



Scope of Interurban Roads

- Interurban Road Segments → **without continuous development** on either side, such as restaurants, factories, or villages.
- Urban/Suburban Road Segments → **continuous permanent development** along all or almost of its length, on at least one side of the road. Population at least 100,000

Scope of Interurban Roads

- Interurban Road Types
 - Two-lane two-way roads (2/2 UD)
 - Four-lane two-way roads
 - Undivided (i.e. no median) (4/2 UD)
 - Divided (i.e. with median) (4/2 D)
 - Six-lane two-way divide roads (6/2 D)

Scope of Interurban Roads

- **Conditions:**
- Flat, rolling or hilly alignment
- Specific grades (e.g. climbing lane)

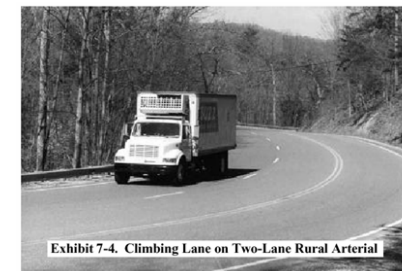


Exhibit 7-4. Climbing Lane on Two-Lane Rural Arterial

Scope of Interurban Roads

- **Road Segments:**
- Between and unaffected by major intersections, and
- Having similar geometric design and traffic flow and composition along its length.

Objective of Interurban Roads

- Design of interurban roads should be selected with the aim to ensure that degree of saturation does not exceed an acceptable value (**normally 0,75**)

Traffic Safety Considerations

- Widening of the lane decreases the accident rates between 2-15% per meter widening (the high number refers to small roads).
- Widening and improvement of shoulder surface conditions improves traffic safety, although to a smaller degree than lane widening





Traffic Safety Considerations

- Climbing lane in steep grades reduce the accident rate with 25-30%.
- Passing lanes (extra lanes for overtaking in flat terrain) reduce the accident rate with 15-20%
- Straightening of isolated, sharp curves reduces accident rates with 25-60%



Traffic Safety Considerations

- A median reduces the accident rate with 30%
- Median barriers (used when the space is insufficient to make a full median) reduce fatal and severe injury accidents with 10-30%, but increase damage only accidents.

Interurban Roads Performance Indicator

- Degree of Saturation ($\leq 0,75$)
- Level of Service (A – F)
- Actual Free-Flow Speed
- Travel Time
- Degree of Bunching
- Actual Uphill Speed (*)
- Uphill Travel Time (*)

STEP A-1: General Data

- Date (day, month, year) and Handled by
- Province
- Link number/road name
- Segment code
- Segment between ... or ...
- Administrative road class (National, Provincial or Kabupaten)
- Road type (4/2 D, 4/2 UD, 2/2 UD, 2/1)
- Length of segments
- Road function (Arterial, Collector or Local)
- Time period
- Case number

STEP A-2: Geometric Conditions

- Compass arrow showing North
- Km-posts
- Sketch of the horizontal alignment
- Arrows identifying Direction 1 (North or East-bound) and Direction 2 (South or West-bound)
- Names of the places
- Major buildings
- Intersections and entries/exits
- Pavement markings

STEP A-2: Geometric Conditions

- Sight Distance Class

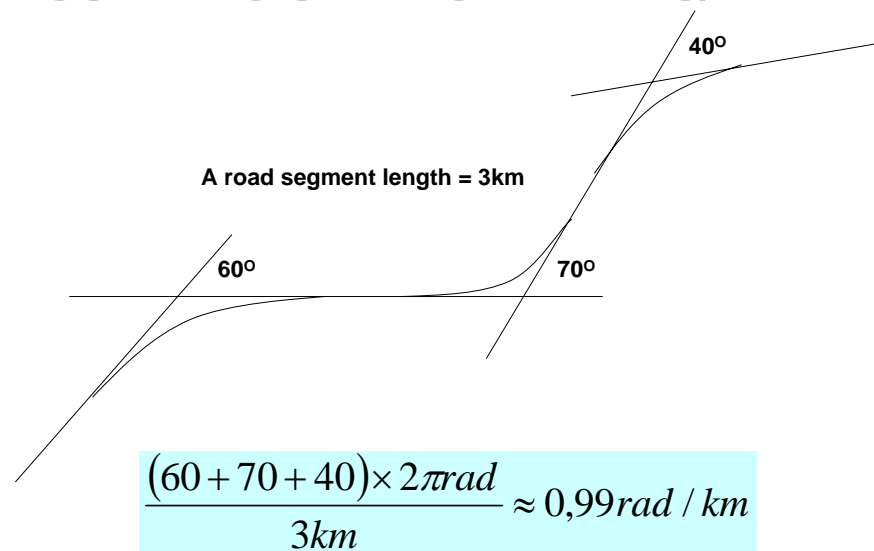
Sight Distance Class	% of Segment with Sight Distance of at least 300m
A	> 70%
B	30 – 70%
C	< 30%

