Railway Curve Cant, Cant Deficiency and Equilibrium Speed

Equilibrium cant for a design speed on a railway curve, the cant deficiency at the maximum speed and excess at low speed, and the unbalanced lateral acceleration.

Method: Track geometry: equilibrium cant e = G v²/(gR)

Input parameters

Unit system: SI

Parameter	Value	Unit
Distance between rail centres (1750 mm broad gauge, 1500 mm standard gauge)	1,750.0	mm
Curve radius	1,000.0	m
Equilibrium (average) speed	80.000	km/h
Maximum speed	110.00	km/h
Lowest regular speed (freight)	60.000	km/h
Cant actually provided (0 = use the equilibrium cant)	0	mm

Calculated results

Parameter	Value	Unit
Equilibrium cant for the equilibrium speed	88.124	mm
Cant used	88.124	mm
Cant deficiency at the maximum speed	78.485	mm
Cant excess at the lowest speed	38.554	mm
Unbalanced lateral acceleration at the maximum speed	0.43981	m/s²
Speed for which the cant used is balanced	80.000	km/h

Notes for this case

• Raising the outer rail by C tilts the track so that gravity balances the centripetal acceleration at one speed: C = G v²/(gR), where G is the distance between rail centres. Faster trains run with a cant deficiency (an unbalanced outward acceleration g C_d/G felt by passengers and carried by the rails); slower trains with a cant excess that wears the inner rail. Railways set maximum values for cant, deficiency and excess (for example about 165 mm, 75–100 mm and 75 mm on Indian broad gauge): use your administration's limits.

Formula and method

$$C = \frac{Gv^2}{gR}, \quad C_d = \frac{Gv_{max}^2}{gR} - C, \quad a_u = \frac{gC_d}{G}$$

Variables

G	Distance between rail centres (1750 mm broad gauge, 1500 mm standard gauge)	m
R	Curve radius	m
V_e	Equilibrium (average) speed	m/s
V_{max}	Maximum speed	m/s
V_{min}	Lowest regular speed (freight)	m/s
C_a	Cant actually provided (0 = use the equilibrium cant)	m
C_e	Equilibrium cant for the equilibrium speed	m
C	Cant used	m
C_d	Cant deficiency at the maximum speed	m

C_x	Cant excess at the lowest speed	m
a_u	Unbalanced lateral acceleration at the maximum speed	m/s²
V_b	Speed for which the cant used is balanced	m/s

Method and standards

Railway cant.

Assumptions and limits

- Steady curving; cant limits from your railway.

References

Track geometry: equilibrium cant e = G v²/(gR)

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/civil/roads/railway-cant-deficiency

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.