GEOMETRIC DESIGN

GUIDELINES

- ATJ 8/86 (Pindaan 2015)

  – A GUIDE ON GEOMETRIC DESIGN OF ROADS

  Replacing :

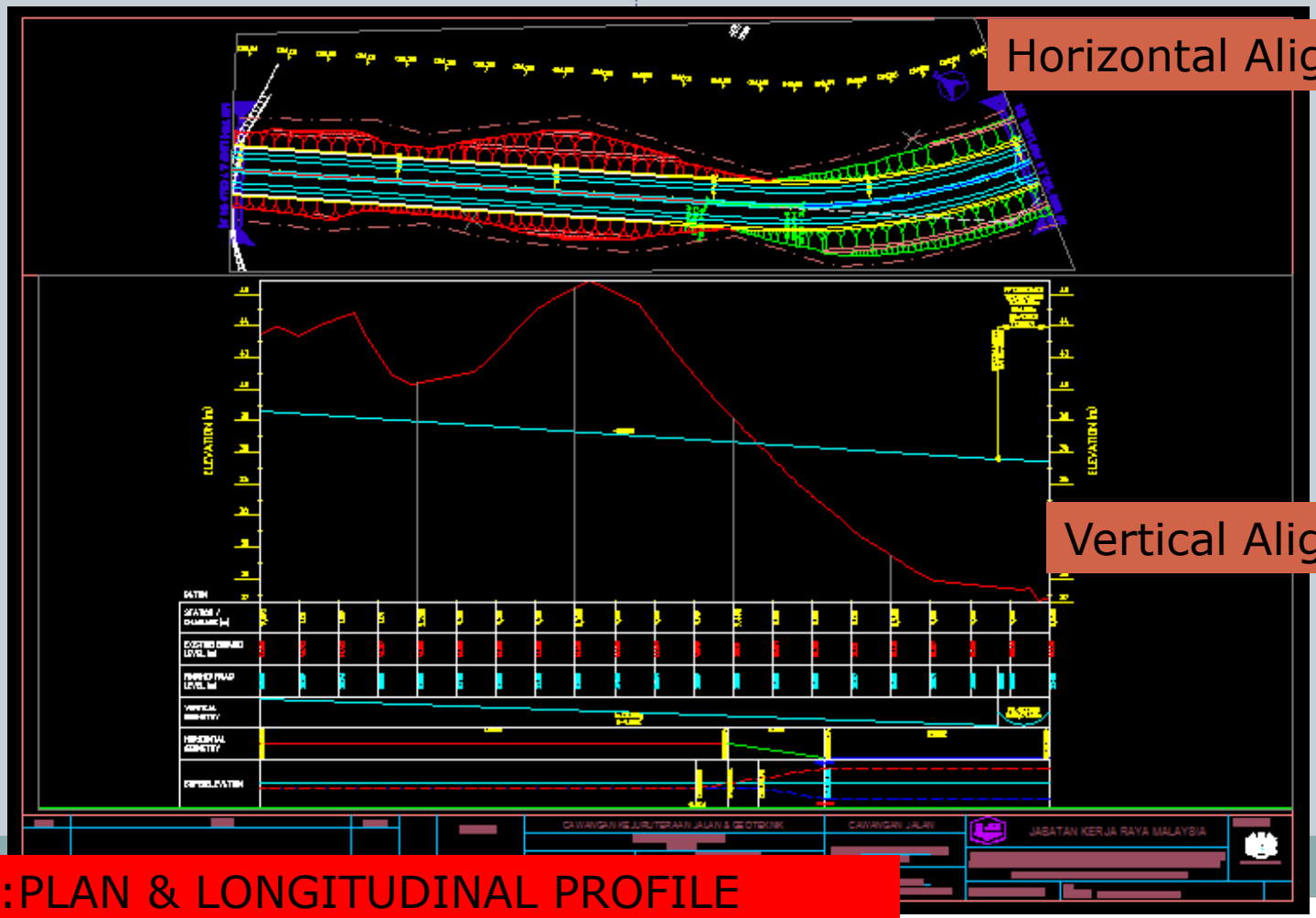
  - REAM-GL 2/2002 – A Guide on Geometric Design of Road
  - Arahan Teknik (Jalan) 8/86

HORIZONTAL ALIGNMENT

- Consists of a series of straight roads or tangent connected by circular curves or transitional curves

PLAN & LONGITUDINAL PROFILE

- **HORIZONTAL ALIGNMENT (PLAN VIEW)**
- **VERTICAL ALIGNMENT (PROFILE VIEW)**



DRAWING:PLAN & LONGITUDINAL PROFILE

HORIZONTAL ALIGNMENT

HORIZONTAL ALIGNMENT

ELEMENTS IN HORIZONTAL ALIGNMENT'S DESIGN

- Superelevation
- Minimum radius
- Type of Curves – Transitional Curves and Circular Curves
- Pavement widening on curves
- Sight distance on horizontal curves
- Overtaking lane

JAJARAN MENDATAR

- Rekabentuk lengkung bergantung kepada:
  - Halaju rekabentuk
  - Kadar sendengan (Superelevation rates)
  - Jejari (Radius)
  - Lengkung peralihan

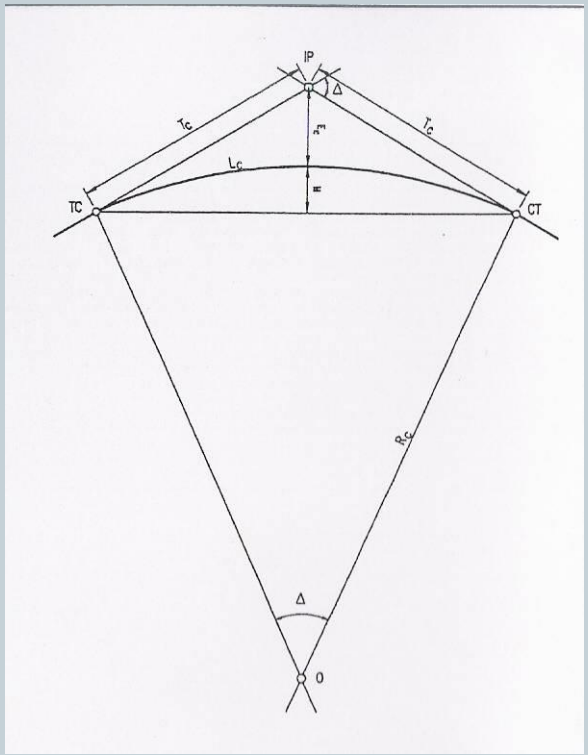
JAJARAN MENDATAR

1. Jenis lengkung

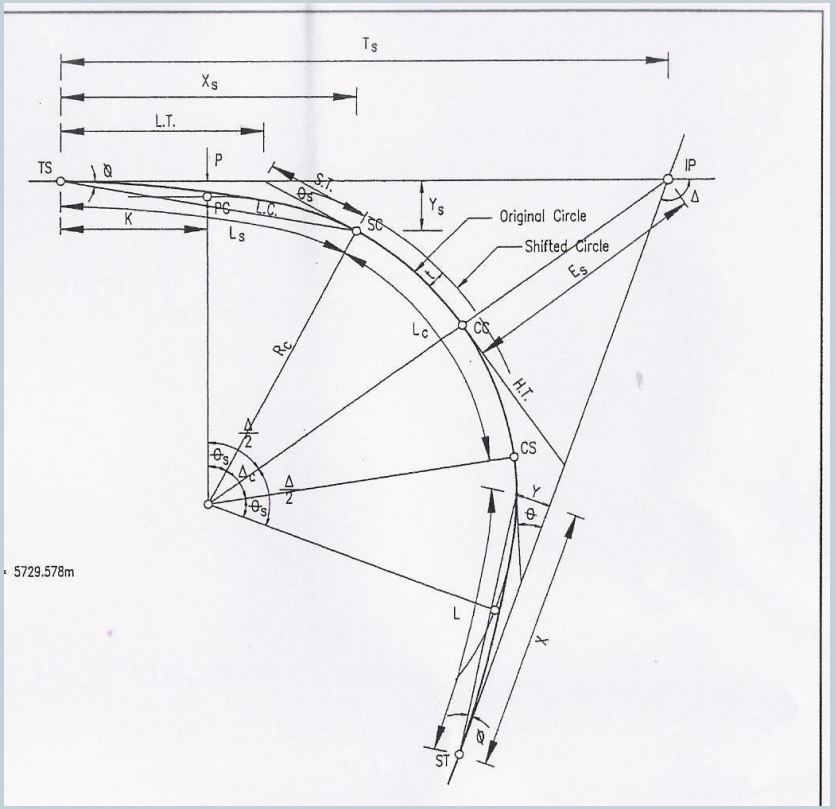
- Lengkung mudah (Simple curve)
  - Sesuai digunakan untuk kawalan lengkung yang besar & nilai radius melebihi 2000m
- Lengkung peralihan (Transition/Spiral curve)
  - Kenderaan mengikut laluan peralihan sebelum memasuki lengkung bulat (circular curve) & selepasnya
  - Lebih selamat dan selesa
  - Length of superelevation runoff should not exceed a longitudinal slope of 1:200

JAJARAN MENDATAR

Lengkung mudah (berjejari tunggal)