STEP A-2: Geometric Conditions

• Alignment Type

Alignment Type	Rise + Fall (m/km)	Horizontal Curvature (rad/km)
Flat	< 10	< 1,0
Rolling	10 – 30	1,0 – 2,5
Hilly	> 30	> 2,5

CONVERSION INTO RADIANS/KM



STEP A-3: Traffic Conditions Two-Way Undivided Roads (2/2 UD)

Alignment Type	Total Flow veh/h	pce					
		MHV	LB	LT	MC		
					Carriageway Width (m)		
					< 6 m	6 – 8 m	> 8 m
Flat	0	1,2	1,2	1,8	0,8	0,6	0,4
	800	1,8	1,8	2,7	1,2	0,9	0,6
	1.350	1,5	1,6	2,5	0,9	0,7	0,5
	≥ 1.900	1,3	1,5	2,5	0,6	0,5	0,4
Rolling	0	1,8	1,6	5,2	0,7	0,5	0,3
	650	2,4	2,5	5,0	1,0	0,8	0,5
	1.100	2,0	2,0	4,0	0,8	0,6	0,4
	≥ 1.600	1,7	1,7	3,2	0,5	0,4	0,3
Hilly	0	3,5	2,5	6,0	0,6	0,4	0,2
	450	3,0	3,2	5,5	0,9	0,7	0,4
	900	2,5	2,5	5,0	0,7	0,5	0,3
	≥ 1.350	1,9	2,2	4,0	0,5	0,4	0,3

STEP A-3: Traffic Conditions Four-Lane Two-Way Roads (4/2 D/UD)

Alignment Type	Traffic Flow veh/h		pce			
	Divided road per direction veh/h	Undivided road per direction veh/h	MHV	LB	LT	MC
Flat	0	0	1,2	1,2	1,6	0,5
	1.000	1.000	1,4	1,4	2,0	0,6
	1.800	3.250	1,6	1,7	2,5	0,8
	≥ 2.150	≥ 3.950	1,3	1,5	2,0	0,5
Rolling	0	0	1,8	1,6	4,8	0,4
	750	1.350	2,0	2,0	4,6	0,5
	1.400	2.500	2,2	2,3	4,3	0,7
	≥ 1.750	≥ 3.150	1,8	1,9	3,5	0,4
Hilly	0	0	3,2	2,2	5,5	0,3
	550	1.000	2,9	2,6	5,1	0,4
	1.100	2.000	2,6	2,9	4,8	0,6
	≥ 1.500	≥ 2.700	2,0	2,4	3,8	0,3

STEP A-3: Traffic Conditions

Six-Lane Two-Way Divided Roads (6/2 D)

Alignment Type	Traffic Flow per direction veh/h	pce			
		MHV	LB	LT	MC
Flat	0	1,2	1,2	1,6	0,5
	1.500	1,4	1,4	2,0	0,6
	2.750	1,6	1,7	2,5	0,8
	≥ 3.250	1,3	1,5	2,0	0,5
Rolling	0	1,8	1,6	4,8	0,4
	1.100	2,0	2,0	4,6	0,5
	2.100	2,2	2,3	4,3	0,7
	≥ 2.650	1,8	1,9	3,5	0,4
Hilly	0	3,2	2,2	5,5	0,3
	800	2,9	2,6	5,1	0,4
	1.700	2,6	2,9	4,8	0,6
	≥ 2.300	2,0	2,4	3,8	0,3

STEP A-3: Traffic Conditions

Six-Lane Two-Way Divided Roads (6/2 D)

