Oblique Shock on a Wedge or Compression Corner (θ–β–M)

Shock angle, downstream Mach number and pressure, temperature and stagnation-pressure ratios of the weak attached oblique shock for a given flow deflection.

Method: θ–β–M relation and normal-shock relations on the normal component

Input parameters

Unit system: SI

Parameter	Value	Unit
Upstream Mach number	2.5000	
Flow deflection (wedge half-angle or ramp angle)	12.000	°
Ratio of specific heats	1.4000	

Calculated results

Parameter	Value	Unit
Shock wave angle (weak solution)	33.802	°
Maximum deflection for an attached shock	29.797	°
Normal Mach number upstream	1.3908	
Downstream Mach number	2.0022	
Static pressure ratio	2.0900	
Temperature ratio	1.2488	
Stagnation pressure ratio	0.96046	

Notes for this case

- θ–β–M relation solved for the weak shock (the one normally seen on wedges and ramps); the normal-shock relations then apply to the normal Mach number $M_1 \sin\beta$.

Formula and method

$$\tan\theta = 2\cot\beta\,\frac{M_1^2\sin^2\beta - 1}{M_1^2(\gamma + \cos 2\beta) + 2}, \quad M_{n1} = M_1\sin\beta, \quad M_2 = \frac{M_{n2}}{\sin(\beta-\theta)}$$

Variables

M_1	Upstream Mach number	-
θ	Flow deflection (wedge half-angle or ramp angle)	rad
γ	Ratio of specific heats	-
β	Shock wave angle (weak solution)	rad
θ_{max}	Maximum deflection for an attached shock	rad
M_{n1}	Normal Mach number upstream	-
M_2	Downstream Mach number	-
p_2/p_1	Static pressure ratio	-
T_2/T_1	Temperature ratio	-
p_{02}/p_{01}	Stagnation pressure ratio	-

Method and standards

Oblique shock theory.

Assumptions and limits

- Calorically perfect gas, two-dimensional, attached straight shock.

References

θ–β–M relation and normal-shock relations on the normal component

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/mechanical/fluid-mechanics/oblique-shock-wedge

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.