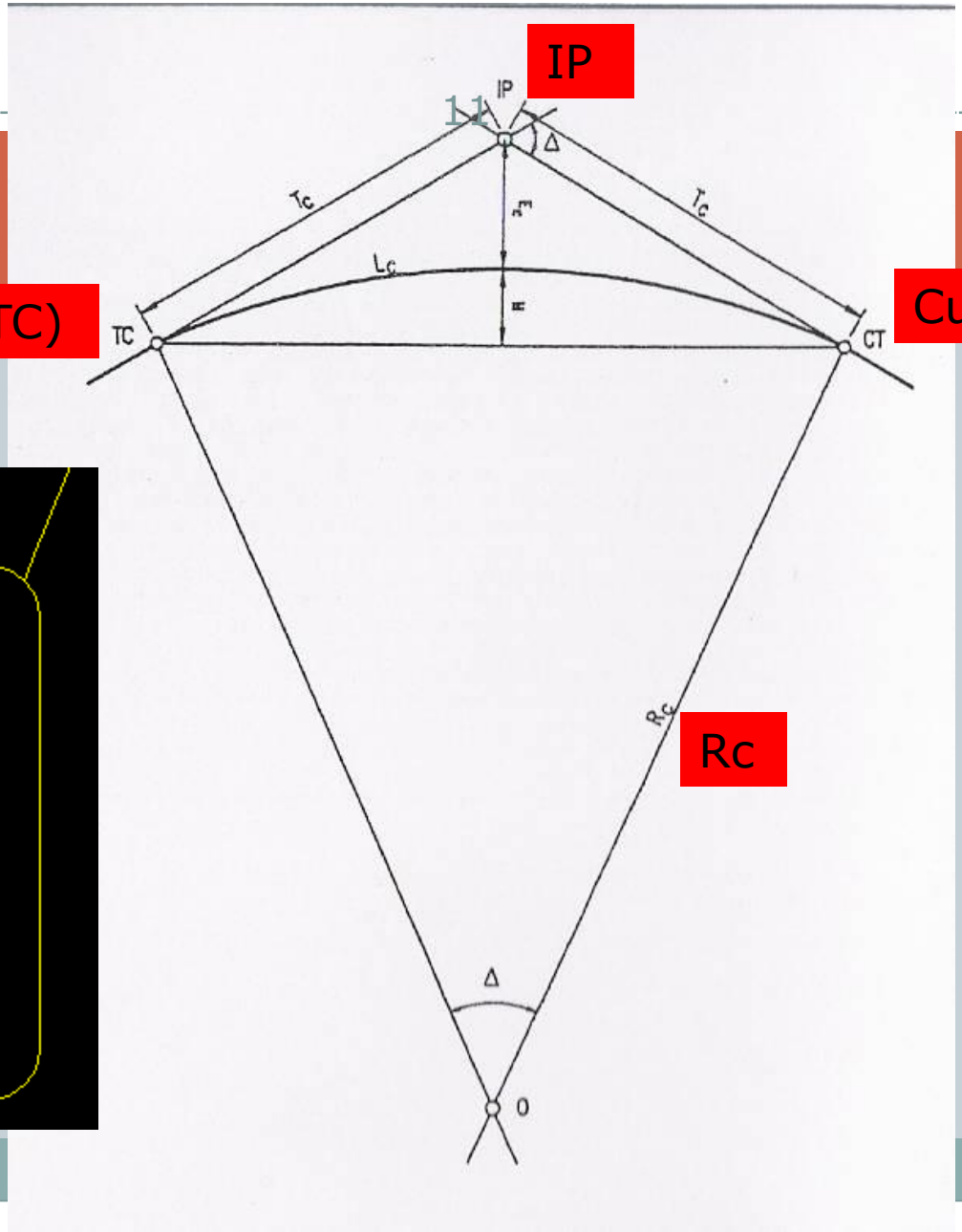


Lengkung peralihan (berjejari berubah)



Lengkung mudah (berjejari tunggal)

Tangent Curve (TC)



Curve Tangent (CT)

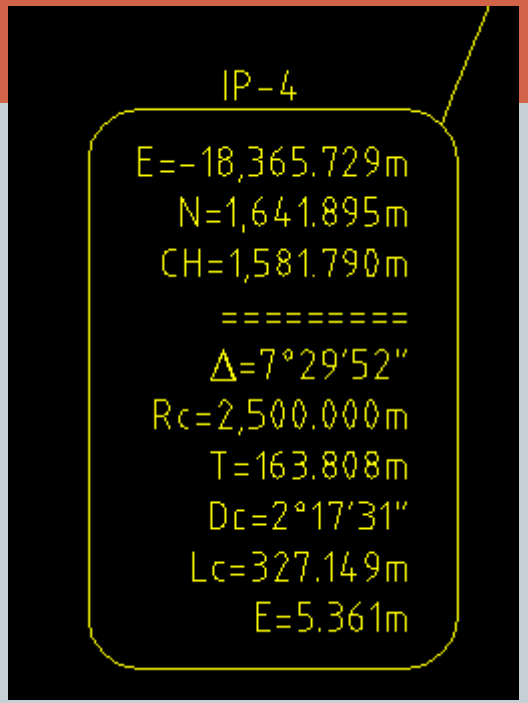
IP-4

E=-18,365.729m
N=1,641.895m
CH=1,581.790m
=========
Δ=7°29'52"
Rc=2,500.000m
T=163.808m
Dc=2°17'31"
Lc=327.149m
E=5.361m

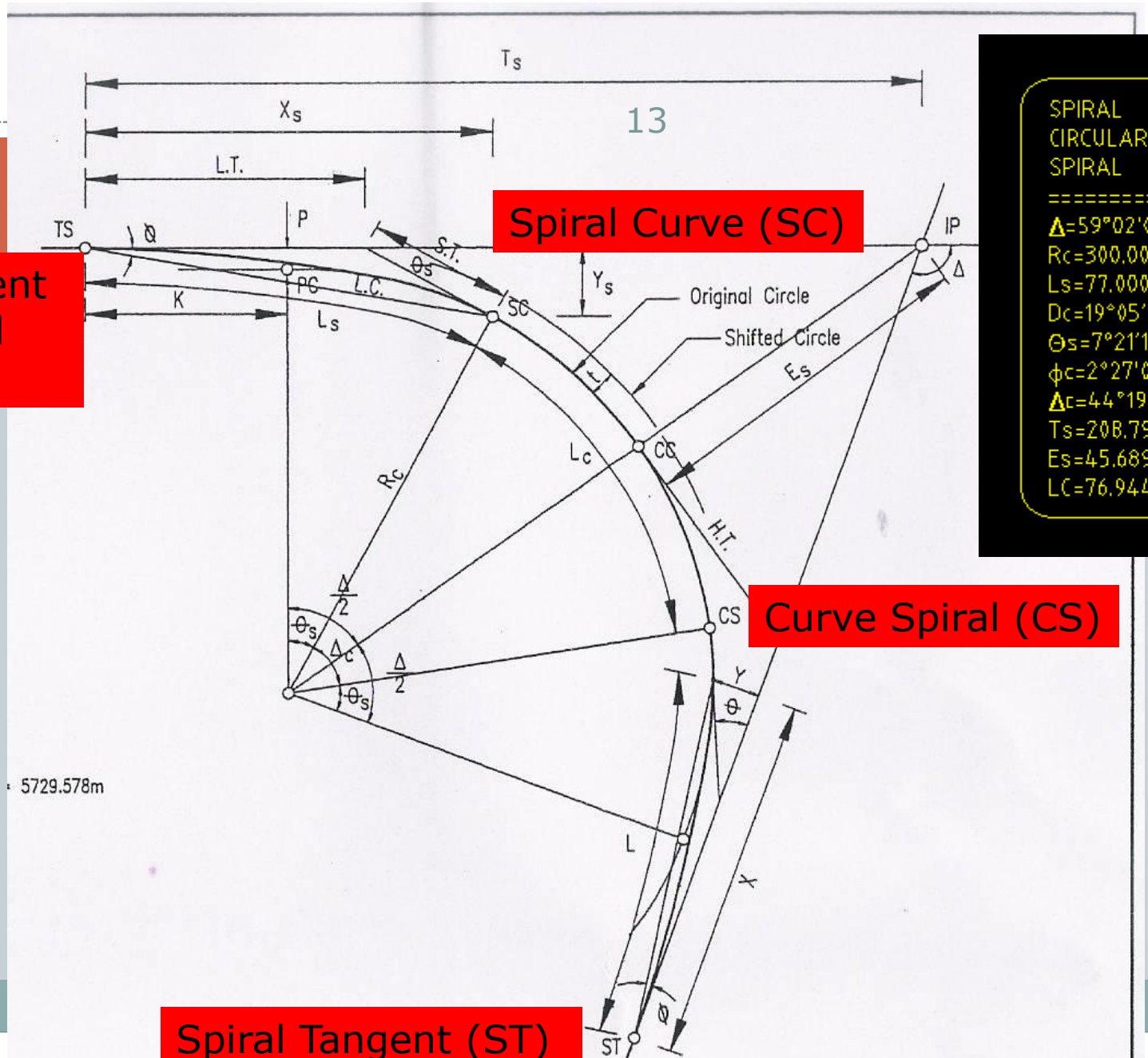
Lengkung mudah (berjejari tunggal)

Horizontal Curve Data

Circular	IP = 4	Coordinates	Northing	Easting
Δ	7° 29 ' 52 "	Xs		0.000
Rc	2500 m	Ys		0.000
Ls	0.000 m	LT		0.000
Dc	2° 17 ' 31 "	ST		0.000
θ s	0.000	Lc		327.153
ϕ c	0.000	p		0.000
Δc	0.000	k		0.000
Ts	163.810 m	SE		0.00%
Es	5.361 m	LR		0 m
LC	0 m	Speed		70 km/j



Lengkung peralihan (berjejari berubah)



IP-2

SPIRAL	E=-19,240.536m
CIRCULAR	N=2,160.321m
SPIRAL	CH=547.005
Δ=59°02'00"	xs=76.873m
Rc=300.000m	ys=3.290m
Ls=77.000m	LT=51.378m
Dc=19°05'55"	ST=25.707m
θs=7°21'11"	Lc=232.098m
ϕc=2°27'02"	p=0.823m
Δc=44°19'39"	k=38.479m
Ts=208.792m	
Es=45.689m	
LC=76.944m	

Tangent Spiral (TS)

Spiral Curve (SC)

Curve Spiral (CS)

Spiral Tangent (ST)

Lengkung peralihan (berjejari berubah)

Horizontal Curve Data

Spiral / Circular / Spiral	IP = 1				Coordinates	Northing	Easting	
Δ	11	° 30	' 49	"	Xs		61.963	
Rc		400	m		Ys		1.601	
Ls		62	m		LT		41.346	
Dc	14	° 19	' 26	"	ST		20.678	
θ s	4	° 26	' 26	"	Lc		18.380	
ϕ c	1	° 28	' 48	"	p		0.400	
Δc	2	° 37	' 58	"	k		30.994	
Ts		71.360	m		SE		6.30%	
Es		2.430	m		LR		24800	m
LC		61.9766	m		Speed		70	km/j

