Traffic Flow, Speed and Density (Greenshields Model)

Speed, flow, headway and spacing at a traffic density, with the capacity, critical density and speed of a road lane, by Greenshields' linear speed–density model.

Method: Greenshields' linear speed–density model and q = kv

Input parameters

Unit system: SI

Parameter	Value	Unit
Free-flow speed	90.000	km/h
Jam density (vehicles per km per lane)	140.00	
Traffic density (vehicles per km per lane)	45.000	

Calculated results

Parameter	Value	Unit
Space-mean speed	61.071	km/h
Flow (vehicles per hour per lane)	2,748.2	
Capacity v_f k_j/4 (veh/h/lane)	3,150.0	
Critical density k_j/2 (veh/km/lane)	70.000	
Speed at capacity v_f/2	45.000	km/h
Mean time headway	1.3099	s
Mean spacing	22.222	m
Volume-to-capacity ratio	0.87245	

Notes for this case

- Uncongested: below the critical density, flow rises with density.

Formula and method

$$v = v_f\left(1 - \frac{k}{k_j}\right), \quad q = kv, \quad q_{max} = \frac{v_f k_j}{4} \text{ at } k_c = \frac{k_j}{2}, \quad h = \frac{1}{q}, \quad s = \frac{1}{k}$$

Variables

v_f	Free-flow speed	m/s
k_j	Jam density (vehicles per km per lane)	-
k	Traffic density (vehicles per km per lane)	-
v	Space-mean speed	m/s
q	Flow (vehicles per hour per lane)	-
q_{max}	Capacity v_f k_j/4 (veh/h/lane)	-
k_c	Critical density k_j/2 (veh/km/lane)	-
v_c	Speed at capacity v_f/2	m/s
h	Mean time headway	s
s	Mean spacing	m
q/q_{max}	Volume-to-capacity ratio	-

Method and standards

Macroscopic traffic flow.

Assumptions and limits

- Homogeneous, steady traffic on one lane.

References

Greenshields' linear speed–density model and q = kv

Report details

Report reference	FCC-5YZ2-687M (the same inputs always give the same reference)
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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/civil/roads/greenshields-traffic-flow

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.