

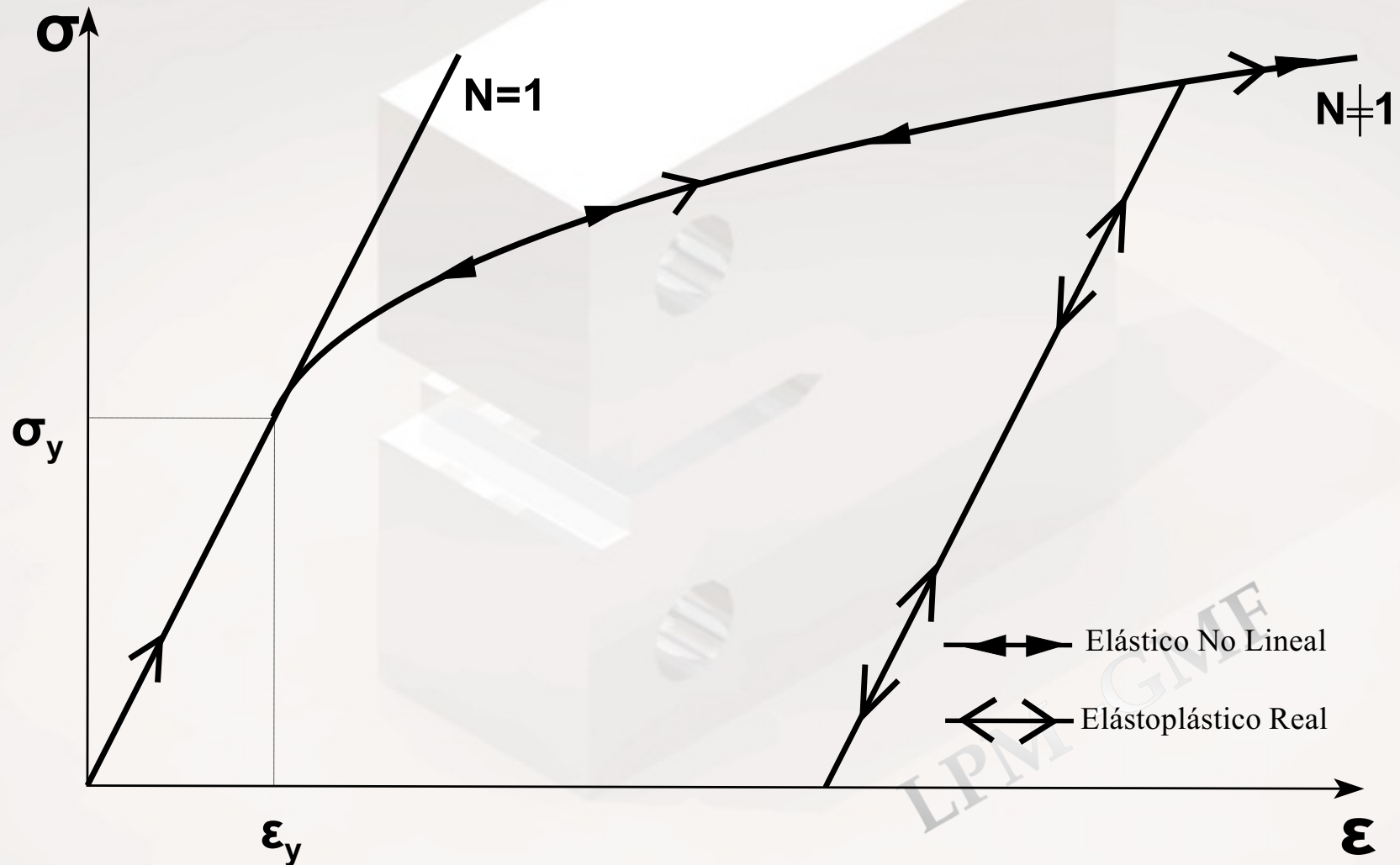
# Criterio J

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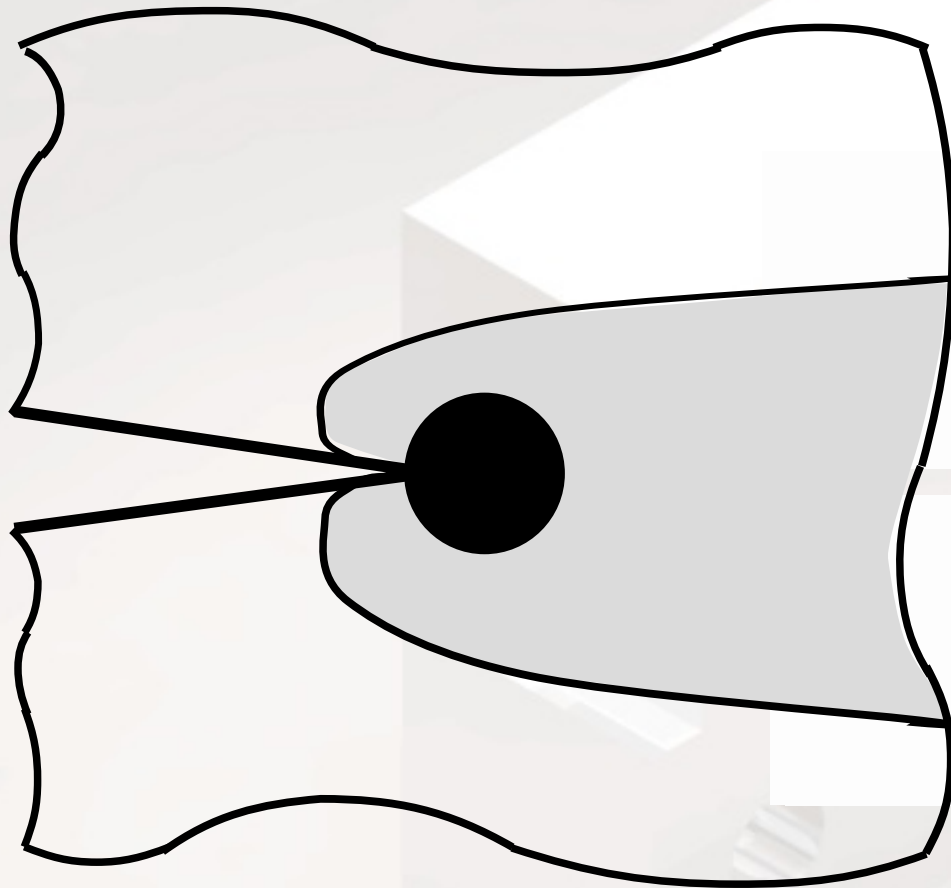
LPM -GME

# Elastoplasticidad y Elasticidad No Lineal

## Modelo de Ramberg - Oswood



# Campo HRR

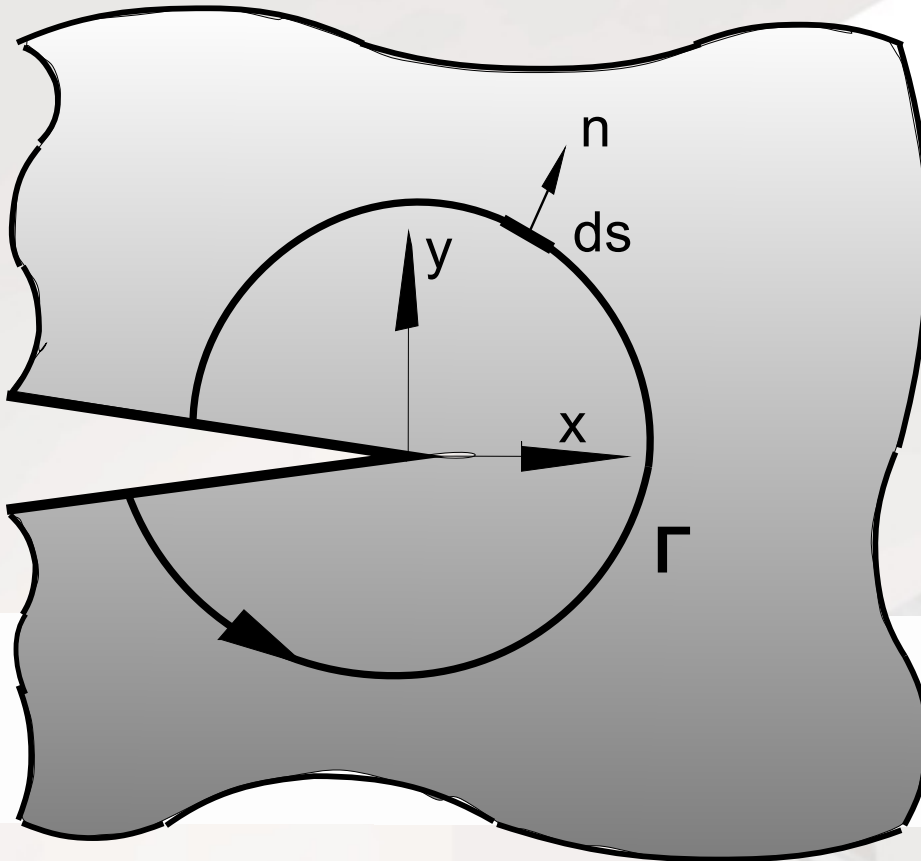


 Zona deformada plásticamente

$$\sigma_{ij} = \sigma_y \left( \frac{J_I}{r \sigma_y \epsilon_y} \right)^{\frac{1}{N+1}} f(r, \theta, N)$$

$$\epsilon_{ij} = \epsilon_y \left( \frac{J_I}{r \sigma_y \epsilon_y} \right)^{\frac{N}{N+1}} g(r, \theta, N)$$

# Integral J de Rice



$$J = \int_{\Gamma} (W dy - \vec{T} \frac{\partial \vec{u}}{\partial x} ds)$$

$\vec{T}$  : Vector tracción:  $T_i = \sigma_{ij} n_j$ .