IP-2

SPIRAL E=-19,240.536m
CIRCULAR N=2,160.321m
SPIRAL CH=547.005

Δ=59°02'00" xs=76.873m
Rc=300.000m ys=3.290m
Ls=77.000m LT=51.378m
Dc=19°05'55" ST=25.707m
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Ts=208.792m
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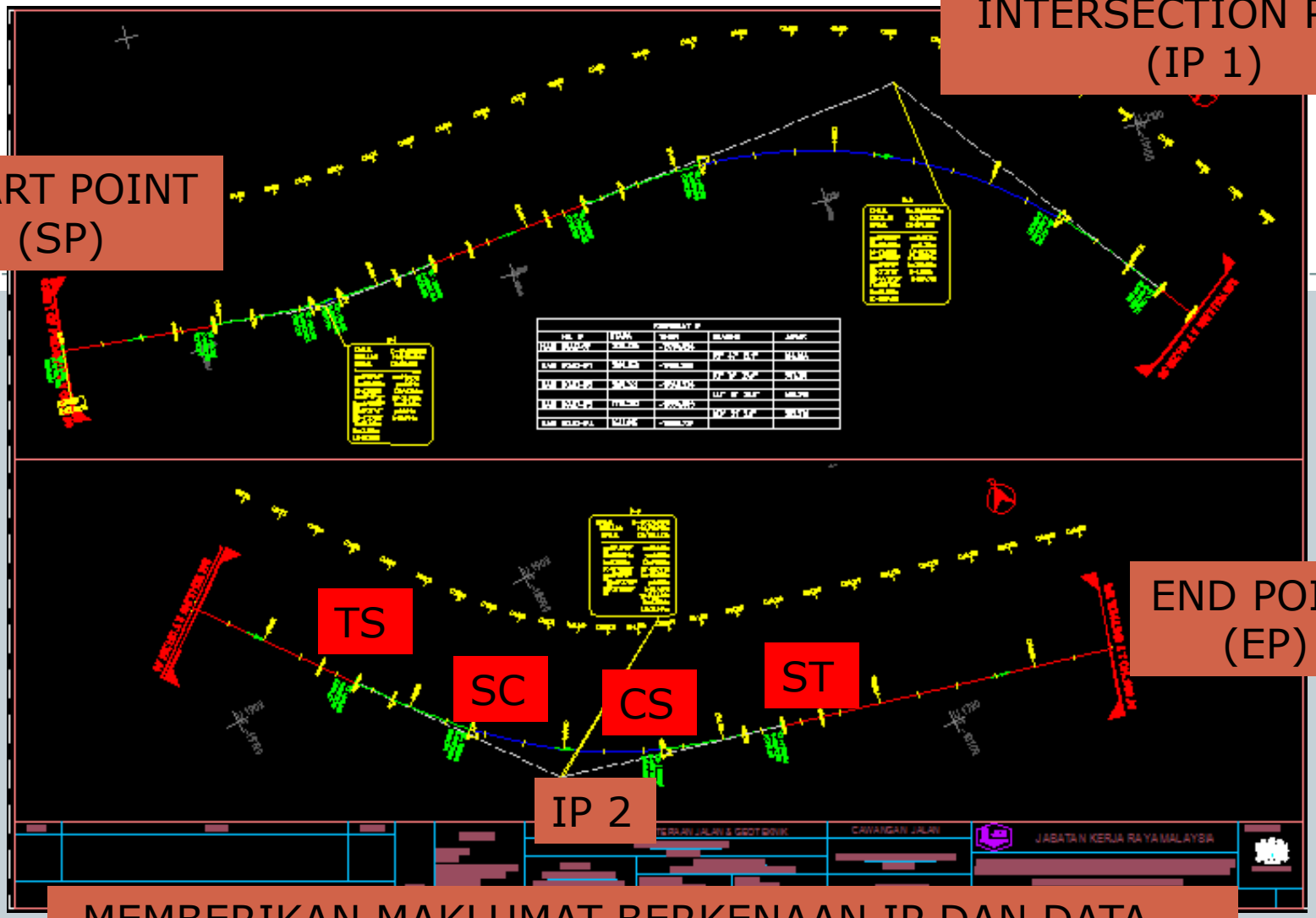
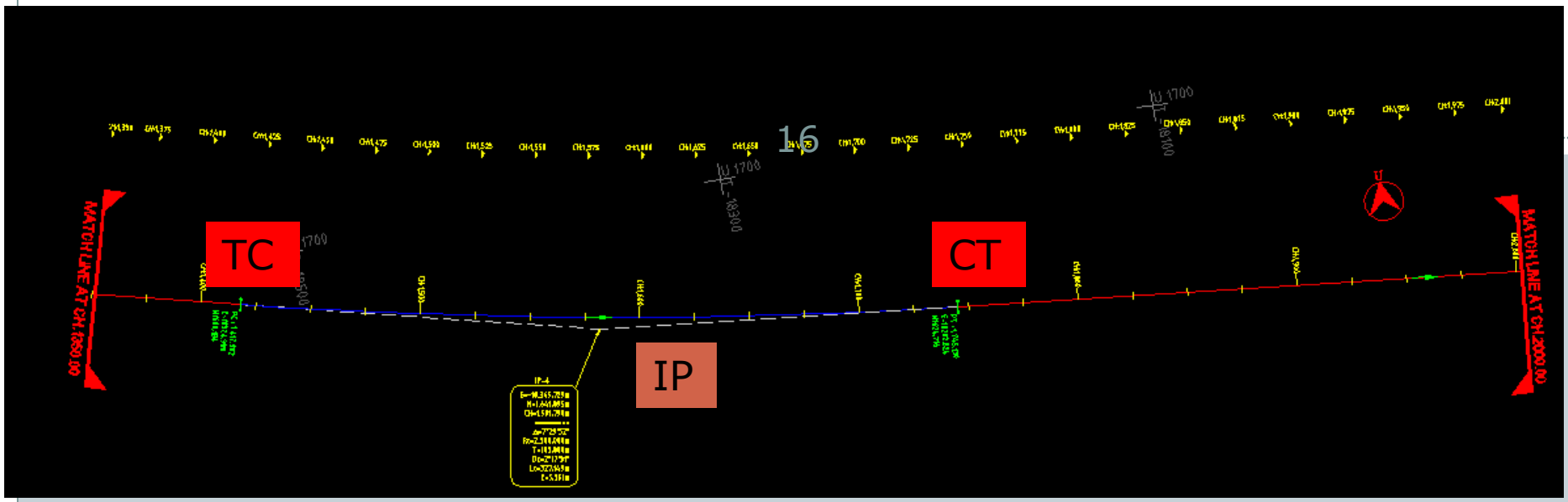
LUKISAN : ALIGNMENT CONTROL PLAN

