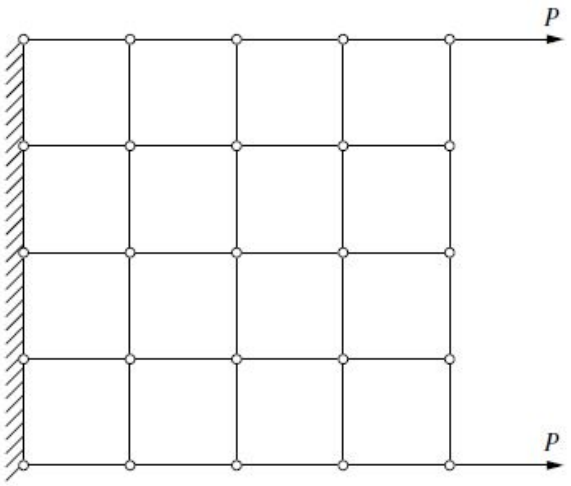
Recomendaciones y técnicas de y mallado



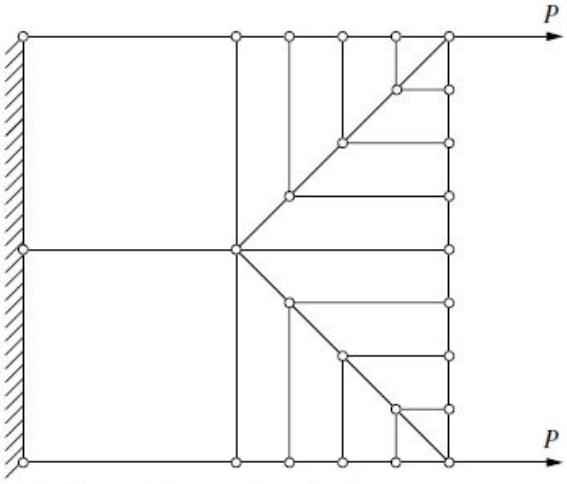
Refinamiento p y h



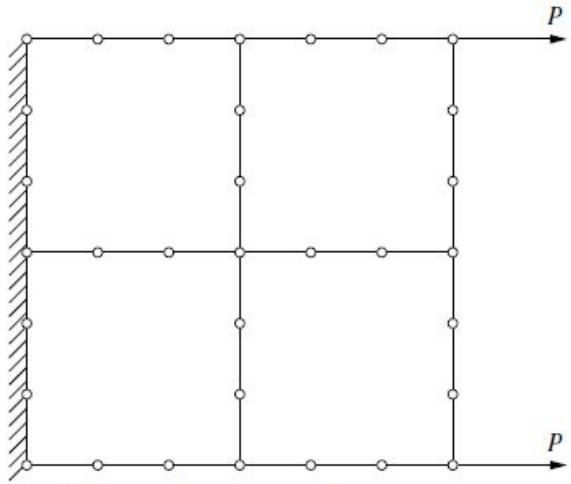
(a) Original mesh



(b) A uniformly refined mesh



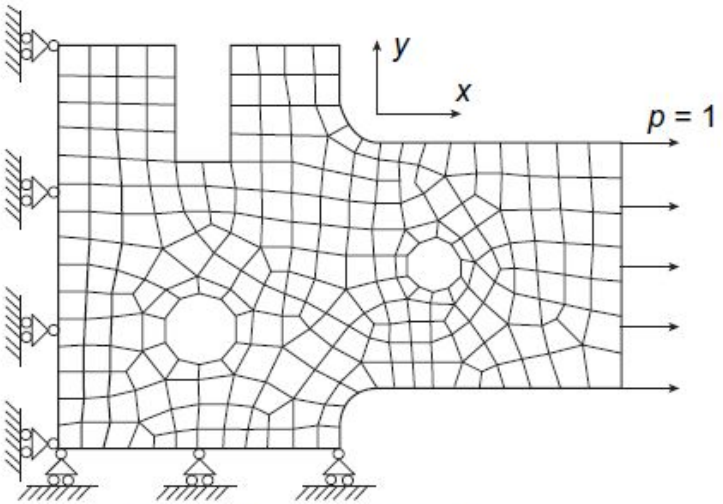
(c) A possible nonuniform *h* refinement