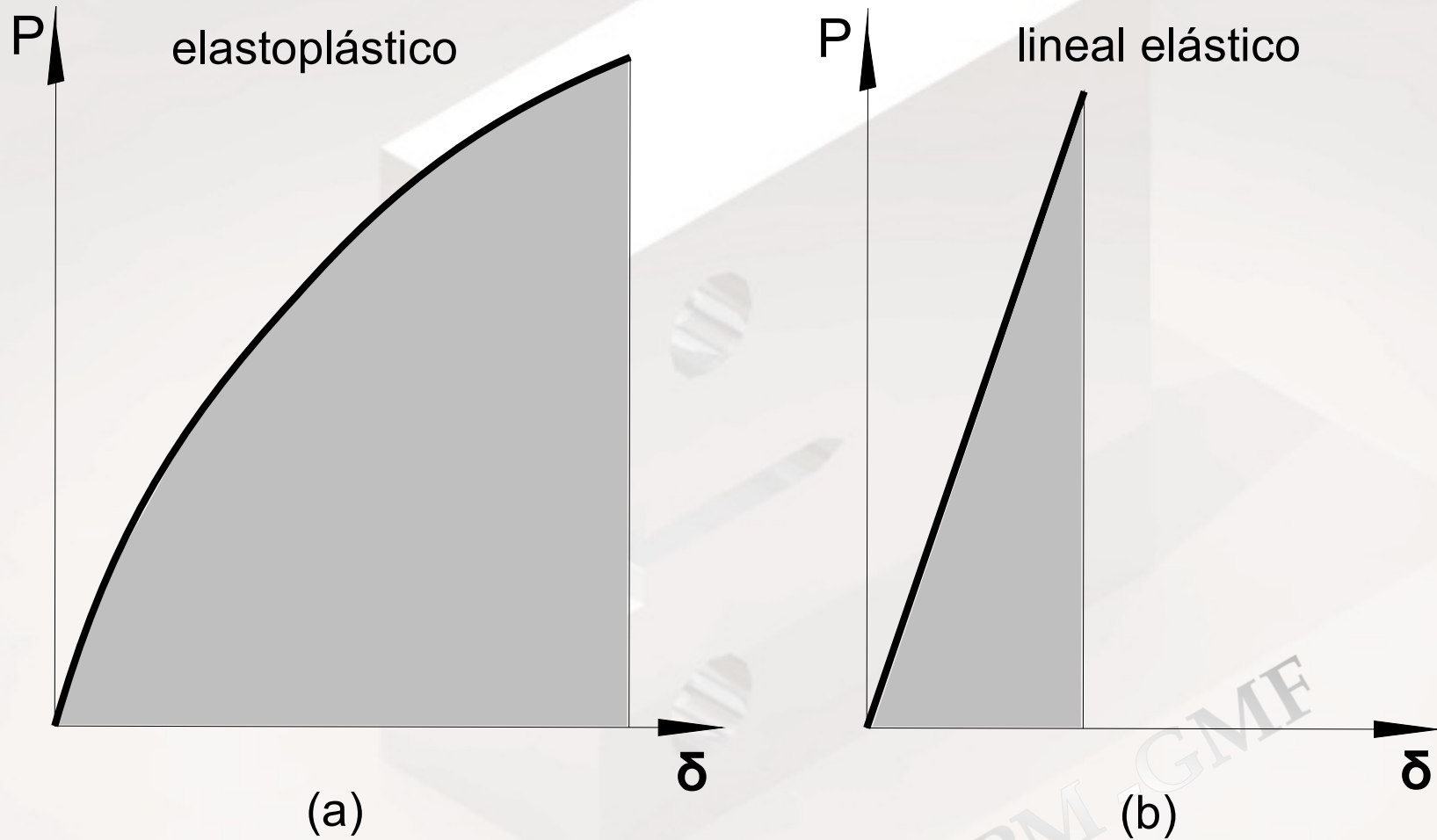
$n_j$ : versor normal a la curva  $\Gamma$ .

$\vec{u}$  : vector desplazamiento.

$ds$ : elemento de arco de  $\Gamma$ .

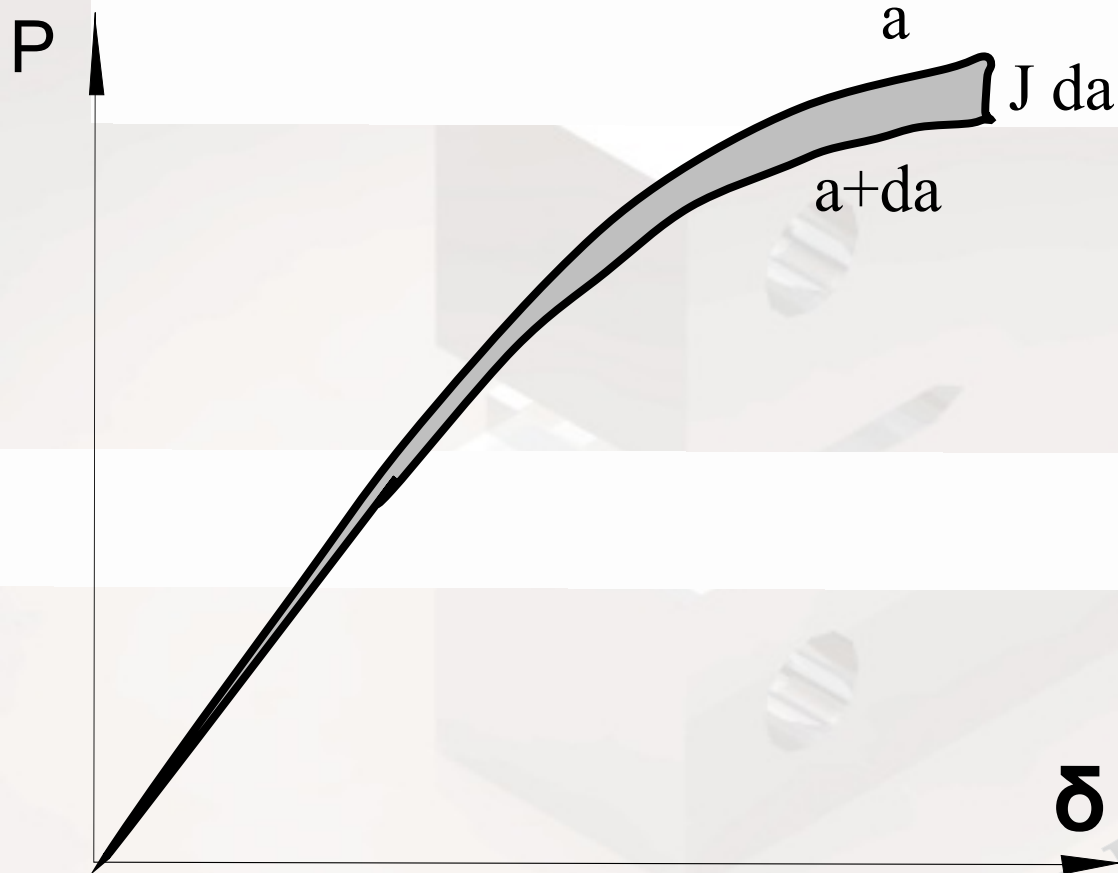
$W = W(x,y) = \int \sigma_{ij}^e \epsilon_{ij}$  : densidad de energía de deformación (figura 4).

# Densidad de Energía de Deformación



# Interpretación Energética

$$J = - \frac{dU_P}{da} \quad (5)$$



$$G = J$$

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# Criterio de Fractura

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Begley & Landes

$$J_I \geq J_{IC}$$

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# Relación entre CTOD y J

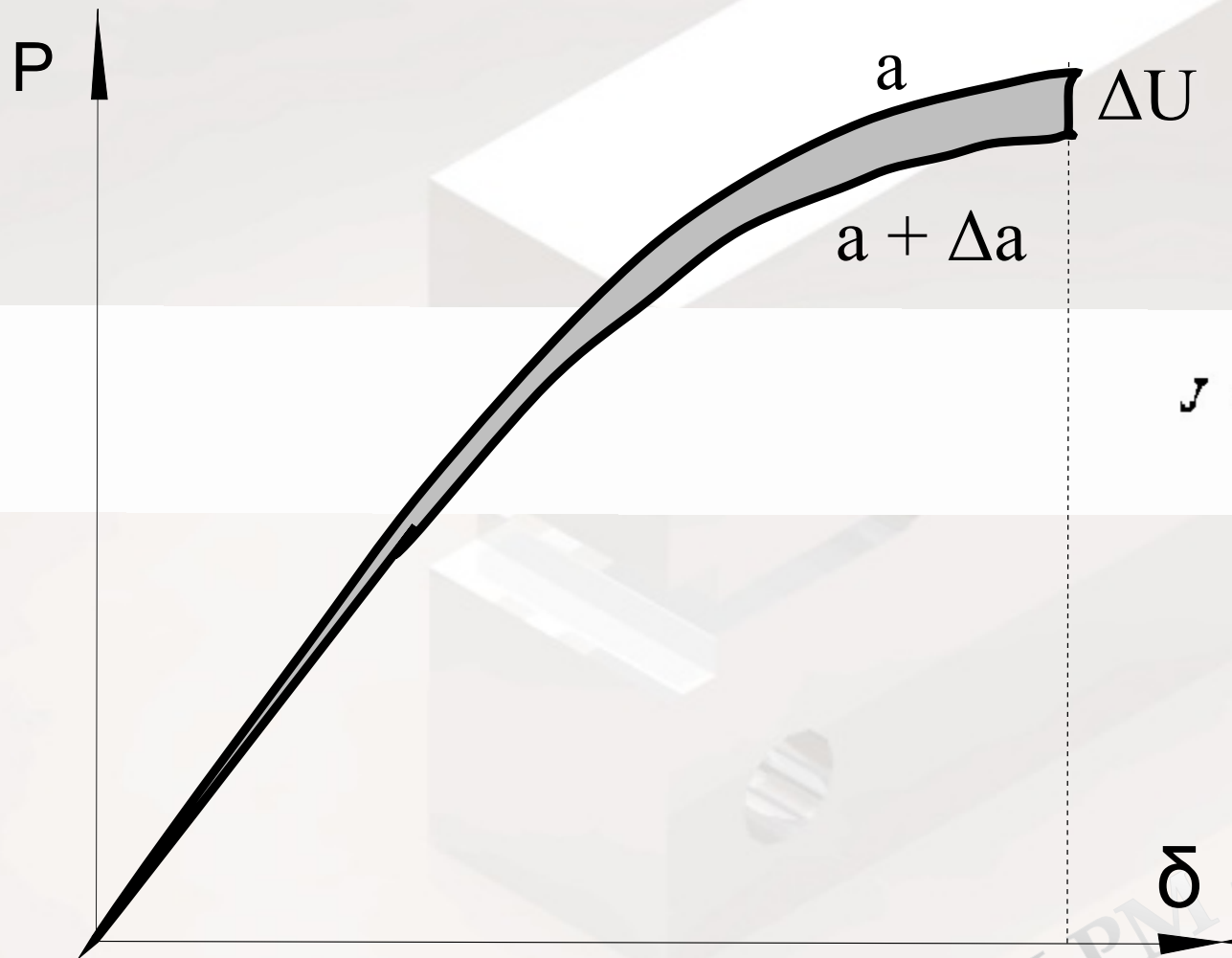
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$$J = m\sigma_y \delta$$