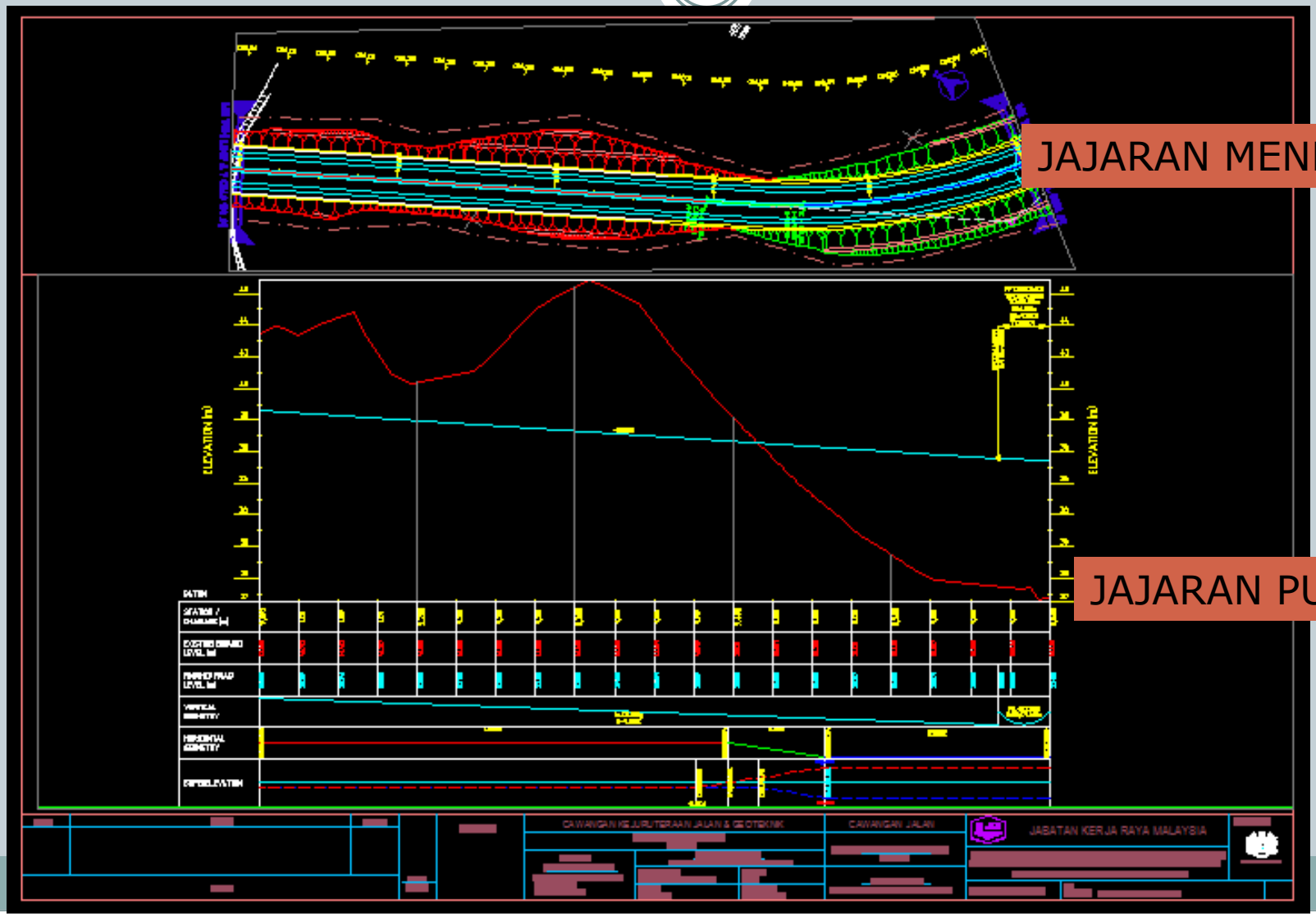


-MEMBERIKAN MAKLUMAT BERKENAAN IP DAN DATA LENGKUNG/CURVE.
- CENTER LINE

LUKISAN : ALIGNMENT CONTROL PLAN



LUKISAN : PLAN & LONGITUDINAL PROFILE

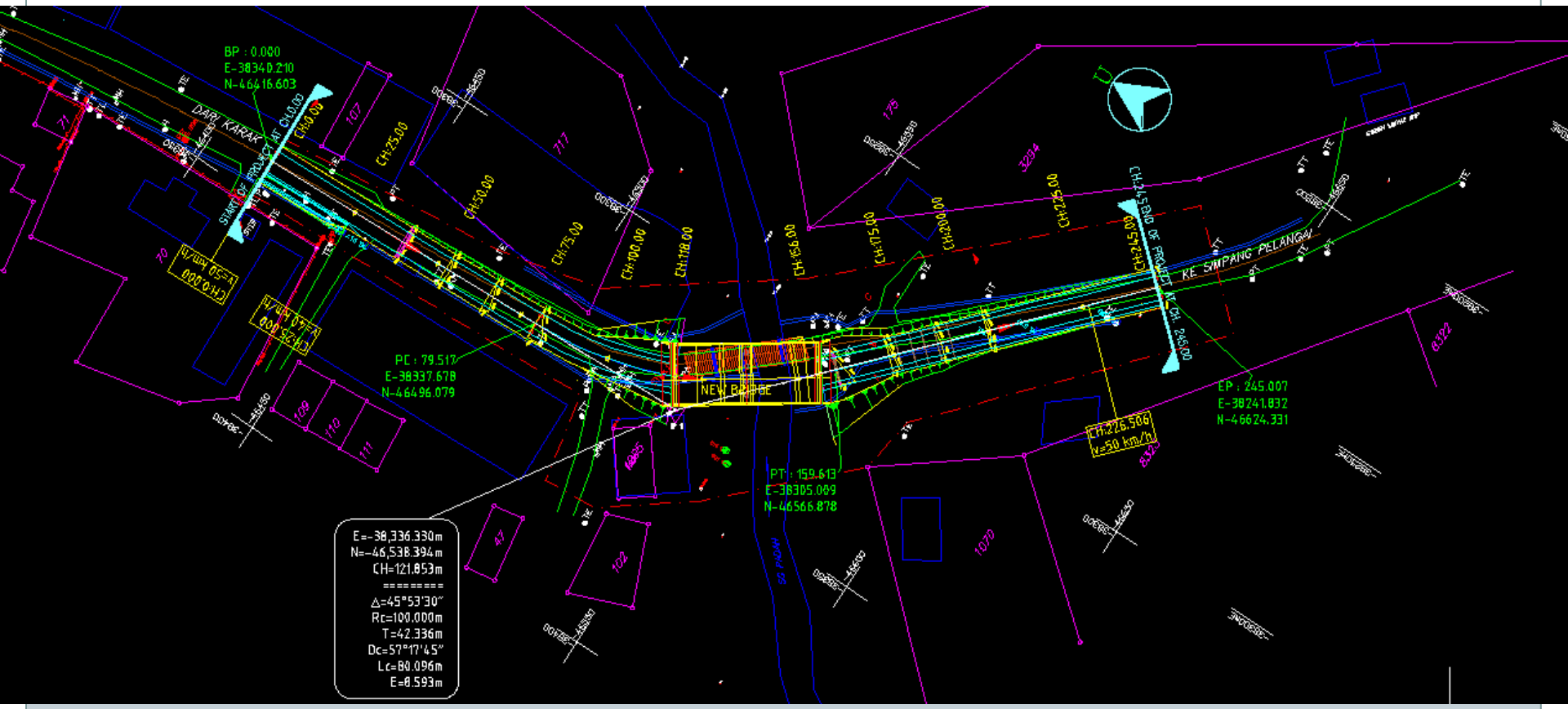


LUKISAN : PLAN & LONGITUDINAL PROFILE

START OF PROJECT (CH.0.00)

EVERY 25m CHAINAGE

END OF PROJECT (CH.....00)



SUPERELEVATION RATES

- Maximum superelevation rates are controlled by several factors:
  - Climatic conditions
  - Terrain conditions
  - Frequency of slow moving vehicles
- Maximum rates used usually ranges between 6% to 10%

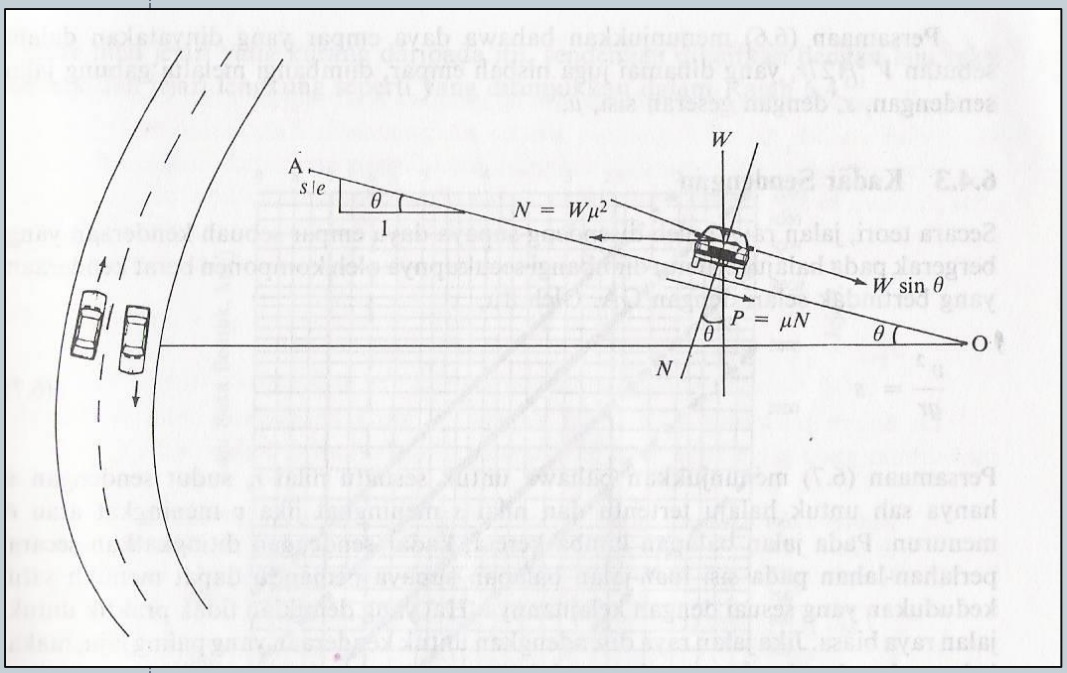
SUPERELEVATION

- Is used at a curve
- Produced a centrifugal force to hold a moving vehicle on the path of the road
- Superelevation rates are determined by the radius of the curves and the design speed
- Maximum superelevation rates are controlled by several factors:
  - Climatic conditions
  - Terrain conditions
  - Frequency of slow moving vehicles