Length (km)	pce									
	Gradient (%)									
	3		4		5		6		7	
	MHV	LT	MHV	LT	MHV	LT	MHV	LT	MHV	LT
0,50	2,00	4,00	3,00	5,00	3,80	6,40	4,50	7,30	5,00	8,00
0,75	2,50	4,60	3,30	6,00	4,20	7,50	4,80	8,60	5,30	9,30
1,00	2,80	5,00	3,50	6,20	4,40	7,60	5,00	8,60	5,40	9,30
1,50	2,80	5,00	3,60	6,20	4,40	7,60	5,00	8,50	5,40	9,10
2,00	2,80	5,00	3,60	6,20	4,40	7,50	4,90	8,30	5,20	8,90
3,00	2,80	5,00	3,60	6,20	4,20	7,50	4,60	8,30	5,00	8,90
4,00	2,80	5,00	3,60	6,20	4,20	7,50	4,60	8,30	5,00	8,90
5,00	2,80	5,00	3,60	6,20	4,20	7,50	4,60	8,30	5,00	8,90

STEP A-4: Side Friction

- Number of pedestrians passing along or crossing the road segment (0,6) /h, 200m
- Number of stopping vehicles and parking maneuvers (0,8) /h, 200m
- Number of motor vehicle entries and exists to/from roadside properties and side roads (1,0) /h, 200m
- Flow of slow-moving vehicles (bicycles, tricycles, horse-charts, oxcarts, tractors, etc.) (0,4) /h

STEP A-4: Side Friction

Side friction class	Code	Weighted number of events per 200 m per hour (both sides)	Typical conditions
Very low	VL	< 50	Rural, agriculture or undeveloped, almost no activities
Low	L	50 – 149	Rural, some roadside buildings & activities
Medium	M	150 – 249	Village, local transport & activities
High	H	250 – 350	Village, some market activities
Very High	VH	> 350	Almost urban, market/business activities

STEP B-1: Analysis of Free-flow Speed

$$FV = (FV_0 + FV_W) \times FFV_{SF} \times FFV_{RC}$$

- $FV \rightarrow$ free-flow speed for LV at actual conditions (kph)
- $FV_0 \rightarrow$ Base free-flow speed for light vehicles (kph)
- $FV_W \rightarrow$ Adjustment for effective carriageway width (km/h)
- $FFV_{SF} \rightarrow$ Adjustment factor for side friction conditions
- $FFV_{RC} \rightarrow$ Adjustment factor for road function class

STEP B-1: Analysis of Free-flow Speed

Road Type/Alignment Type/Sight Distance Class	Base Free-Flow Speed FV_0 (km/h)				
	LV	MHV	LB	LT	MC
Six-Lane Divided					
Flat	83	67	86	64	64
Rolling	71	56	68	52	58
Hilly	62	45	55	40	55
Four-Lane Divided					
Flat	78	65	81	62	64
Rolling	68	55	66	51	58
Hilly	60	44	53	39	55

STEP B-1: Analysis of Free-flow Speed

Road Type/Alignment Type/Sight Distance Class	Base Free-Flow Speed FV_0 (km/h)				
	LV	MHV	LB	LT	MC
Four-Lane Undivided					
Flat	74	63	78	60	60
Rolling	66	54	65	50	56
Hilly	58	43	52	39	53
Two-Lane Undivided					
Flat SDC A	68	60	73	58	55
Flat SDC B	65	57	69	55	54
Flat SDC C	61	54	63	52	53
Rolling	61	52	62	49	53
Hilly	55	42	50	38	51

STEP B-1: Analysis of Free-flow Speed

Rise + Fall (m/km)	Base Free-Flow Speed (LV), Two-Way Two-Lane Roads						
	Horizontal Curvature rad/km						
	< 0,5	0,5 - 1	1 - 2	2 - 4	4 - 6	6 - 8	8 - 10
5	68	65	63	58	52	47	43
15	67	64	62	58	52	47	43
25	66	64	62	57	51	47	43
35	65	63	61	57	50	46	42
45	64	61	60	56	49	45	42
55	61	58	57	53	48	44	41
65	58	56	55	51	46	43	40
75	56	54	53	50	45	42	39
85	54	52	51	48	43	41	38
95	52	50	49	46	42	40	37

STEP B-2: Free-flow Speed Adjustment FV_W for Carriageway Width [Table B-2:1]

- Four and Six-Lane Divided
- For Flat SDC ABC, Rolling SDC ABC
- $FV_W = 21,333W_C^3 - 216W_C^2 + 732,67W_C - 833$
- For Hilly
- $FV_W = 10,667W_C^3 - 104W_C^2 + 341,33W_C - 378$

STEP B-2: Free-flow Speed Adjustment FV_W for Carriageway Width [Table B-2:1]

- Four-Lane Undivided
- For Flat SDC AB
- $FV_W = 21,333W_C^3 - 216W_C^2 + 732,67W_C - 833$
- For Flat SDC C, Rolling SDC ABC
- $FV_W = 10,667W_C^3 - 104W_C^2 + 341,33W_C - 378$
- For Hilly
- $FV_W = 8W_C^2 - 50W_C + 77$