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# Determinación Experimental de J

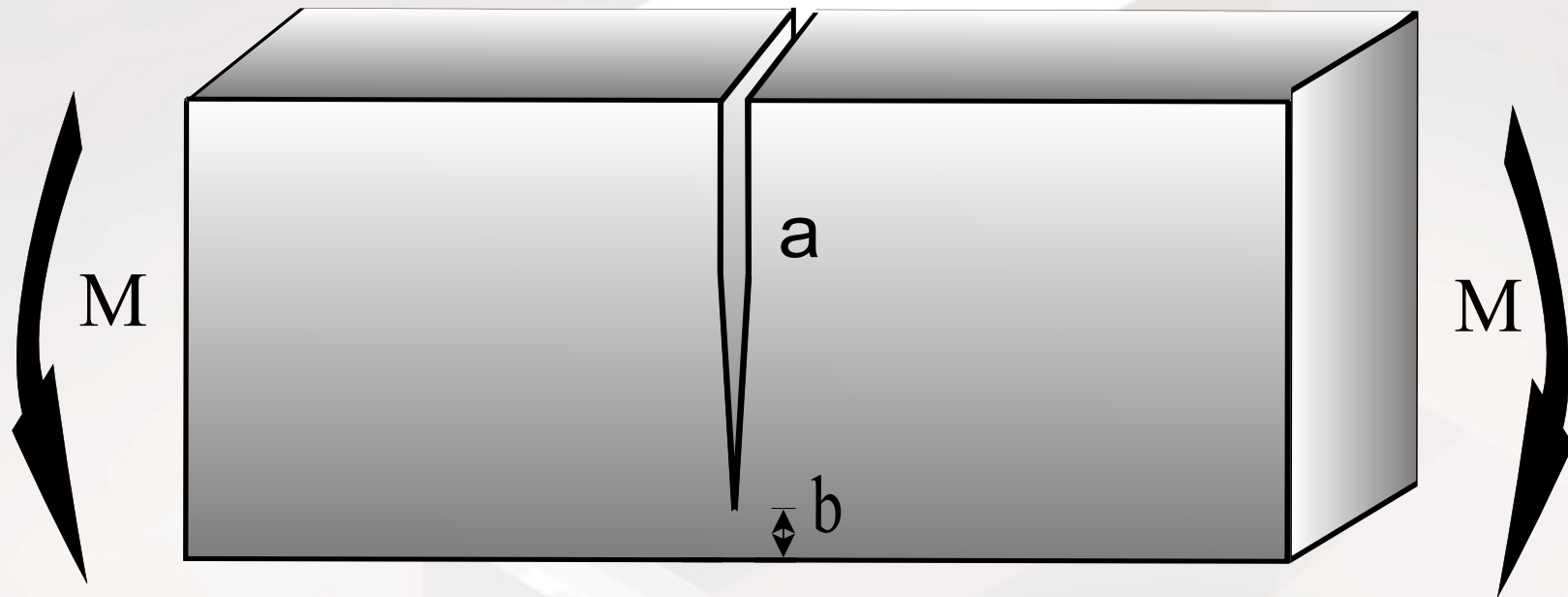


$$J = \frac{1}{B} \frac{\Delta U}{\Delta a} \quad (1)$$

LPM-GMF

# Propuesta de Rice, Paris & Merkle

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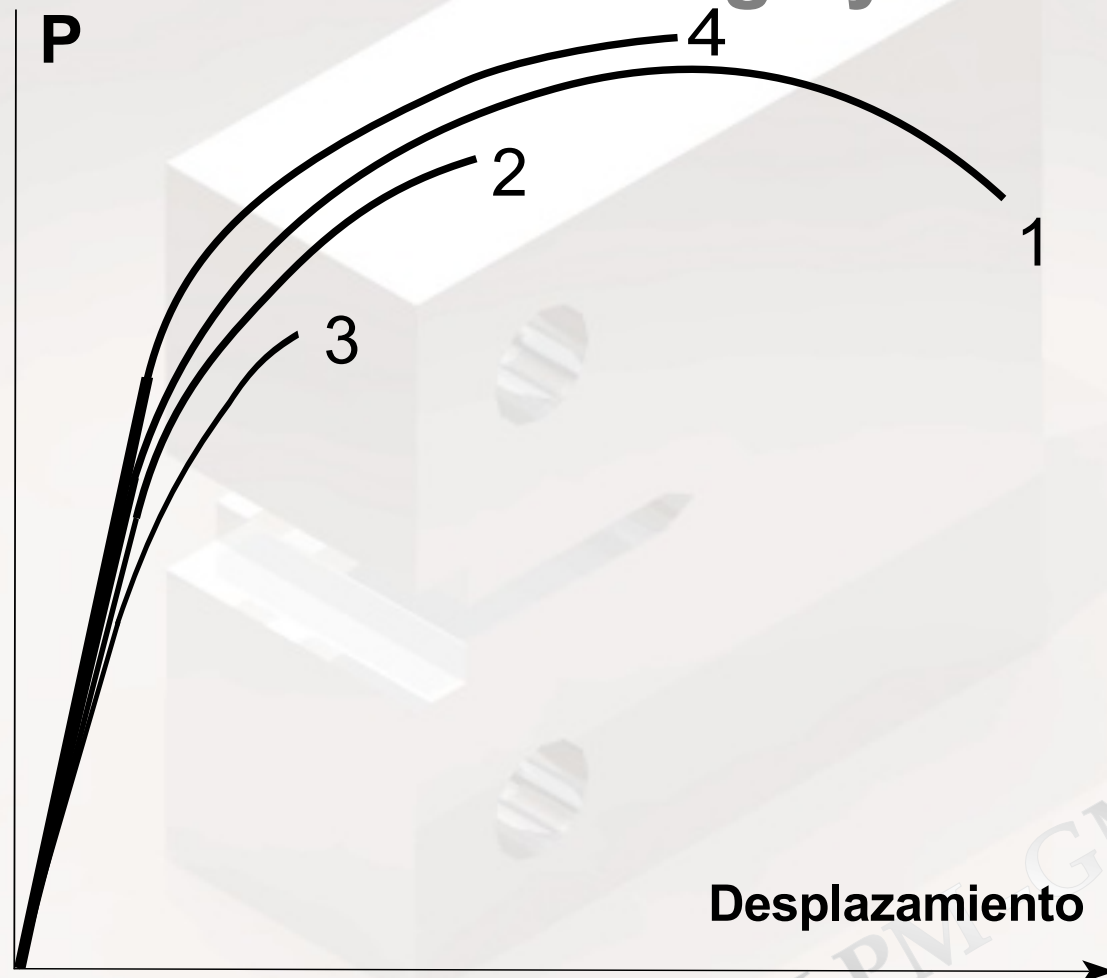