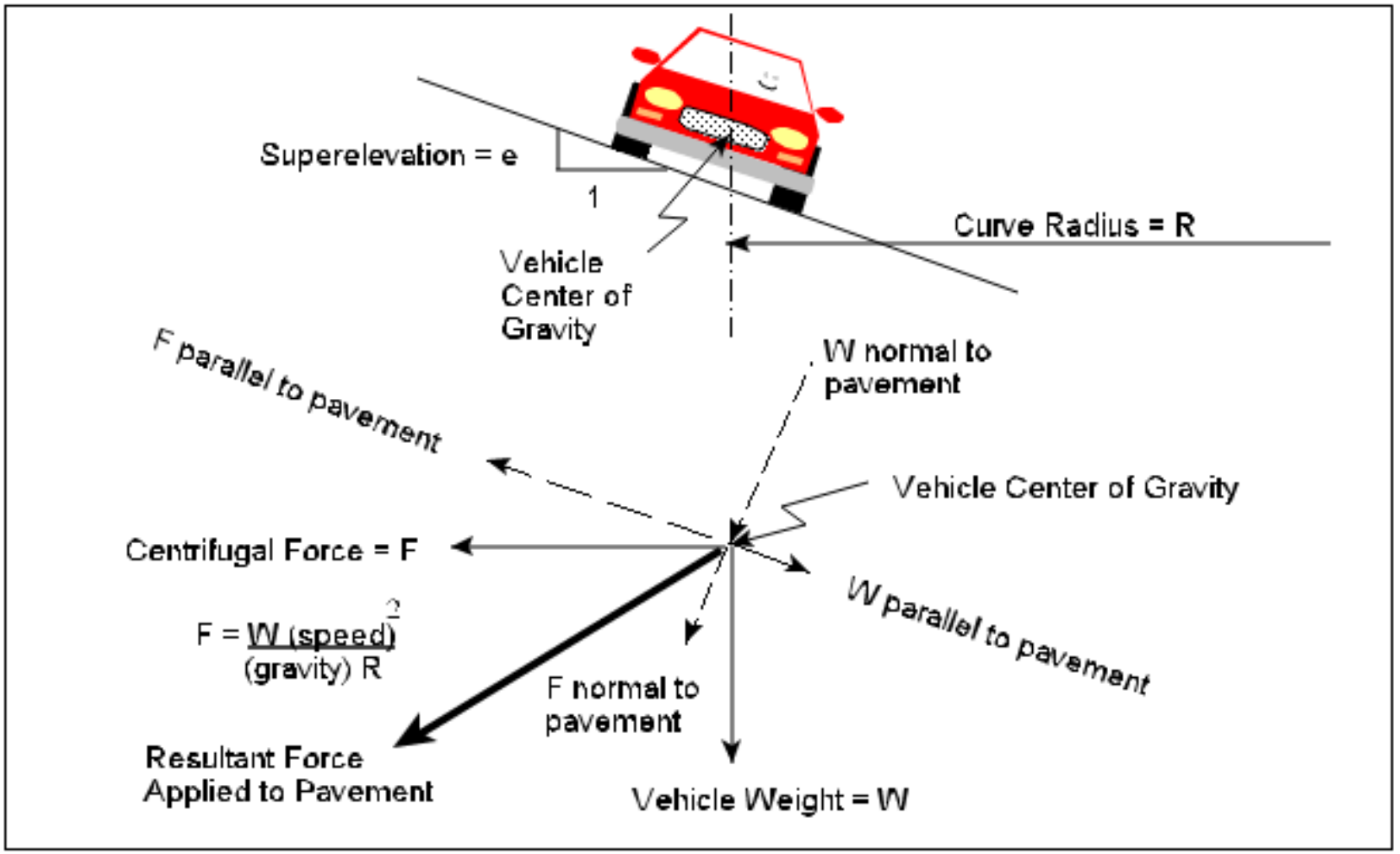
JAJARAN MENDATAR

2. Sendengan (Superelevation)

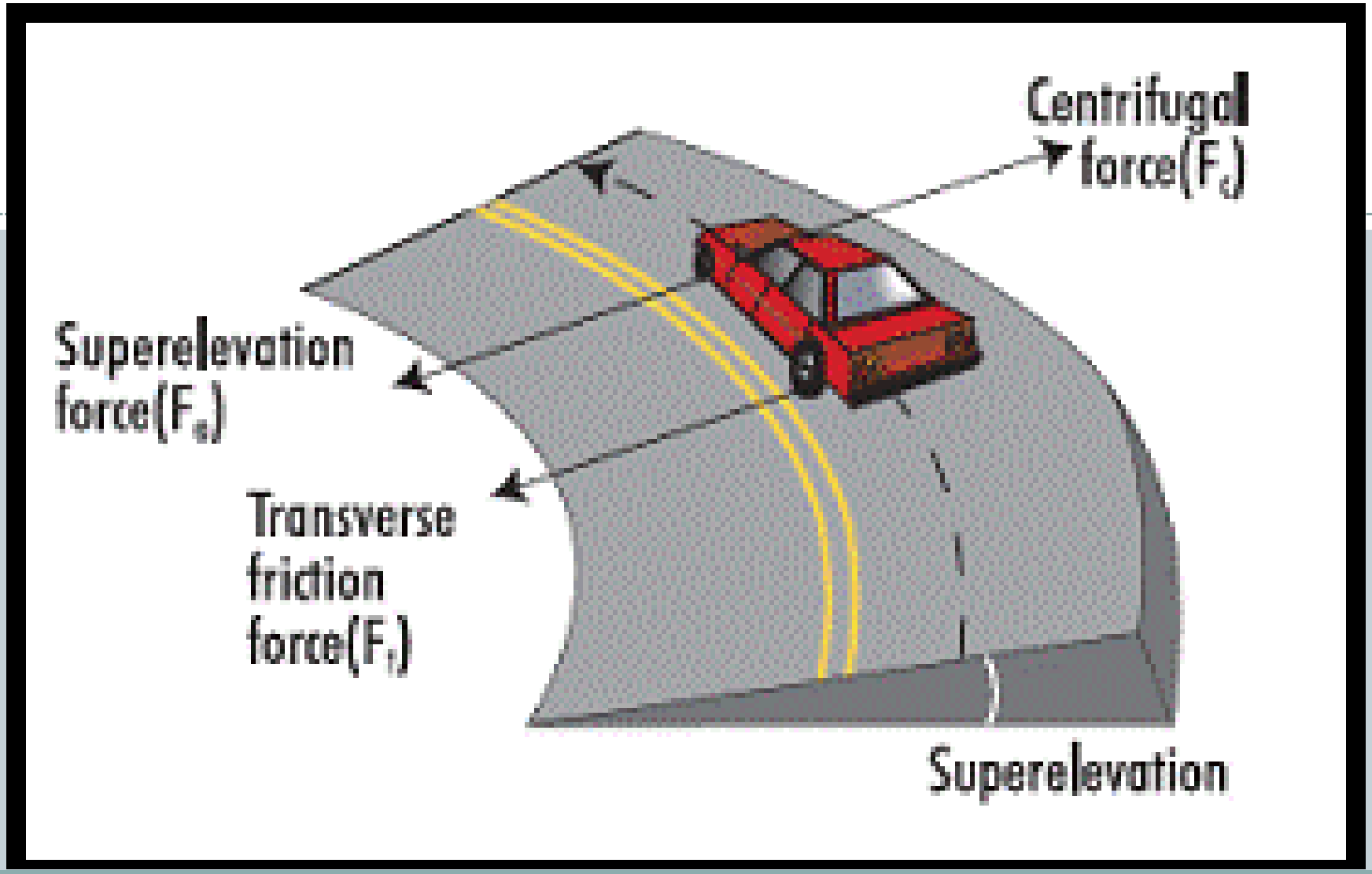
- **Apabila sebuah kenderaan yang bergerak dari jalan lurus dan seterusnya menyelekoh, terdapat tiga daya yang bertindak terhadap kenderaan tersebut, iaitu:**
  - **Daya empar (centrifugal force) - yang bertindak melintang keluar**
  - **Komponen berat kenderaan - yang bertindak ke bawah**
  - **Geseran sisi pada antara muka tayar dan jalan raya.**



Superelevation



Superelevation



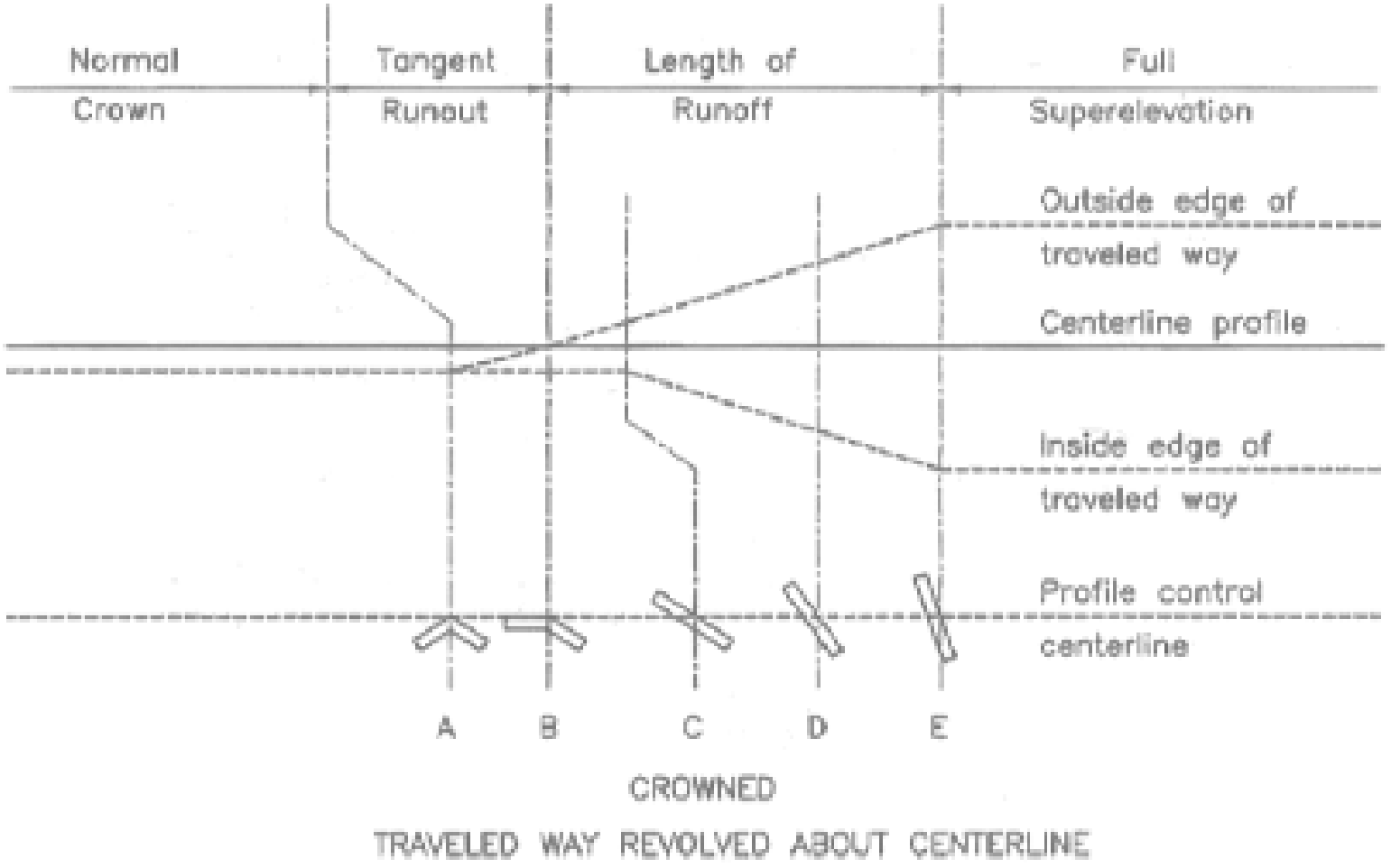
Superelevation

- **Oleh yang demikian bagi mengimbangi dan mengelakkan kenderaan daripada terbalik atau tergelincir serta memberi keselesaan kepada pemanduan, kaedah sendengan (superelevation) di perkenalkan di kawasan selekoh peralihan.**

- **Mengambilkira perkara berikut:**

  - **Halaju rekabentuk di lengkung (curve)**
  - **Kemungkinan kenderaan yang bergerak perlahan menghala ke tengah jalan**
  - **Kestabilan kenderaan berat melalui lengkung**
  - **Nilai maksimum sendengan:**
    - ***Rural Roads*: 0.1 (10%)**
    - ***Urban Roads*: 0.06 (6%)**

Superelevation Transition



from AASHTO's *A Policy on Geometric Design of Highways and Streets 2001*

Superelevation Transition

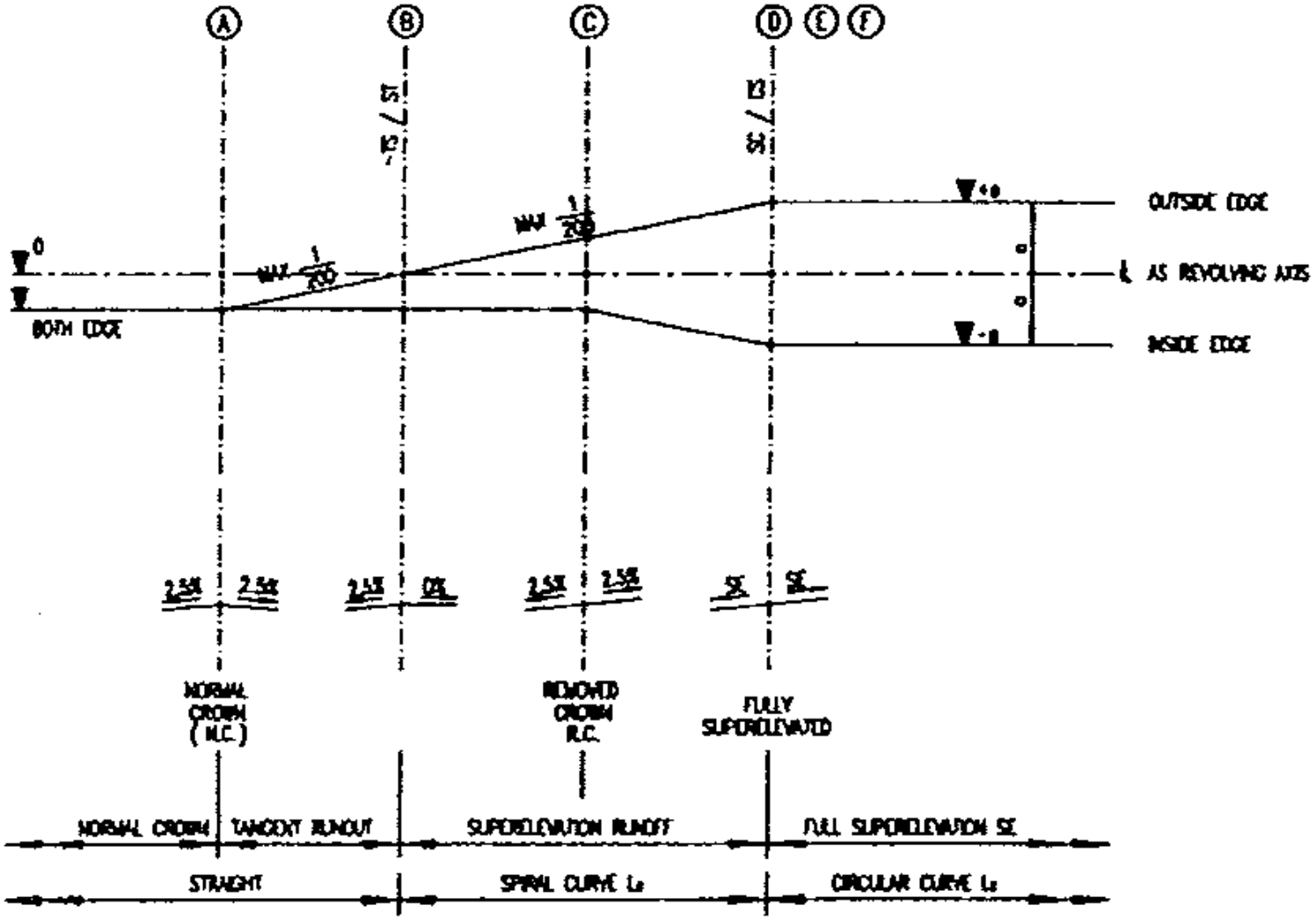


Table 4-7A: Design Superelevation Table – ATJ 8/86 (Pindaan 2015)

