Sheet Metal Plastic Strain Ratio (r-Value) and Anisotropy

Lankford r-value of a tensile specimen from its width and length strains, the normal anisotropy r̄ and planar anisotropy Δr from the 0°, 45° and 90° values.

Method: Plastic strain ratio (Lankford)

Input parameters

Unit system: SI

Parameter	Value	Unit
Initial gauge width	12.500	mm
Final gauge width	11.620	mm
Initial gauge length	50.000	mm
Final gauge length	59.000	mm
r at 0° to rolling	1.9000	
r at 45°	1.5000	
r at 90°	2.3000	

Calculated results

Parameter	Value	Unit
Width strain	-0.073001	
Thickness strain (volume constancy)	-0.092514	
Specimen r-value	0.78908	
Normal anisotropy	1.8000	
Planar anisotropy (earing tendency)	0.60000	

Notes for this case

• r = ε_w/ε_t, the width strain over thickness strain, with ε_t = −(ε_w + ε_l) by volume constancy because thin-sheet thickness is hard to measure. A high average r̄ (above about 1.5) means the sheet resists thinning, giving deeper draws; Δr ≠ 0 means earing in drawn cups (four ears at 0/90° when Δr > 0). Measure at a fixed strain (often 15–20 %) and avoid the necked region.

Formula and method

$$r = \frac{\varepsilon_w}{\varepsilon_t} = \frac{\ln(w/w_0)}{-\ln(w/w_0) - \ln(l/l_0)}, \quad \bar{r} = \frac{r_0 + 2r_{45} + r_{90}}{4}, \quad \Delta r = \frac{r_0 - 2r_{45} + r_{90}}{2}$$

Variables

w_0	Initial gauge width	m
w	Final gauge width	m
l_0	Initial gauge length	m
l	Final gauge length	m
r_0	r at 0° to rolling	-
r_{45}	r at 45°	-
r_{90}	r at 90°	-
ε_w	Width strain	-
ε_t	Thickness strain (volume constancy)	-
r	Specimen r-value	-
$\bar{r}$	Normal anisotropy	-
Δr	Planar anisotropy (earing tendency)	-

Method and standards

r-value.

Assumptions and limits

- Uniform deformation; volume constancy.

References

Plastic strain ratio (Lankford)

Report details

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Release checks	3 reference cases of this calculator, computed independently, are checked on every release

Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/materials/properties/sheet-anisotropy-r-value

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.