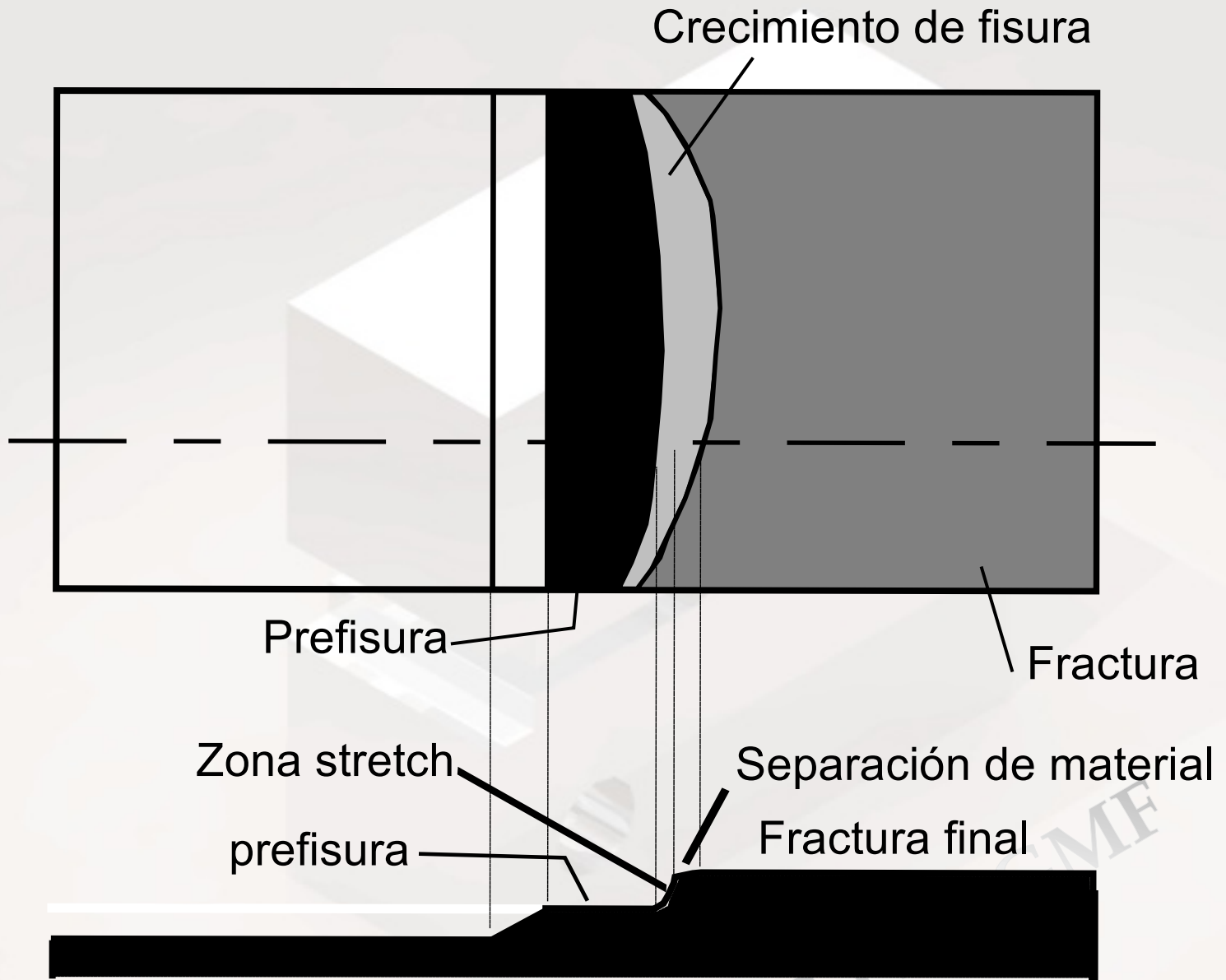
$$J_I = \frac{2}{Bb} \int_0^{v_f} P dv = \frac{2}{Bb} A \quad (1)$$

LPN

# Método Multiprobeta para $J_{IC}$

Landes & Begley





Crecimiento de fisura

Prefisura

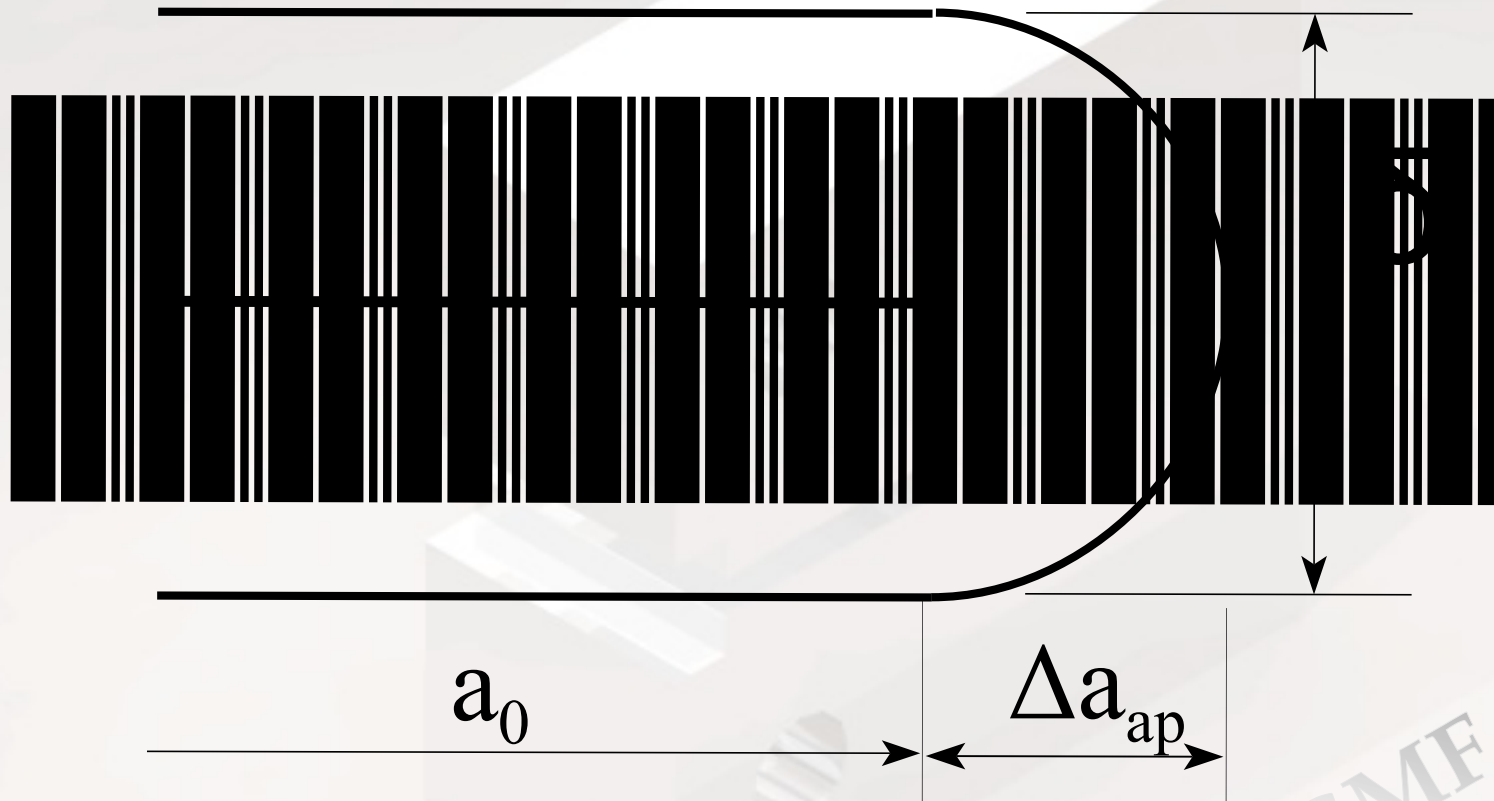
Fractura

Zona stretch

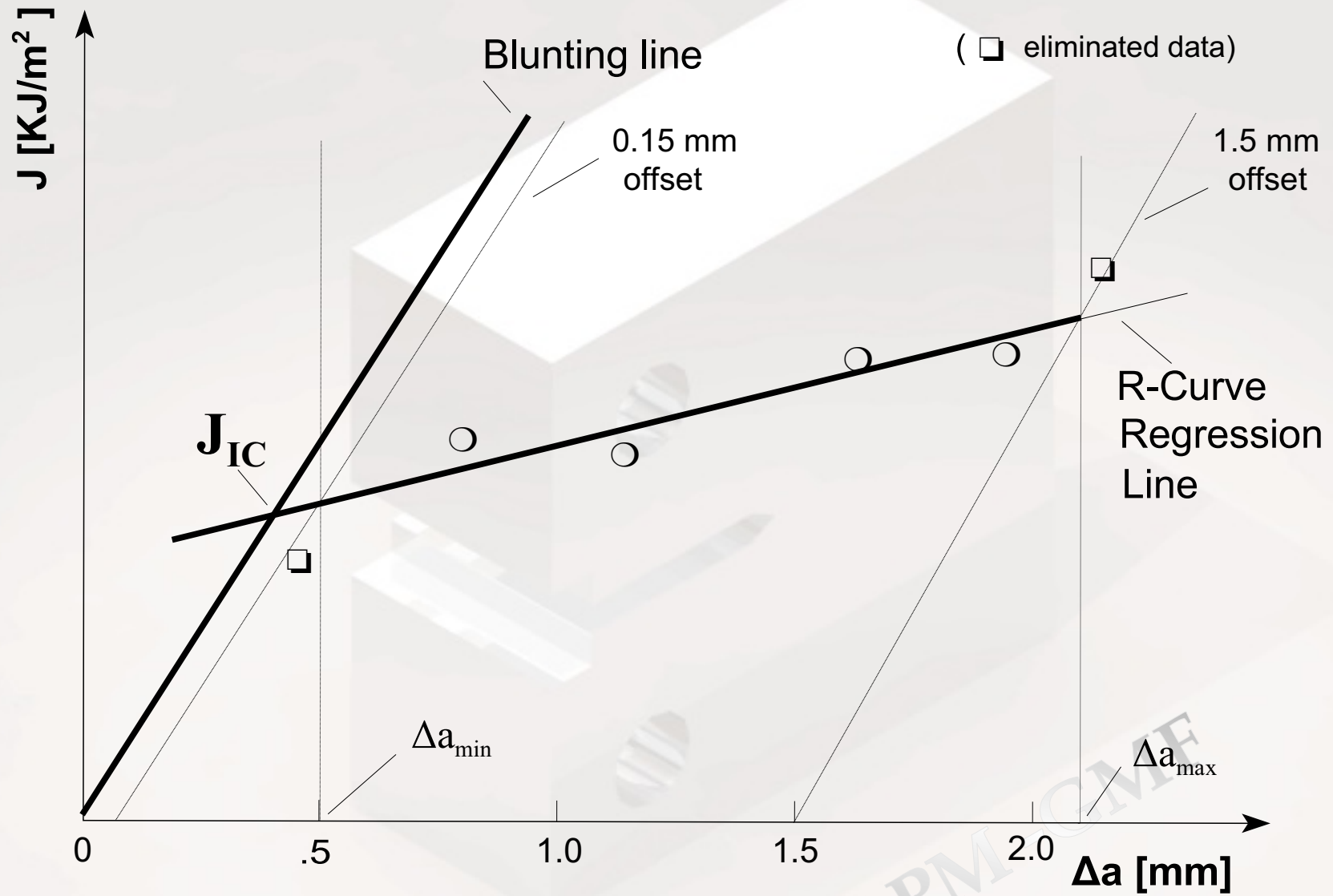
Separación de material

prefisura

Fractura final



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# Corrección por Componente de Tracción en CT