TABLE 4-7A : DESIGN SUPERELEVATION TABLE

R (m)	V = 30kph				V = 40kph				V = 50kph				V = 60kph				V = 70kph				V = 80kph				V = 90kph				V = 100kph				V = 110kph				V = 120kph			
	e (%)	2 L(m)	4 L(m)	6 L(m)	e (%)	2 L(m)	4 L(m)	6 L(m)	e (%)	2 L(m)	4 L(m)	6 L(m)	e (%)	2 L(m)	4 L(m)	6 L(m)	e (%)	2 L(m)	4 L(m)	6 L(m)	e (%)	2 L(m)	4 L(m)	6 L(m)	e (%)	2 L(m)	4 L(m)	6 L(m)	e (%)	2 L(m)	4 L(m)	6 L(m)	e (%)	2 L(m)	4 L(m)	6 L(m)	e (%)	2 L(m)	4 L(m)	6 L(m)
7000	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0
5000	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0
3000	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0	RC	20	31	40	RC	23	34	46	RC	24	37	48
2500	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0	RC	19	28	38	RC	20	31	40	RC	23	34	46	2.7	26	38	52
2000	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0	RC	18	27	36	RC	19	28	38	RC	20	31	40	2.8	25	37	50	3.3	31	47	62
1500	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0	RC	17	26	34	RC	18	27	36	2.7	21	31	42	3.1	25	38	50	3.6	32	47	64	4.2	40	60	80
1400	NC	0	0	0	NC	0	0	0	NC	0	0	0	RC	15	23	30	RC	17	26	34	RC	18	27	36	2.8	21	32	42	3.3	27	41	54	3.8	33	50	66	4.4	42	63	84
1300	NC	0	0	0	NC	0	0	0	NC	0	0	0	RC	15	23	30	RC	17	26	34	2.7	19	29	38	3	23	34	46	3.5	29	43	58	4	35	53	70	4.7	45	67	90
1200	NC	0	0	0	NC	0	0	0	NC	0	0	0	RC	15	23	30	RC	17	26	34	3.1	22	33	44	3.2	25	37	50	3.7	30	45	60	4.2	37	55	74	5	47	71	94
1000	NC	0	0	0	NC	0	0	0	RC	14	21	28	RC	15	23	30	2.6	17	26	34	3.4	24	37	48	3.6	28	41	56	4.2	34	52	68	4.8	42	63	84	5.6	53	80	106
900	NC	0	0	0	NC	0	0	0	RC	14	21	28	RC	15	23	30	2.8	18	27	36	3.6	26	39	52	3.9	30	45	60	4.5	37	55	74	5.1	45	67	90	5.8	55	82	110
800	NC	0	0	0	NC	0	0	0	RC	14	21	28	RC	15	23	30	3.1	20	30	40	4	29	43	58	4.2	32	48	64	4.9	40	60	80	5.4	47	71	94	6	57	85	114
700	NC	0	0	0	RC	13	19	26	RC	14	21	28	2.8	17	25	34	3.4	22	33	44	4.3	31	46	62	4.6	35	53	70	5.2	43	64	86	5.8	51	76	102	R min = 755			
600	NC	0	0	0	RC	13	19	26	RC	14	21	28	3.1	19	28	38	3.8	25	37	50	4.8	35	52	70	5	38	57	76	5.6	46	69	92	6	53	79	106				
500	NC	0	0	0	RC	13	19	26	2.8	15	23	30	3.5	21	32	42	4.2	27	41	54	5.3	38	57	76	5.4	41	62	82	5.9	48	72	96	R min = 560							
400	RC	10	14	20	RC	13	19	26	3.3	18	27	36	4	24	36	48	4.7	31	46	62	5.9	42	64	84	5.9	45	68	90	R min = 435											
300	RC	10	14	20	3.1	16	24	32	3.9	22	32	44	4.6	28	41	56	5.4	35	53	70	6	43	65	86	R min = 335															
250	RC	10	14	20	3.5	18	27	36	4.2	23	35	46	5	30	45	60	5.8	38	57	76	R min = 250																			
200	2.8	13	20	26	3.9	20	30	40	4.7	26	39	52	5.5	33	50	66	6	39	59	78																				
175	3	14	22	28	4.1	21	32	42	5	28	42	56	5.8	35	52	70	R min = 195																							
150	3.3	16	24	32	4.4	23	34	46	5.3	29	44	58	6	36	54	72																							
140	3.5	17	25	34	4.5	23	35	46	5.4	30	45	60	6	36	54	72																							
130	3.6	17	25	34	4.6	24	35	48	5.6	31	47	62	R min = 135																											
120	3.8	18	27	36	4.8	25	37	50	5.7	32	47	64																											
110	3.9	19	28	38	5	26	39	52	5.8	32	48	64																											
100	4.1	20	30	40	5.2	27	40	54	6	33	50	66																											
90	4.2	20	30	40	5.4	28	42	56	6	33	50	66																											
80	4.5	22	32	44	5.6	29	43	58	R min = 90																														
70	4.7	23	34	46	5.8	30	45	60																															
60	5	24	36	48	6	31	46	62																															
50	5.4	26	39	52	R min = 55																																		
40	5.8	28	42	56																																			
30	6	29	43	58																																			
	R min = 30																																						

e max	=	6%
R	=	Radius of curve
Vd	=	Design speed
L	=	Minimum length of runoff (excluding tangent runout) length are for 3.6m lane width and the respective maximum relative slope for each design speed

Notes:-

The RC row presents minimum radii for a compute

The row NC designates a travel way cross section

For curve radii falling between NC and RC, a plane

Source: Adapted from AASHTO – A Policy on Geome

Halaju = 80km/h
Radius = 800m
Superelevation = 0.040 (4.0%)
Ls = 29m (2 lanes)
43m (4 lanes)

Table 4-7B: Design Superelevation Table –ATJ 8/86 (Pindaan 2015)

TABLE 4-7B : DESIGN SUPERELEVATION TABLE

R (m)	V = 30kph				V = 40kph				V = 50kph				V = 60kph				V = 70kph				V = 80kph				V = 90kph				V = 100kph				V = 110kph				V = 120kph			
	e (%)	2 L(m)	4 L(m)	6 L(m)	e (%)	2 L(m)	4 L(m)	6 L(m)	e (%)	2 L(m)	4 L(m)	6 L(m)	e (%)	2 L(m)	4 L(m)	6 L(m)	e (%)	2 L(m)	4 L(m)	6 L(m)	e (%)	2 L(m)	4 L(m)	6 L(m)	e (%)	2 L(m)	4 L(m)	6 L(m)	e (%)	2 L(m)	4 L(m)	6 L(m)	e (%)	2 L(m)	4 L(m)	6 L(m)	e (%)	2 L(m)	4 L(m)	6 L(m)
7000	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0
5000	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0
3000	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0	RC	21	32	42	RC	22	33	44	RC	24	36	48
2500	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0	RC	19	29	38	RC	21	32	42	RC	22	33	44	2.9	27	41	54
2000	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0	RC	18	27	36	RC	19	29	38	2.6	21	32	42	3.0	26	40	52	3.5	33	50	66
1500	NC	0	0	0	NC	0	0	0	NC	0	0	0	RC	15	23	30	RC	17	25	34	RC	18	27	36	2.8	21	32	42	3.4	28	42	56	3.9	34	51	68	4.6	44	65	88
1400	NC	0	0	0	NC	0	0	0	NC	0	0	0	RC	15	23	30	RC	17	25	34	RC	18	27	36	3.0	23	34	46	3.6	29	44	58	4.1	36	54	72	4.9	46	70	92
1300	NC	0	0	0	NC	0	0	0	NC	0	0	0	RC	15	23	30	RC	17	25	34	2.7	19	29	38	3.2	25	37	50	3.8	31	47	62	4.4	39	58	78	5.2	49	74	98
1200	NC	0	0	0	NC	0	0	0	NC	0	0	0	RC	15	23	30	RC	17	25	34	2.9	21	31	42	3.4	26	39	52	4.1	34	50	68	4.7	41	62	82	5.6	53	80	106
1000	NC	0	0	0	NC	0	0	0	RC	14	21	28	RC	15	23	30	2.8	18	27	36	3.4	24	37	48	4.0	31	46	62	4.8	39	59	78	5.5	48	72	96	6.5	62	92	124
900	NC	0	0	0	NC	0	0	0	RC	14	21	28	RC	15	23	30	3.1	20	30	40	3.7	27	40	54	4.4	34	51	68	5.2	43	64	86	6.0	53	79	106	7.1	67	101	134
800	NC	0	0	0	NC	0	0	0	RC	14	21	28	RC	15	23	30	3.4	22	33	44	4.1	30	44	60	4.8	37	55	74	5.7	47	70	94	6.6	58	87	116	7.6	72	108	144
700	NC	0	0	0	RC	13	20	26	RC	14	21	28	2.7	15	23	30	3.8	25	37	50	4.5	32	49	64	5.3	41	61	82	6.3	52	77	104	7.2	63	95	126	8.0	76	114	152
600	NC	0	0	0	RC	13	20	26	2.6	14	21	28	3.0	18	27	36	4.3	28	42	56	5.1	37	55	74	6.0	46	69	92	6.9	55	85	110	7.7	68	101	136	R min = 665			
500	NC	0	0	0	RC	13	20	26	3.0	17	25	34	3.4	20	31	40	4.9	32	48	64	5.8	42	63	84	6.7	51	77	102	7.6	62	93	124	8.0	70	105	140				
400	RC	12	18	24	2.7	14	21	28	3.6	20	30	40	3.9	23	35	46	5.7	37	56	74	6.6	48	71	96	7.5	57	88	114	8.0	65	98	130	R min = 500							
300	RC	12	18	24	3.4	17	26	34	4.5	25	37	50	4.7	28	42	56	6.7	44	66	88	7.6	55	82	110	R min = 396															
250	2.5	12	18	24	4.0	21	31	42	5.1	26	42	52	5.6	34	50	68	7.4	48	73	96	7.9	57	85	114																
200	3.0	14	22	28	4.6	24	35	48	5.8	32	48	64	6.2	37	56	74	7.9	52	78	104	R min = 305																			
175	3.4	16	24	32	5.0	26	39	52	6.2	34	52	68	7.0	42	63	84	8.0	52	79	104	R min = 230																			
150	3.8	18	27	36	5.4	28	42	56	6.7	37	56	74	7.4	44	67	88	R min = 175																							
140	4.0	19	29	38	5.6	29	43	58	6.9	38	57	76	7.8	47	70	94																								
130	4.2	20	30	40	5.8	30	45	60	7.1	39	59	78	7.9	47	71	94																								
120	4.4	21	32	42	6.0	31	46	62	7.4	41	61	82	8.0	48	72	96																								
110	4.7	23	34	46	6.3	32	49	64	7.6	42	63	84	R min = 125																											
100	5.0	24	36	48	6.6	34	51	68	7.8	43	65	86																												
90	5.2	25	37	50	6.9	35	53	70	7.9	44	66	88																												
80	5.5	26	40	52	7.2	37	56	74	8.0	44	66	88																												
70	5.9	28	42	56	7.5	39	58	78	R min = 80																															
60	6.4	31	46	62	7.8	40	60	80																																
50	6.9	33	50	66	8.0	41	62	82																																
40	7.5	36	54	72	R min = 50																																			
30	8	38	58	76																																				
	R min = 30																																							

e max	=	8%
R	=	Radius of curve
Vd	=	Design speed
L	=	Minimum length of runoff (excluding tangent runout) length are for 3.6m lane width and the respective maximum relative slope for each design speed
NC	=	Normal crown 2.5%