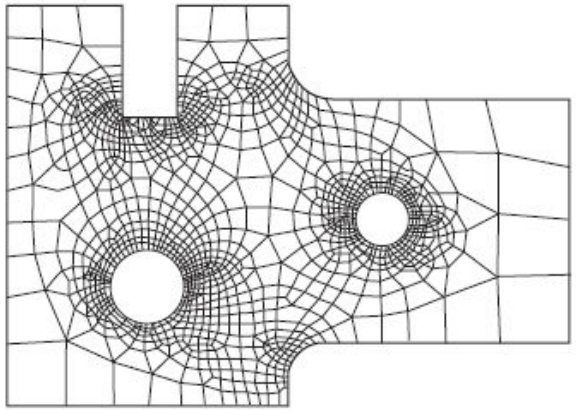
(d) A possible uniform *p* refinement

Recomendaciones y técnicas de y mallado

Refinamiento adaptativo

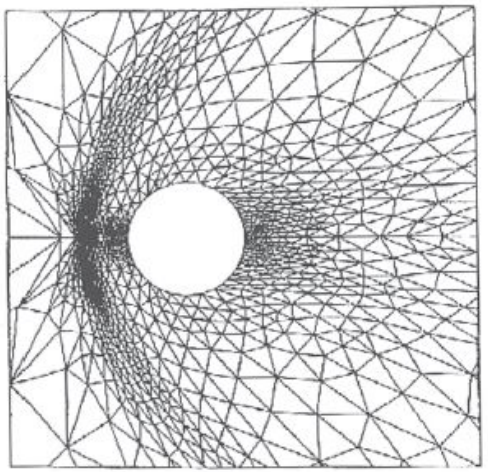


Mesh 1 (565 d.o.f.) $\eta = 9.75\%$

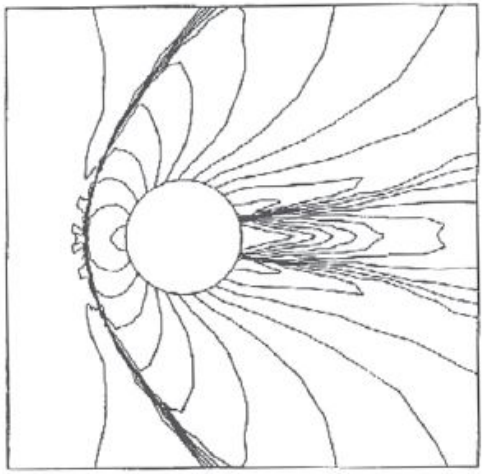


Mesh 2 (3155 d.o.f.) $\eta = 4.85\%$

Refinamiento direccional



(a)

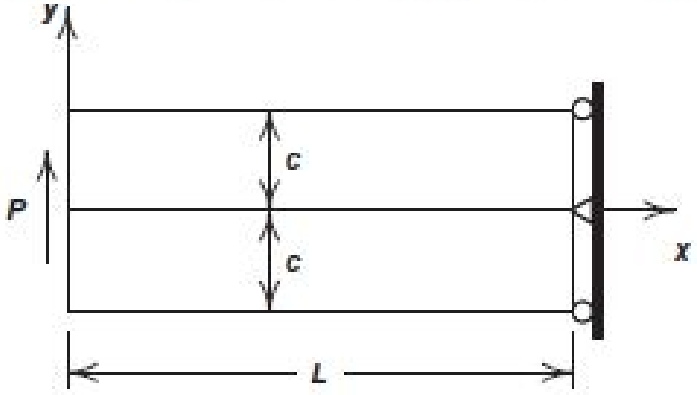


(b)

Problema de estado plano de tensión

Datos

$$c = 10, \quad L = 100, \quad w = 1, \quad P = 80, \quad E = 1000, \quad \text{and} \quad \nu = 0.25$$



Condiciones de borde

$$u(L, 0) = v(L, 0) = 0$$
$$u(L, c) = u(L, -c) = 0$$

Cargas

$$\begin{Bmatrix} t_x \\ t_y \end{Bmatrix} = w \begin{Bmatrix} 0 \\ -\tau_{xy} \end{Bmatrix} \quad x = 0, \ -c \le y \le c$$

$$\begin{Bmatrix} t_x \\ t_y \end{Bmatrix} = w \begin{Bmatrix} -\sigma_x \\ \tau_{xy} \end{Bmatrix} \quad x = L, \ -c \le y \le c$$

Solución exacta

$$u = -\frac{P(x^2 - L^2)y}{2EI} - \frac{\nu P y(y^2 - c^2)}{6EI} + \frac{Py(y^2 - c^2)}{6GI}$$
$$v = \frac{\nu P x y^2}{2EI} + \frac{P(x^3 - L^3)}{6EI} - \left(\frac{PL^2}{2EI} + \frac{\nu Pc^2}{6EI} + \frac{Pc^2}{3GI}\right)(x - L)$$

$$\sigma_x = -\frac{3}{2}\frac{Pxy}{c^3}$$
$$\sigma_y = 0$$
$$\tau_{xy} = -\frac{3P}{4c}\left[1 - \left(\frac{y}{c}\right)^2\right]$$

Problema de estado plano de tensión

Estudiar convergencia de desplazamientos y tensiones para

- Elementos Q4 integración full
- Elementos Q4 integración reducida
- Elementos Q8 integración full
- Elementos Q8 integración reducida

usando al menos 3 mallas y que la primera tenga solo un elemento en altura.