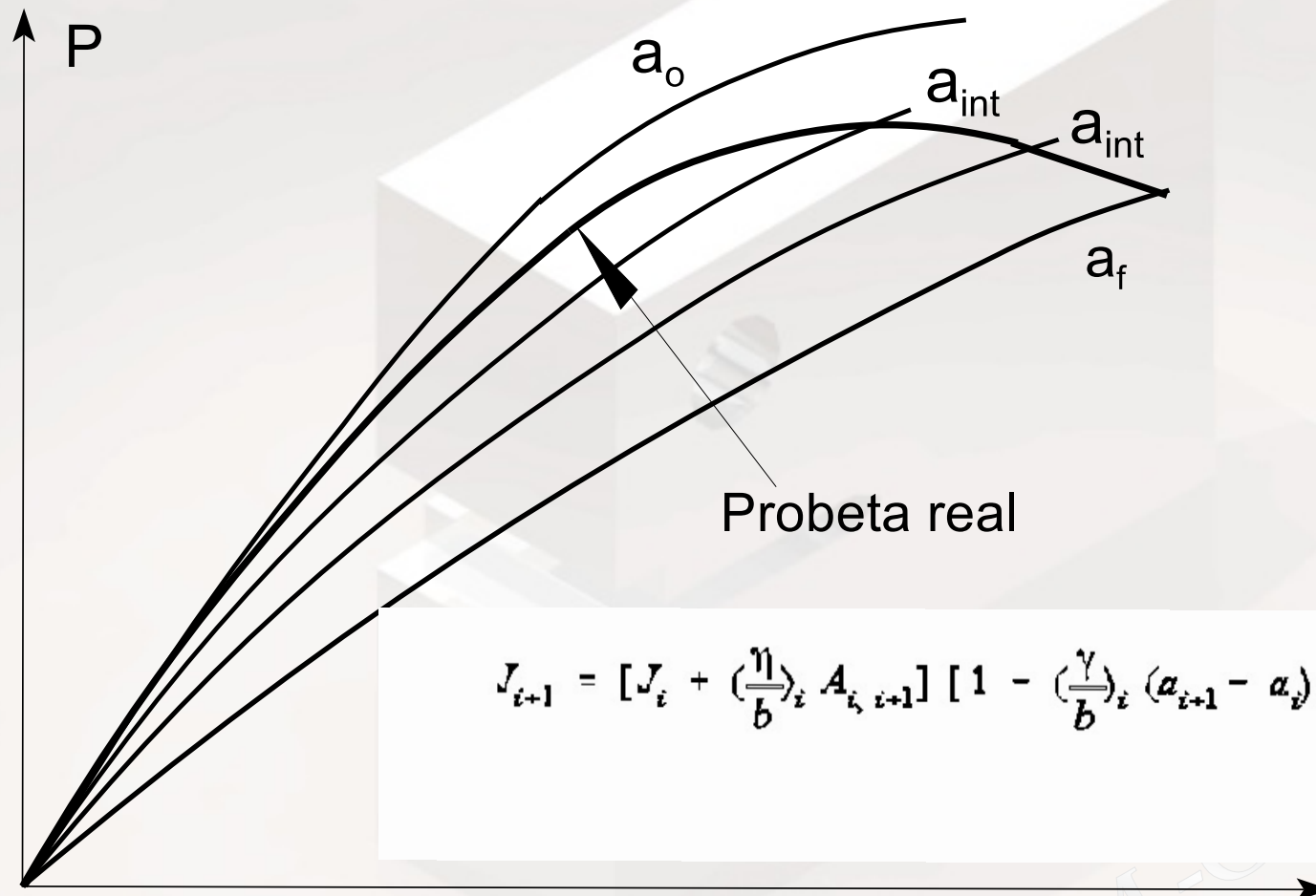
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$$J = J_{el} + J_{pl} = \frac{\eta_{el}}{bB} A_{el} + \frac{\eta_{pl}}{bB} A_{pl} \quad (1)$$

$$J = \eta \frac{A}{bB} \quad (1)$$

$$\eta = 2 + 0.522 \frac{b}{W} \quad (1)$$

# Corrección de J por Crecimiento Estable de Fisura

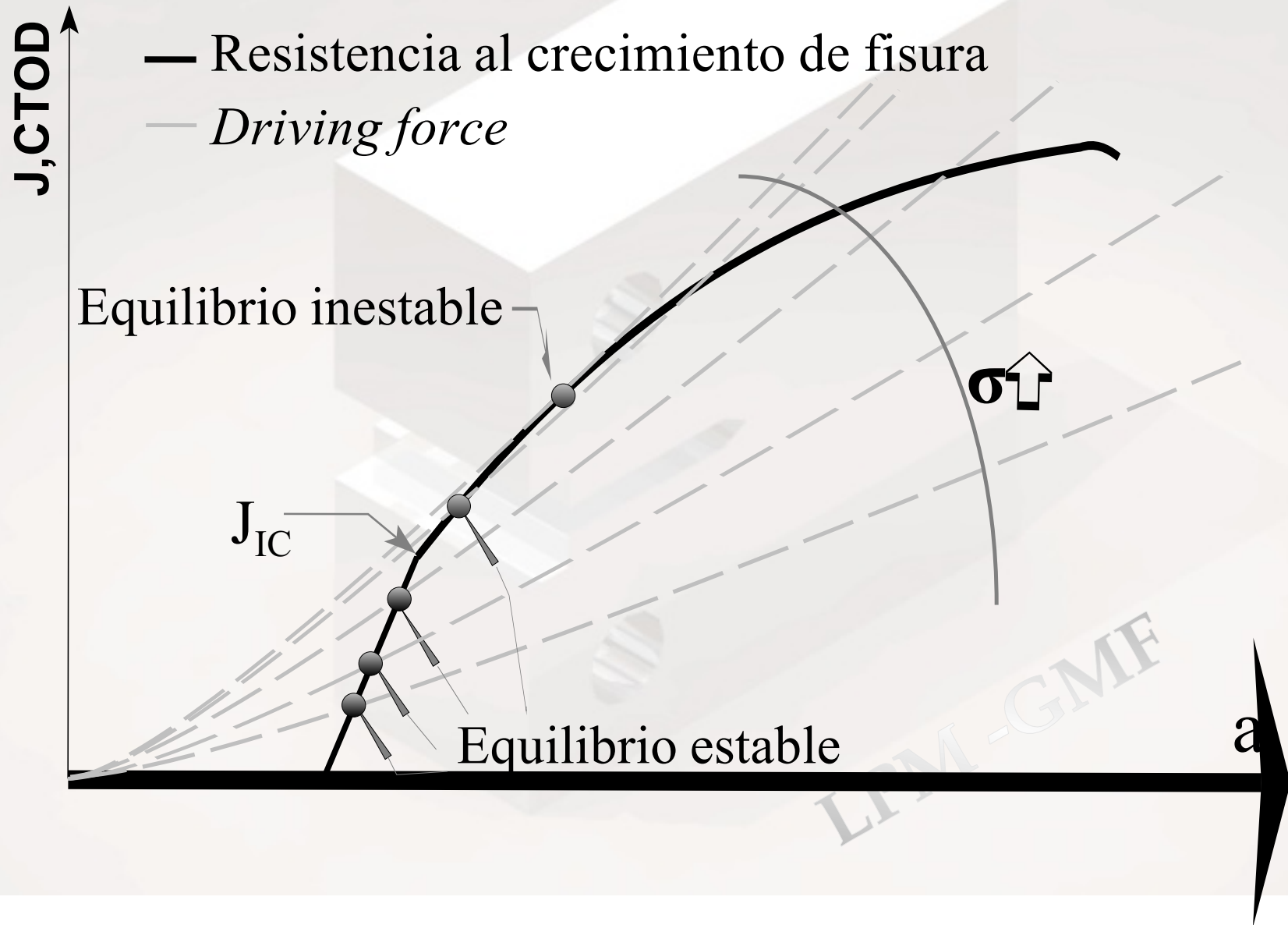


$$J_{i+1} = [J_i + \left(\frac{\eta}{b}\right)_i A_{i, i+1}] \left[1 - \left(\frac{\gamma}{b}\right)_i (a_{i+1} - a_i)\right]$$

