Angle of Incidence on a Sloped Surface of Any Orientation and Rb

Angle of incidence of beam radiation on a surface of any slope and azimuth, the beam ratio Rb to a horizontal surface and the profile angle.

Input parameters

Unit system: SI

Parameter	Value	Unit
Latitude (north positive, south negative)	19.000	°
Day of the year (1 = 1 January, 365 = 31 December)	121.00	
Solar time (24-hour clock)	8.0000	h
Surface slope from horizontal	90.000	°
Surface azimuth (facing south 0, west positive, east negative)	-90.000	°
Declination formula	Spencer (1971), more precise	

Calculated results

Parameter	Value	Unit
Declination	14.829	°
Hour angle	-60.000	°
Zenith angle	57.293	°
Solar azimuth	-95.773	°
Angle of incidence on the surface	33.156	°
Cosine of the angle of incidence	0.83718	
Beam ratio, tilted to horizontal	1.5494	
Profile angle (for row and overhang shading)	32.839	°

Notes for this case

• R_b is the ratio of beam radiation on the surface to that on a horizontal surface at this instant; for an hour use the time at its midpoint.

Formula and method

$$\cos\theta = \sin\delta\sin\phi\cos\beta - \sin\delta\cos\phi\sin\beta\cos\gamma + \cos\delta\cos\phi\cos\beta\cos\omega + \cos\delta\sin\phi\sin\beta\cos\gamma\cos\omega + \cos\delta\sin\beta\sin\gamma\sin\omega$$

$$R_b = \frac{\cos\theta}{\cos\theta_z}, \quad \tan\alpha_p = \frac{\tan\alpha_s}{\cos(\gamma_s - \gamma)}$$

Variables

ϕ	Latitude (north positive, south negative)	rad
n	Day of the year (1 = 1 January, 365 = 31 December)	-
t_s	Solar time (24-hour clock)	s
β	Surface slope from horizontal	rad
γ	Surface azimuth (facing south 0, west positive, east negative)	rad
δ formula	Declination formula	-
δ	Declination	rad
ω	Hour angle	rad

θ_z	Zenith angle	rad
γ_s	Solar azimuth	rad
θ	Angle of incidence on the surface	rad
$\cos\theta$	Cosine of the angle of incidence	-
R_b	Beam ratio, tilted to horizontal	-
α_p	Profile angle (for row and overhang shading)	rad

Method and standards

Beam geometry of an arbitrarily oriented plane (Benford and Bock).

Assumptions and limits

- Instantaneous geometry; the sun's disc is treated as a point.

Report details

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

This calculator online

https://calc.firecad.com/environmental/solar-thermal/solar-incidence-angle-any-surface

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Reopens the calculator with the inputs of this report.