STEP B-2: Free-flow Speed Adjustment FV_W for Carriageway Width [Table B-2:1]

- Two-Lane Undivided
- For Flat SDC AB
- $FV_W = -0,0606W_C^4 + 2,1061W_C^3 - 27,288W_C^2 + 157,2W_C - 340,17$
- For Flat SDC C, Rolling SDC ABC
- $FV_W = 0,0083W_C^5 - 0,3977W_C^4 + 7,4356W_C^3 - 68,254W_C^2 + 309,25W_C - 555,83$
- For Hilly
- $FV_W = 0,0056W_C^6 - 0,2583W_C^5 + 4,8472W_C^4 - 46,625W_C^3 + 239,65W_C^2 - 610,62W_C - 574$

STEP B-3: Free-flow Speed Adjustment Factor FFV_{SF} for Side Friction

- Road with shoulders
- Table B-3:1
- Adjustment factor FFV_{SF} for six-lane roads
- $FFV_{6SF} = 1 - 0,8 \times (1 - FFV_{4SF})$

STEP B-4: Free-flow Speed Adjustment Factor FFV_{CS} for City Size

Road Type	Adjustment Factor FFV_{RC}				
	Roadside Development (%)				
	0	25	50	75	100
Four-Lane Divided					
Arterial	1,00	0,99	0,98	0,96	0,95
Collector	0,99	0,98	0,97	0,95	0,94
Local	0,98	0,97	0,96	0,94	0,93
Four-Lane Undivided					
Arterial	1,00	0,99	0,97	0,96	0,945
Collector	0,97	0,96	0,94	0,93	0,915
Local	0,95	0,94	0,92	0,91	0,895
Two-Lane Undivided					
Arterial	1,00	0,98	0,97	0,96	0,94
Collector	0,94	0,93	0,91	0,90	0,88
Local	0,90	0,88	0,87	0,86	0,84

STEP B-5: Determination of Free-flow Speed for Actual Conditions

- Free-flow speed for light vehicles (LV)
- $FV = (FV_0 + FV_W) \times FFV_{SF} \times FFV_{RC}$
- Free-flow speed for other vehicle types
- $FFV = FV_0 - FV$
- $FVMHV = FV_{MHV0} - FFV \times FV_{MHV0}/FV_0$
- $FV_{MHV0} \rightarrow$ Table B-1:1

STEP B-6: Determination of Free-flow Speed for Specific Grades

- Free-flow speed for light vehicles (LV)
- $FV = (FV_0 + FV_W) \times FFV_{SF} \times FFV_{RC}$
- Free-flow speed for other vehicle types
- $FFV = FV_0 - FV$
- $FVHV = FV_{HV0} - FFV \times FV_{HV0}/FV_0$
- $FV_{HV0} \rightarrow$ Table B-1:1

STEP B-6: Determination of Free-flow Speed for Specific Grades

Length km	Direction 1, Uphill Gradient %					Direction 2, Downhill Gradient %				
	3	4	5	6	7	3	4	5	6	7
0,5	68,0	65,7	62,6	59,5	55,2	68,0	68,0	68,0	65,7	62,6
1,0	67,7	64,3	60,3	56,0	51,4	68,0	68,0	67,7	64,3	60,3
2,0	67,6	63,4	58,9	54,3	49,5	68,0	68,0	67,6	63,4	58,9
3,0	67,5	63,1	58,5	53,8	48,9	68,0	68,0	67,5	63,1	58,5
4,0	67,4	62,9	58,2	53,4	48,5	68,0	68,0	67,4	62,9	58,2
5,0	67,4	62,8	58,0	53,2	48,5	68,0	68,0	67,4	62,8	58,0

STEP B-6: Determination of Free-flow Speed for Specific Grades

Length km	LT Uphill Gradient %				
	3	4	5	6	7
0,5	50,9	45,0	39,5	34,3	29,4
1,0	47,6	40,9	34,6	30,2	26,1
2,0	45,2	38,6	32,5	28,5	24,7
3,0	44,4	37,9	31,8	27,9	24,3
4,0	44,1	37,6	31,5	27,7	24,1
5,0	43,8	37,3	31,3	27,5	23,9