LPM



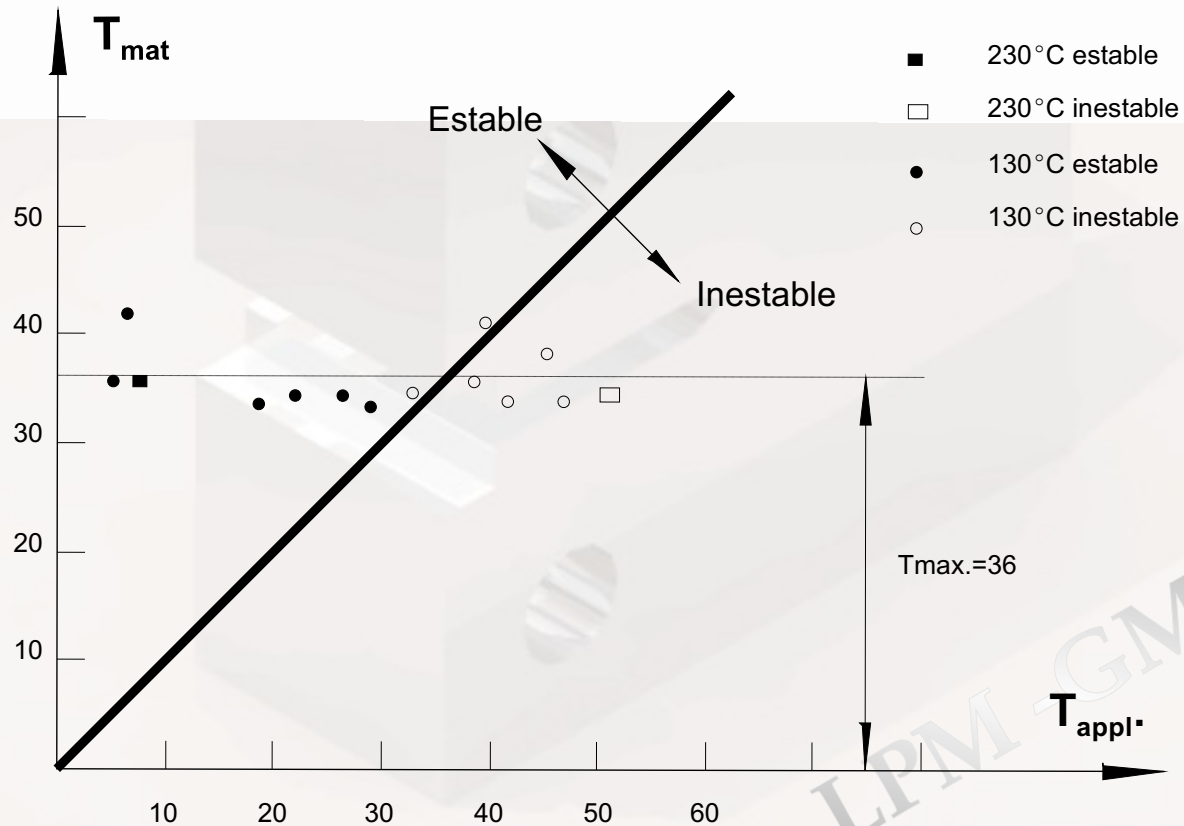
# Curvas J-R

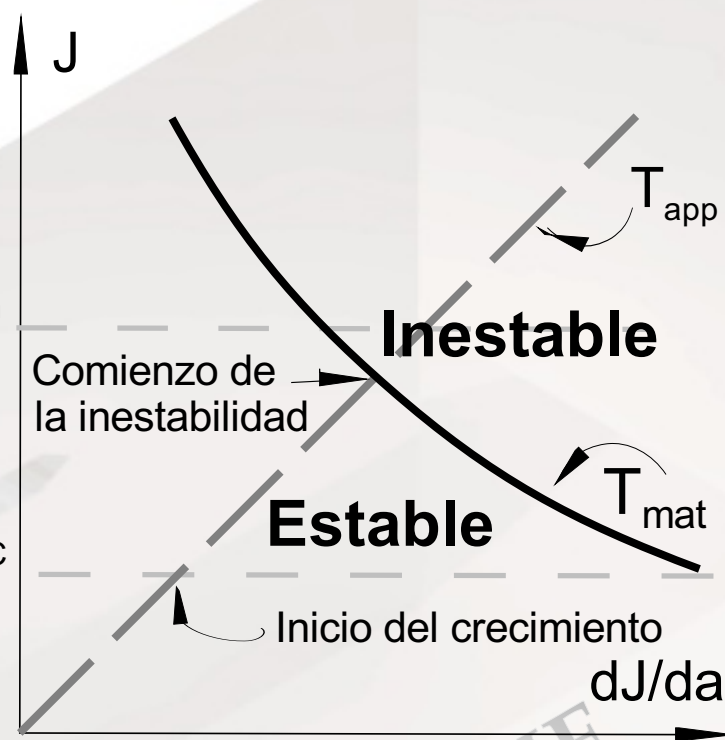
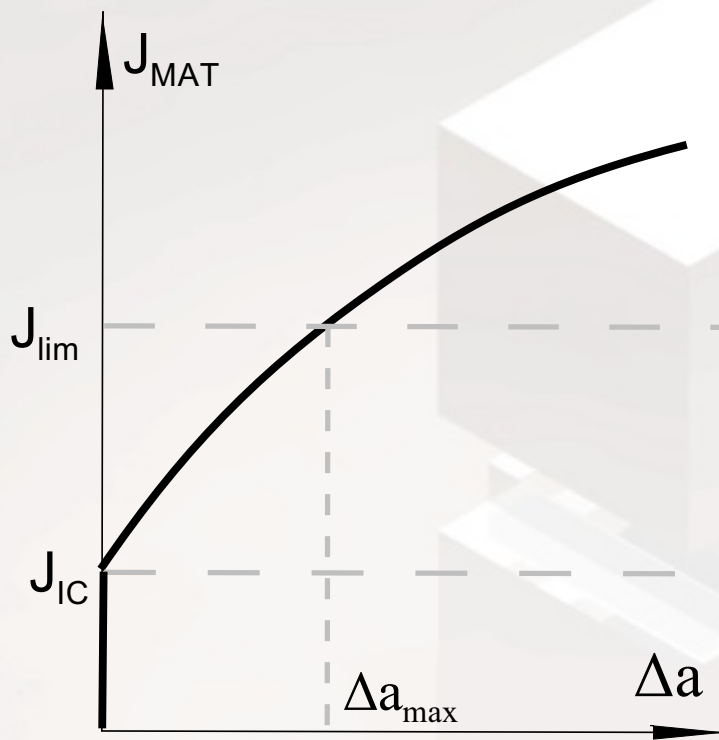


# Módulo de Desgarramiento, T

$$T = \frac{E}{\sigma_0^2} \frac{dJ}{da} \quad (1)$$

$$T_{app} > T_{mat}$$





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# Límites en J

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- Validez en fluencia en gran escala
- Crecimiento estable de fisura
- Pérdida de *Constraint*

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# Validez en fluencia en gran escala

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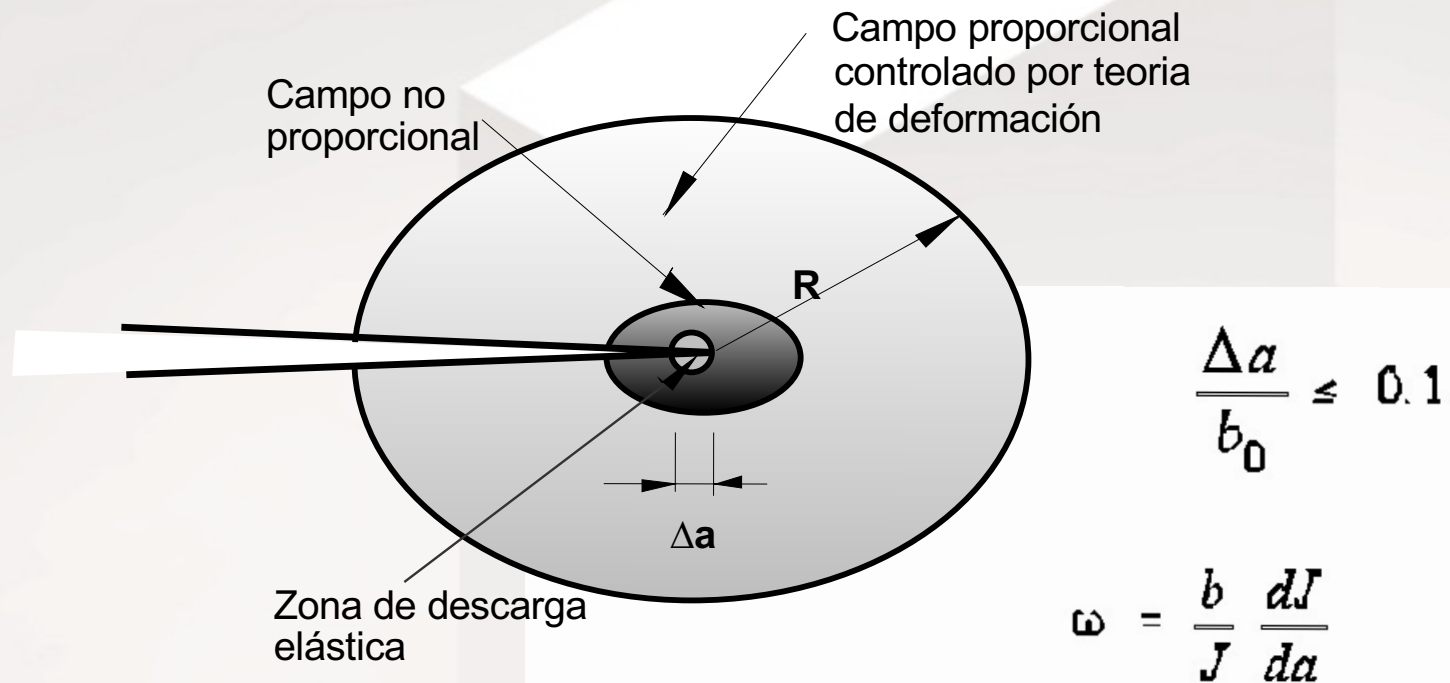
$$\rho = \frac{b\sigma_0}{J} > 1$$