Notes:-

The RC row presents minimum radii for a computed SE rate

The row NC designates a travel way cross section used on cu

For curve radii falling between NC and RC, a plane slope acr

Source: Adapted from AASHTO – A Policy on Ge

Halaju = 80km/h
Radius = 800m
Superelevation = 0.041 (4.1%)
Ls = 30m (2 lanes)
44m (4 lanes)

Table 4-7C: Design Superelevation Table –ATJ 8/86 (Pindaan 2015)

TABLE 4-7C : DESIGN SUPERELEVATION TABLE

R (m)	V = 30kph				V = 40kph				V = 50kph				V = 60kph				V = 70kph				V = 80kph				V = 90kph				V = 100kph				V = 110kph				V = 120kph			
	e (%)	2 L(m)	4 L(m)	6 L(m)	e (%)	2 L(m)	4 L(m)	6 L(m)	e (%)	2 L(m)	4 L(m)	6 L(m)	e (%)	2 L(m)	4 L(m)	6 L(m)	e (%)	2 L(m)	4 L(m)	6 L(m)	e (%)	2 L(m)	4 L(m)	6 L(m)	e (%)	2 L(m)	4 L(m)	6 L(m)	e (%)	2 L(m)	4 L(m)	6 L(m)	e (%)	2 L(m)	4 L(m)	6 L(m)	e (%)	2 L(m)	4 L(m)	6 L(m)
7000	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0
5000	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0
3000	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0	RC	20	30	40	RC	22	33	44	RC	24	36	48
2500	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0	RC	19	28	38	2.7	22	33	44	3.1	27	41	54	3.6	34	51	68
2000	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0	RC	17	26	34	RC	19	28	38	3.5	29	43	58	4.1	36	54	72	4.8	46	68	92
1500	NC	0	0	0	NC	0	0	0	NC	0	0	0	RC	15	23	30	RC	17	26	34	RC	17	26	34	2.9	22	33	44	3.8	31	47	62	4.3	38	57	76	5.1	48	72	96
1400	NC	0	0	0	NC	0	0	0	NC	0	0	0	RC	15	23	30	RC	17	26	34	2.6	19	28	38	3.1	24	36	48	4	33	49	66	4.6	40	61	80	5.5	52	78	104
1300	NC	0	0	0	NC	0	0	0	NC	0	0	0	RC	15	23	30	RC	17	26	34	2.8	20	30	40	3.3	25	38	50	4.3	35	53	70	5	44	66	88	5.9	56	84	112
1200	NC	0	0	0	NC	0	0	0	NC	0	0	0	RC	15	23	30	RC	17	26	34	3	22	32	44	3.6	28	41	56	5.1	42	63	84	5.9	52	78	104	7	66	99	132
1000	NC	0	0	0	NC	0	0	0	RC	15	22	30	RC	15	23	30	2.9	19	28	38	3.5	25	38	50	4.2	32	48	64	5.6	46	69	92	6.4	55	84	110	7.7	73	109	146
900	NC	0	0	0	NC	0	0	0	RC	15	22	30	2.6	15	23	30	3.2	21	31	42	3.9	28	42	56	4.6	35	53	70	6.2	51	76	102	7.1	62	94	124	8.5	81	121	162
800	NC	0	0	0	NC	0	0	0	RC	15	22	30	2.7	16	24	32	3.5	23	34	46	4.3	31	46	62	5.1	39	59	78	6.9	56	85	112	8	70	105	140	9.5	90	135	180
700	NC	0	0	0	RC	14	22	28	RC	15	22	30	3.1	19	28	38	4	26	39	52	4.8	35	52	70	5.8	44	67	88	7.8	64	95	128	9	79	119	158	10	95	142	190
600	NC	0	0	0	RC	14	22	28	2.7	15	22	30	3.6	22	32	44	4.5	29	44	58	5.5	40	59	80	6.5	50	75	100	8.9	73	109	146	9.9	87	130	174	R min = 595			
500	NC	0	0	0	RC	14	22	28	3.1	17	26	34	4.2	25	36	50	5.3	35	52	70	6.4	46	69	92	7.6	58	87	116	9.8	80	120	160	R min = 455							
400	RC	12	19	24	2.8	14	22	28	3.8	21	32	42	5	30	45	60	6.3	41	62	82	7.5	54	81	108	8.8	67	101	134	R min = 360											
300	RC	12	19	24	3.6	19	28	38	4.8	27	40	54	6.3	38	57	76	7.8	51	77	102	9	65	97	130	9.9	76	114	152												
250	2.6	12	19	24	4.2	22	32	44	5.6	31	47	62	7.1	43	64	86	8.7	57	85	114	9.7	70	105	140	R min = 275														
200	3.1	15	22	30	5	26	39	52	6.6	37	55	74	8.2	49	74	98	9.6	63	94	126	R min = 210																		
175	3.5	17	25	34	5.6	29	43	58	7.1	39	59	78	8.8	53	79	106	9.9	65	97	130																				
150	4	19	29	38	6.2	32	48	64	7.8	43	65	86	9.4	56	85	112	R min = 160																							
140	4.3	21	31	42	6.4	33	49	66	8.1	45	67	90	9.7	58	87	116																								
130	4.5	22	32	44	6.7	34	52	68	8.5	47	71	94	9.8	59	88	118																								
120	4.8	23	35	46	7	36	54	72	8.8	49	73	98	10	60	90	120																								
110	5.1	24	37	48	7.4	38	57	76	9.1	50	76	100	R min = 115																												
100	5.5	26	40	52	7.7	40	59	80	9.5	53	79	106																												
90	5.9	28	42	56	8.2	42	63	84	9.8	54	81	108																												
80	6.4	31	46	62	8.6	44	66	88	10	55	83	110																												
70	6.9	33	50	66	9.1	47	70	94	R min = 75																															
60	7.5	36	54	72	9.6	49	74	98																																
50	8.2	39	59	78	10	51	77	102																																
40	9.1	44	65	88	R min = 45																																			
30	9.9	48	71	96																																				
	R min = 25																																							

e max	=	10%
R	=	Radius of curve
Vd	=	Design speed
L	=	Minimum length of runoff (excluding tangent runout) length are for 3.6m lane width and the respective maximum relative slope for each design speed
NC	=	Normal crown 2.5%

Notes:-

The RC row presents minimum radii for a computed SE rate

The row NC designates a travel way cross section used on cu

For curve radii falling between NC and RC, a plane slope acr

Halaju = 80km/h
Radius = 800m
Superelevation = ? %
Ls = ? m (2 lanes)
? m (4 lanes)

Source: Adapted from AASHTO – A Policy on Ge

Table 4-4B: Design Superelevation Table (Urban) – ATJ 8/86

TABLE 4-4B : DESIGN SUPERELEVATION TABLE (URBAN)

R	V = 40 Km/h			V = 50 Km/h			V = 60 Km/h			V = 80 Km/h			V = 100 Km/h			V = 120 Km/h		
	e	L (m)		e	L (m)		e	L (m)		e	L (m)		e	L (m)		e	L (m)	
		2-lane	4-lane		2-lane	4-lane		2-lane	4-lane		2-lane	4-lane		2-lane	4-lane		2-lane	4-lane
5000	NC	0	0	NC	0	0	NC	0	0	NC	0	0	NC	0	0	NC	0	0
4000	NC	0	0	NC	0	0	NC	0	0	NC	0	0	NC	0	0	RC	0	0
3500	NC	0	0	NC	0	0	NC	0	0	NC	0	0	RC	55	55	.020	65	65
3000	NC	0	0	NC	0	0	NC	0	0	NC	0	0	RC	55	55	.023	65	65
2500	NC	0	0	NC	0	0	NC	0	0	NC	0	0	.021	55	55	.027	65	65
2000	NC	0	0	NC	0	0	NC	0	0	RC	0	0	.025	55	55	.033	65	65
1800	NC	0	0	NC	0	0	NC	0	0	RC	45	45	.027	55	55	.036	65	65
1600	NC	0	0	NC	0	0	NC	35	35	.021	45	45	.030	55	55	.039	65	65
1400	NC	0	0	NC	0	0	RC	35	35	.023	45	45	.034	55	55	.043	65	65
1200	NC	0	0	NC	30	30	RC	35	35	.027	45	45	.038	55	55	.049	65	66
1000	NC	0	0	RC	30	30	.021	35	35	.032	45	45	.043	55	55	.054	65	73
800	NC	25	25	RC	30	30	.025	35	35	.037	45	45	.050	55	61	.059	65	79
700	NC	25	25	.021	30	30	.028	35	35	.041	45	45	.053	55	65	Rmin = 710		
600	RC	25	25	.024	30	30	.032	35	35	.045	45	47	.057	55	70			
500	.020	25	25	.027	30	30	.036	35	35	.050	45	53	.060	55	73			
400	.023	25	25	.032	30	30	.041	35	36	.055	45	58	Rmin = 465					
350	.026	25	25	.036	30	30	.044	35	39	.058	45	61						
300	.030	25	25	.039	30	31	.048	35	43	.060	45	63						
250	.034	25	25	.043	30	35	.052	35	46	Rmin = 280								
200	.038	25	25	.048	30	39	.057	35	51									
180	.040	25	26	.051	30	41	.059	35	52									
160	.043	25	27	.053	30	43	.060	35	53									
140	.046	25	29	.056	30	45	Rmin = 150											
130	.047	25	30	.058	31	47												
120	.049	25	31	.059	32	47												
110	.051	25	33	.060	32	48												
100	.053	25	34	.060	32	48												
90	.055	25	35	Rmin = 100														
80	.057	25	36															
70	.059	25	38															
60	.060	26	38															
	Rmin = 60																	