STEP C-1: Base Capacity

Road Type /Alignment Type	Base Capacity pcu/h/lane
Four-Lane Divided	
Flat	1.900
Rolling	1.850
Hilly	1.800
Four-Lane Undivided	
Flat	1.700
Rolling	1.650
Hilly	1.600

STEP C-1: Base Capacity

Road Type /Alignment Type	Base Capacity Total Both Direction pcu/h
Two-Lane Undivided	
Flat	3.100
Rolling	3.000
Hilly	2.900

STEP C-2: Capacity Adjustment Factor FC_W for Carriageway Width [Table C-2:1]

- Four or Six-lane divided (4/2 D or 6/2 D)
- Four-lane undivided (4/2 UD)
- $FC_W = 0,0825W_C^3 - 0,8848W_C^2 + 3,3103W_C - 3,2867$
- Two-lane undivided (2/2 UD)
- $FC_W = -0,0002W_C^6 + 0,0079W_C^5 - 0,1676W_C^4 + 1,884W_C^3 - 11,807W_C^2 + 39,213W_C - 53,18$

STEP C-3: Capacity Adjustment Factor FC_{SP} for Directional Split

Directional split SP %-%		50-50	55-45	60-40	65-35	70-30
FC_{SP}	Two-lane 2/2	1,00	0,97	0,94	0,91	0,88
	Four-lane 4/2	1,00	0,975	0,95	0,925	0,90

STEP C-4: Capacity Adjustment Factor FC_{SF} for Side Friction

- Road with shoulders
- [Table C-4:1](#)
- Adjustment factor FC_{SF} for six-lane roads
- $FC_{6SF} = 1 - 0,8 \times (1 - FC_{4SF})$

STEP C-5: Determination of Capacity for Actual Condition

$$C = C_0 \times FC_W \times FC_{SP} \times FC_{SF}$$

- $C \rightarrow$ Capacity (pcu/h)
- $C_0 \rightarrow$ Base capacity (pcu/h)
- $FC_W \rightarrow$ Adjustment factor for carriageway width
- $FC_{SP} \rightarrow$ Adjustment factor for directional split
- $FC_{SF} \rightarrow$ Adjustment factor for side friction

STEP C-6: Determination of Capacity for Specific Condition

$$C = C_0 \times FC_W \times FC_{SP} \times FC_{SF}$$

- $C \rightarrow$ Capacity (pcu/h)
- $C_0 \rightarrow$ Base capacity (pcu/h)
- $FC_W \rightarrow$ Adjustment factor for carriageway width
- $FC_{SP} \rightarrow$ Adjustment factor for directional split
- $FC_{SF} \rightarrow$ Adjustment factor for side friction

STEP C-6: Determination of Capacity for Specific Condition

Length of Grade /Slope of Grade	Base Capacity pcu/h
Length \leq 0,5 km / all slopes	3.000
Length \leq 0,8 km / slope \leq 4,5%	2.900
All other cases	2.800

STEP C-6: Determination of Capacity for Specific Condition

% Traffic Uphill (direction 1)	FC _{SP}
70	0,78
65	0,83
60	0,88
55	0,94
50	1,00
45	1.03
40	1.06
35	1.09
30	1.12

STEP D-1: Degree of Saturation

$$DS = Q / C$$

- Q → Traffic flow (pcu/h)
- Q → IR-2 (column 14 row 5 for undivided road)
- Q → IR-2 (column 14 row 3 & 4 for each direction of travel on divided road)
- C → Capacity (pcu/h)
- C → IR-3 (column 15)

STEP D-2: Speed and Travel Time

- Determine the speed at actual traffic
- Figure D-2:1 (two-lane undivided roads)
- Figure D-2:2 (four-lane undivided roads)
- Enter segment length (km) in column 24 Form IR-3
- Calculate average travel time (hour) for Light Vehicle

$$TT = L / V_{LV}$$

STEP D-3: Degree of Bunching (Platooning)

- Determine Degree of Bunching (DB) on **two-lane two-way undivided roads** based on Degree of Saturation (DS) column 22 Form IR-3, see figure D-3:1 or using equation:

$$DB = \frac{DS}{(0,814670DS + 0,283470)}$$

STEP D-4: Speed and Travel Time for Specific Grades

- Without Climbing Lane
 - P. 6-75
- With Climbing Lane
 - P. 6-76

STEP D-4: Speed and Travel Time for Specific Grades

- With Climbing Lane
- Uphill direction as one direction of a four-lane undivided road in hilly alignment

STEP D-5: Evaluation of Traffic Performance

- If $DS > 0,75 \rightarrow$ revise calculations