$$\rho_{\min} = f\left(\frac{\sigma_{\text{tension}}}{\sigma_{\text{bending}}}\right)$$

$$b \geq 25 \text{ a } 50 \frac{J}{\sigma_0}$$

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# Validez por crecimiento estable de fisura



$$\frac{\Delta a}{b_0} \leq 0.1$$

$$\omega = \frac{b}{J} \frac{dJ}{da}$$

$$\omega > 1$$

# Efecto de Constraint

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$$\sigma_{ij} = \frac{K}{\sqrt{2\pi r}} f_{ij}(\theta) + T_{ij} \delta_{i1} \delta_{1j}$$

$$Q = \frac{\sigma_{\theta\theta} - \sigma_{\theta\theta HRR}}{\sigma_0}$$

LPM-GMF

# Metodología para medir $\Delta a$

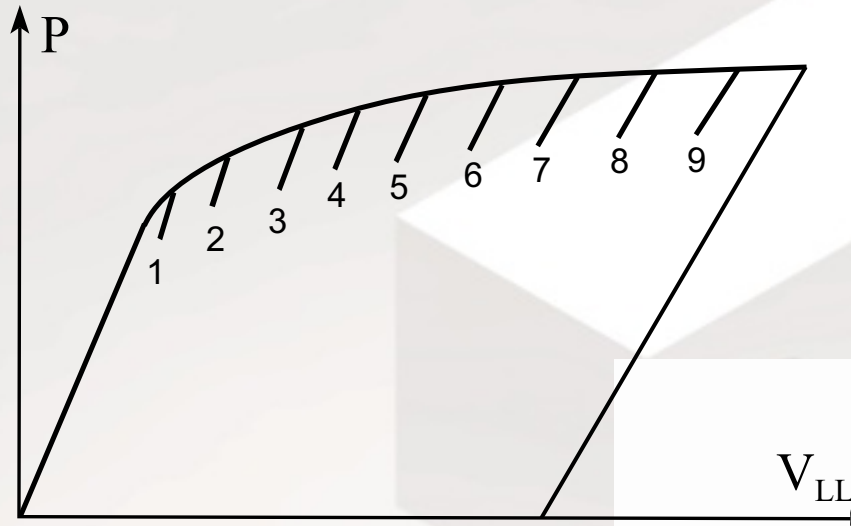
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- *Heat tinting* (múltiples probetas)
- Descargas parciales
- Caída de potencial eléctrico
  - ▶ ac
  - ▶ dc
- *Doble clip gauge*
- *Sin medición de tercera variable:*
  - ▶ *Key curves*
  - ▶ Normalización,
  - ▶ Spb

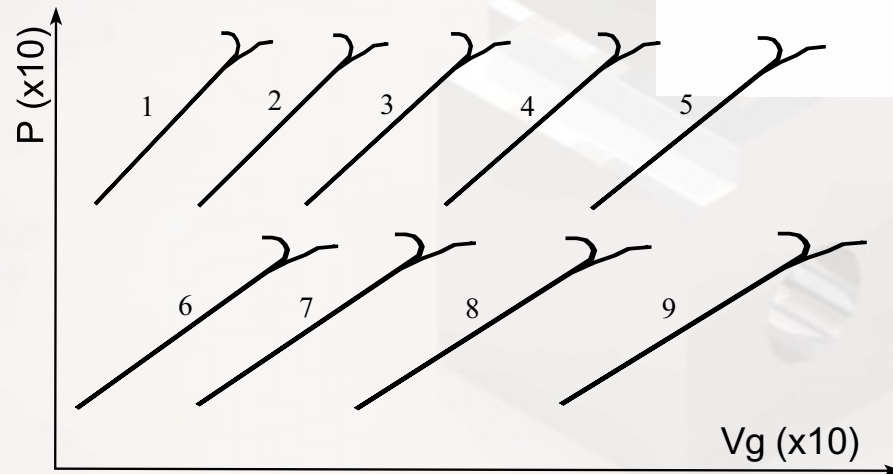
LPM -GME



# Descargas Parciales (unloading compliance)

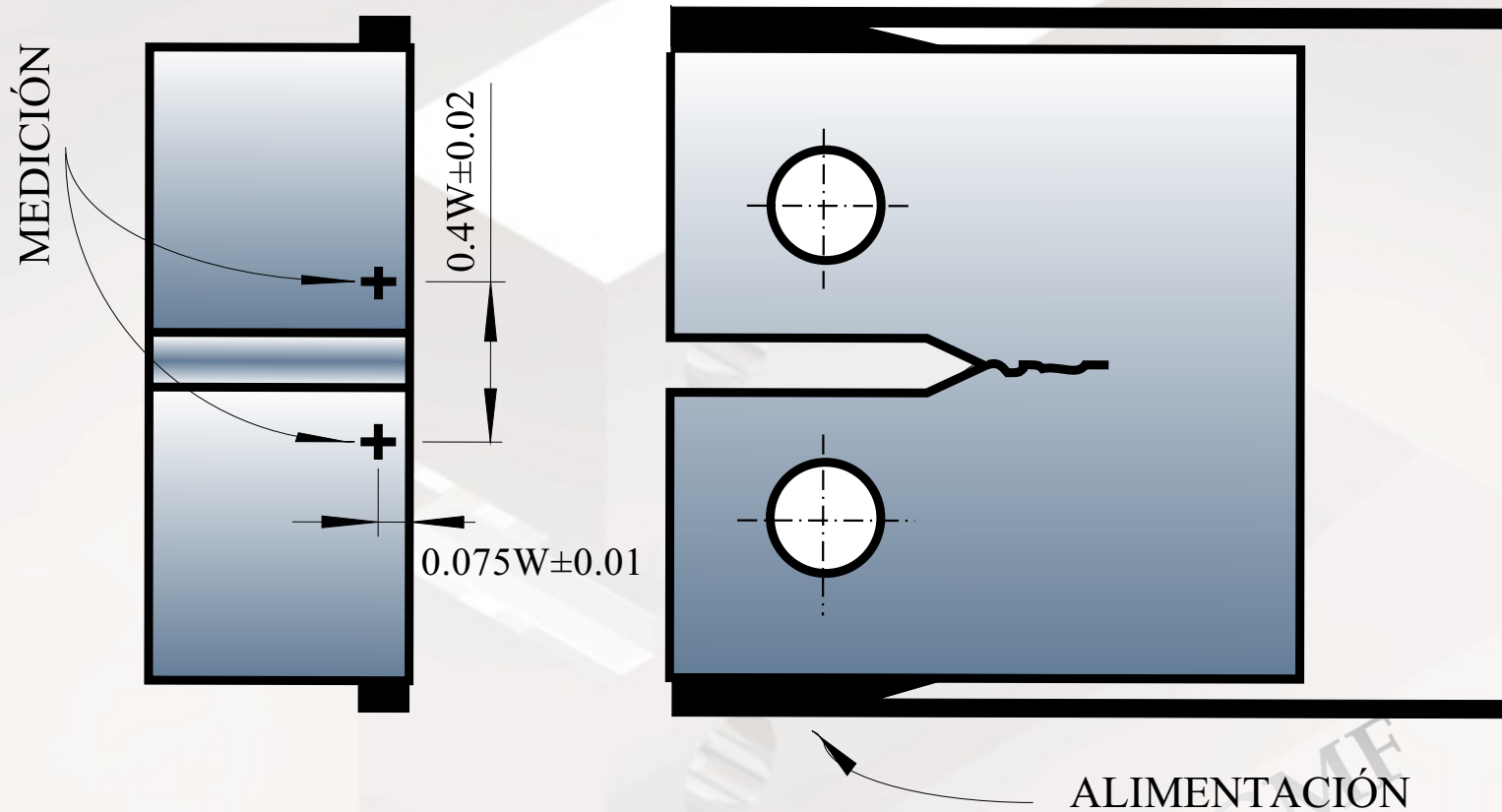


$$\frac{a}{W} = f\left(EB \frac{\Delta v_{el}}{\Delta P}\right)$$



LPM -GME

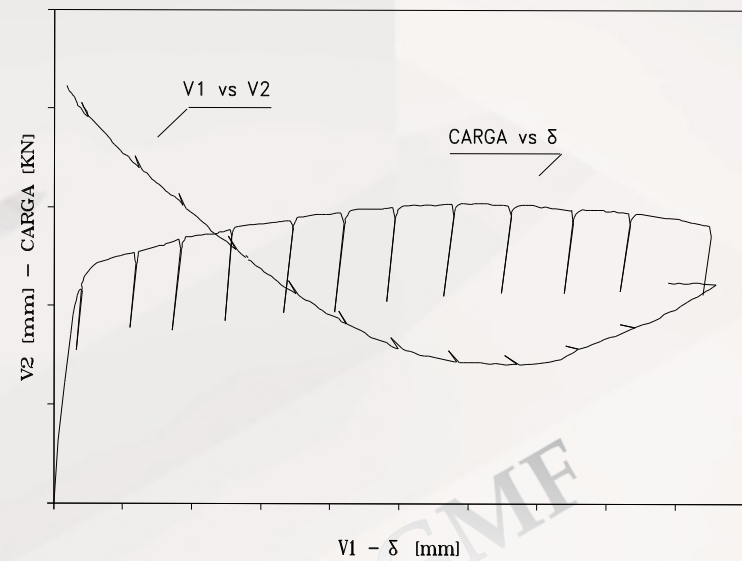
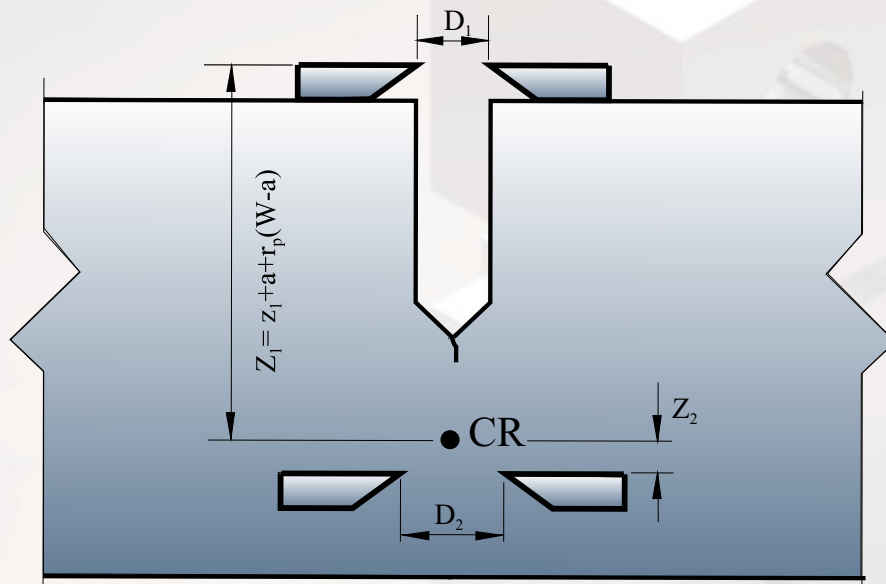
# Caída de potencial eléctrico



LPM - GME

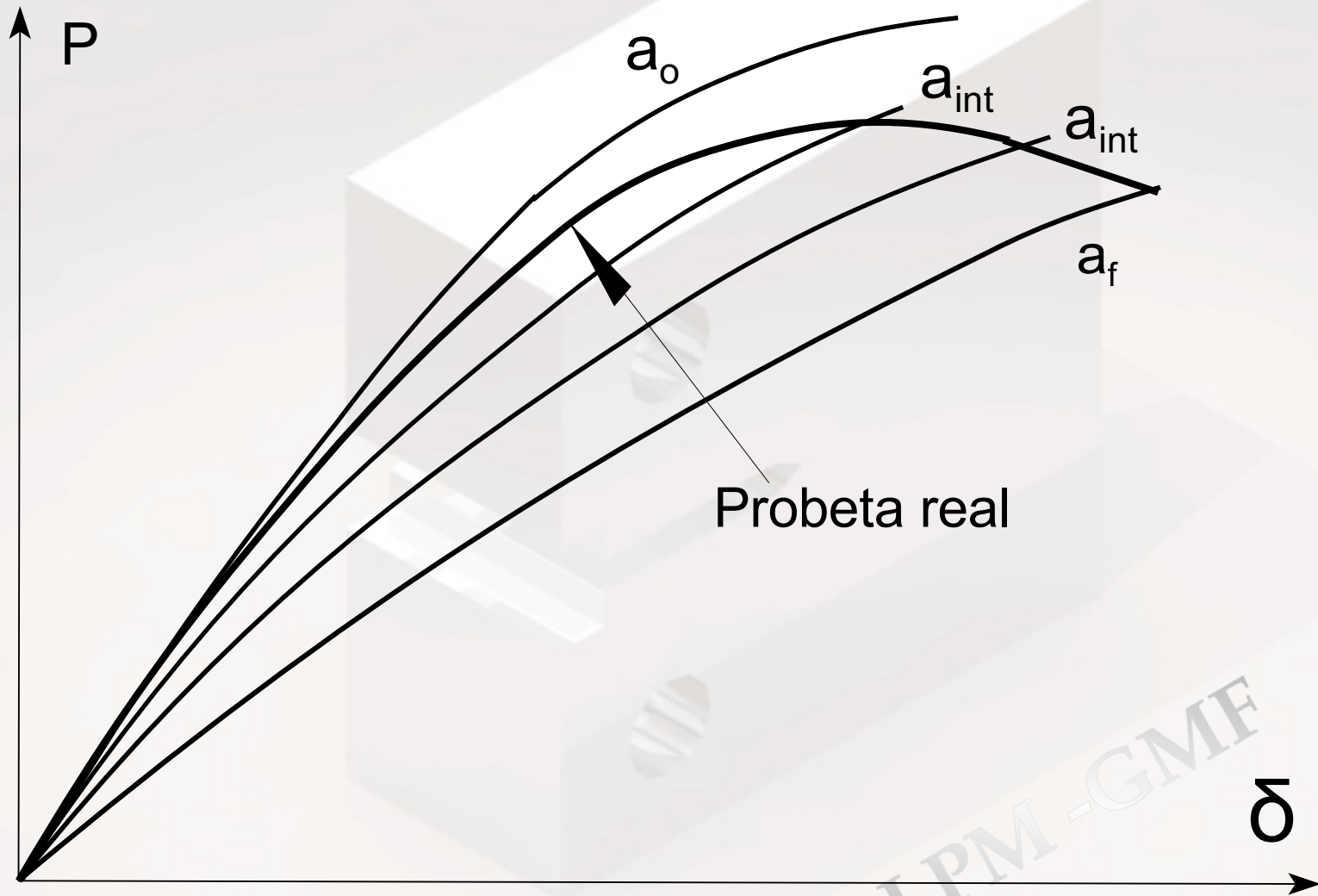
# Doble Clip Gauge

$$\frac{dV_1}{dV_2} = \frac{Z_1 + a + r_p(W-a)}{Z_2 + a + r_p(W-a)}$$

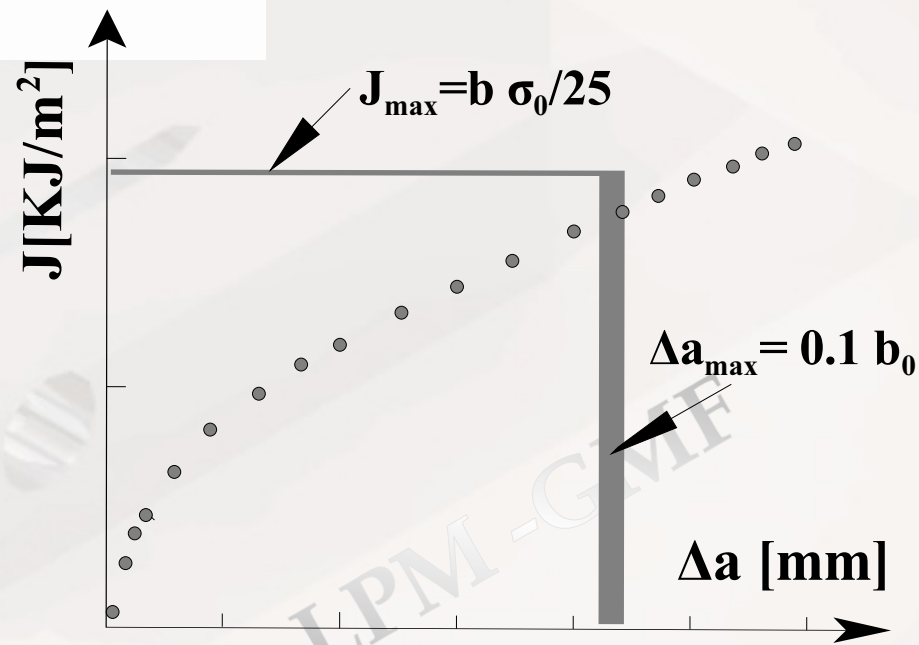
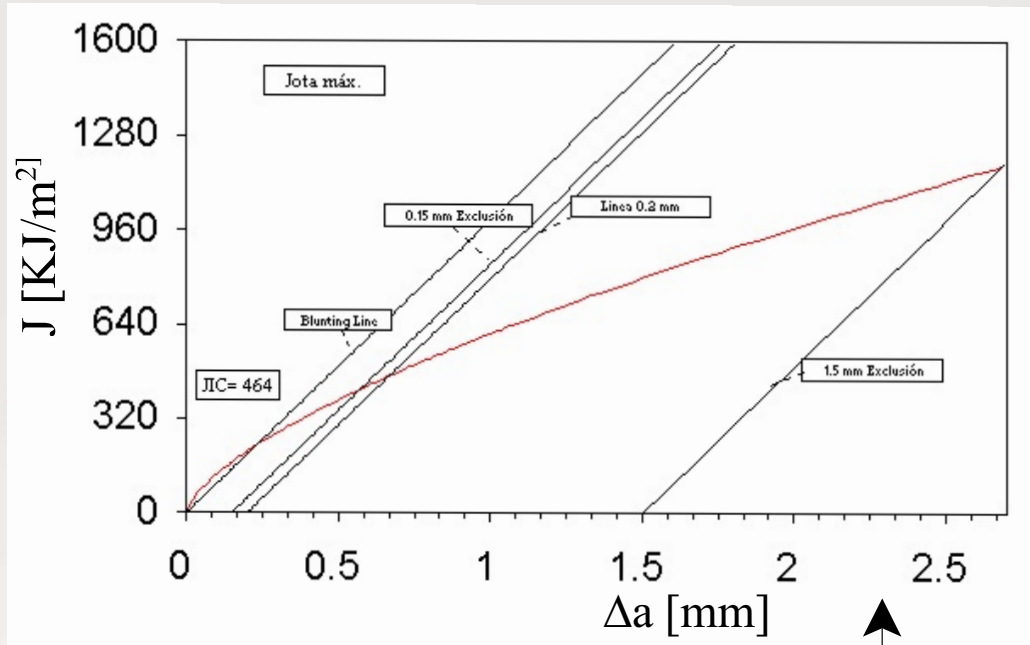


LPM-CME

# Key Curves



LPM - GME



LPM - GMP