e max = 0.06

R = Radius of curve

V = Assumed Design Speed

e = Rate of superelevation

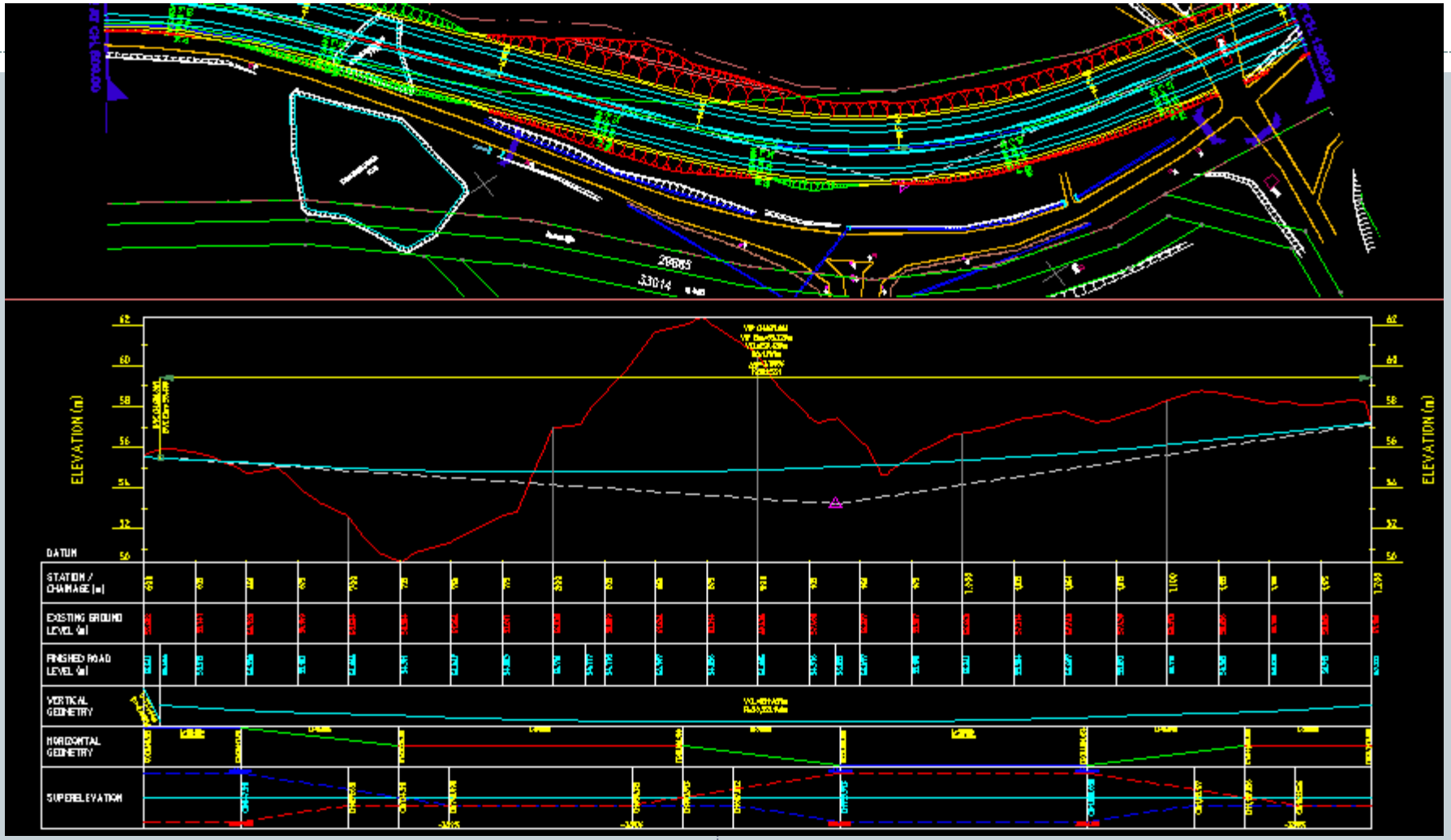
L = Minimum length of runoff spiral curve

NC = Normal crown section.

RC = Remove adverse crown superelevated at normal crown. Spirals desirable but not essential above heavy line Lengths rounded to permit simple calculations.

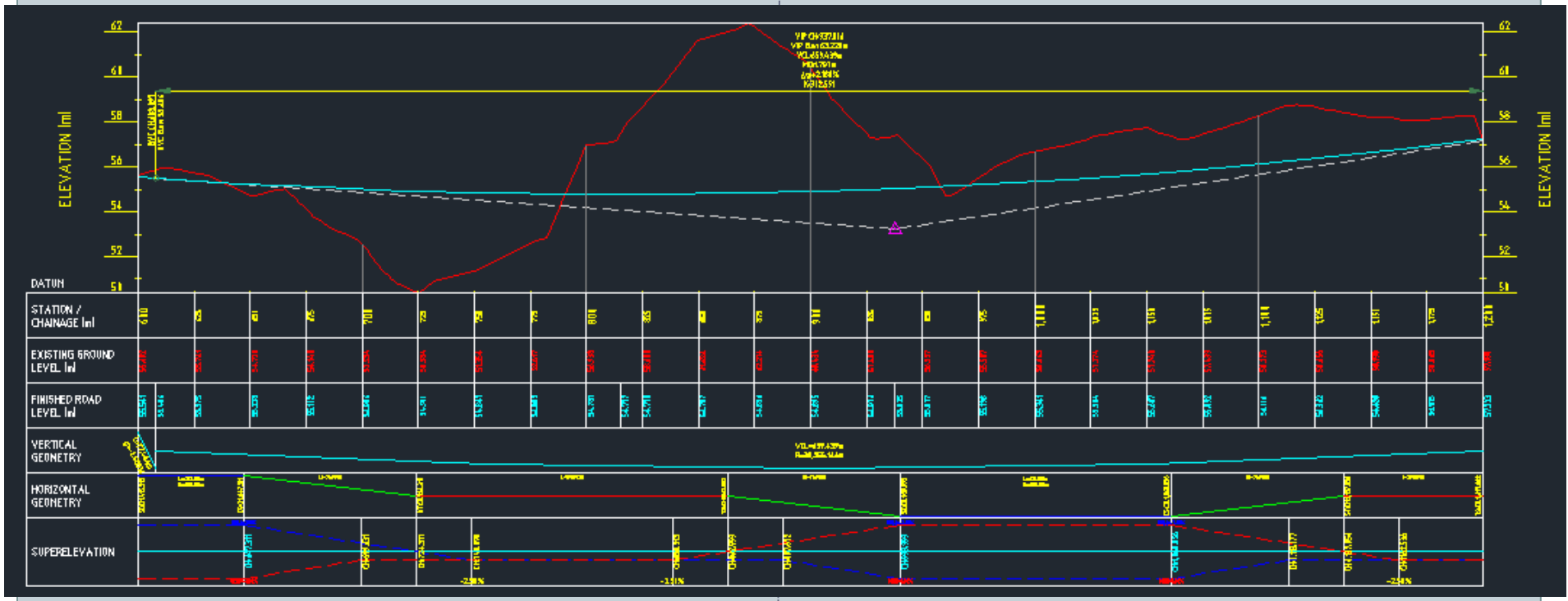
All effort should be made to use higher values

LUKISAN : PLAN & LONGITUDINAL PROFILE



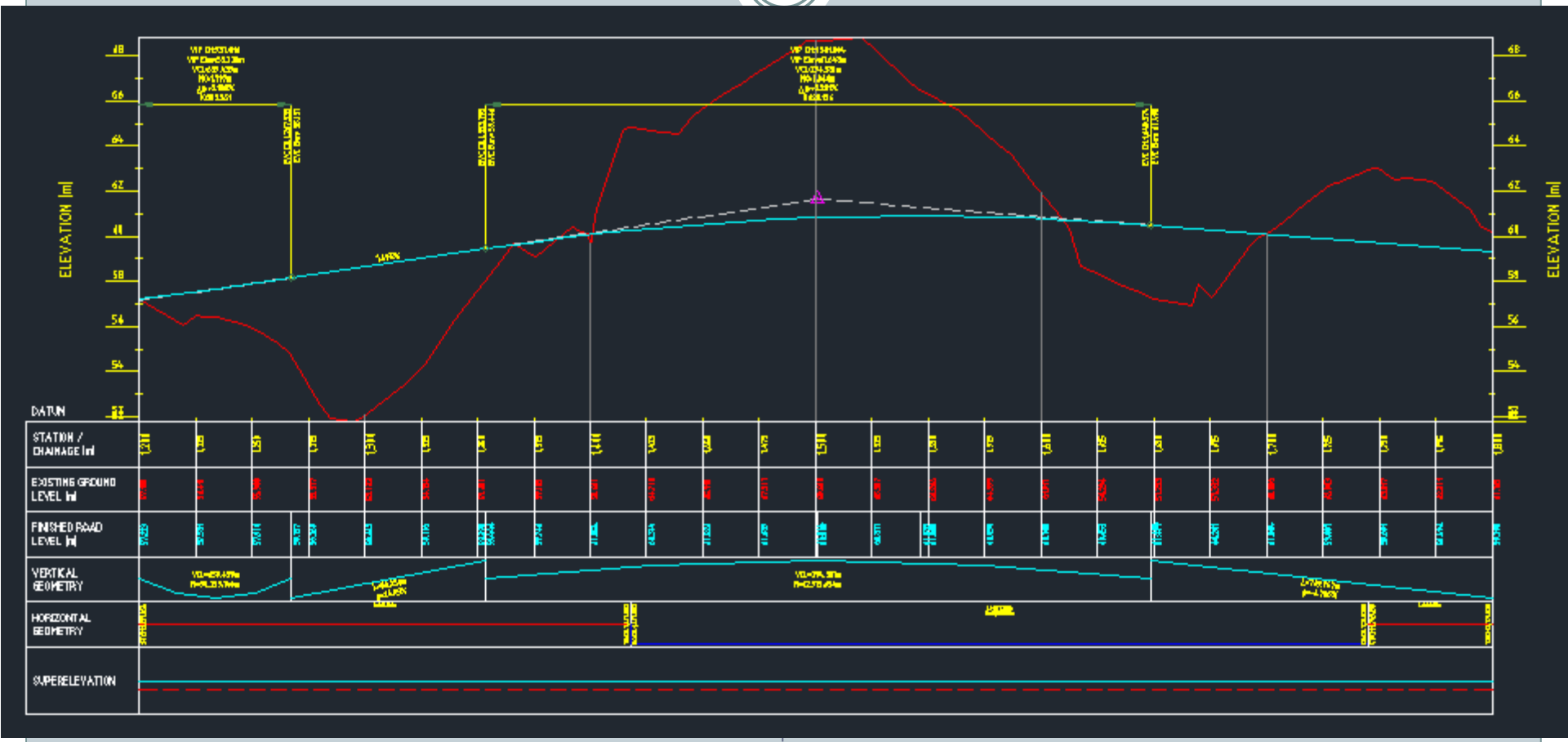
Superelevation Diagram

LUKISAN : PLAN & LONGITUDINAL PROFILE



Superelevation Diagram

LUKISAN : PLAN & LONGITUDINAL PROFILE



Superelevation Diagram

MINIMUM RADIUS

- Is a limiting value of curvature for a given speed and is determined from the maximum rate of superelevation and the maximum allowable side friction factor

$$R_{min} = \frac{V^2}{127(e+f)}$$

Where,

R_{min}	=	Minimum radius of circular curve (m)
V	=	Design Speed (kph)
e	=	Maximum superelevation rate
f	=	Maximum allowable side friction factor

Figure 4.3 illustrates the range of side friction factors (f) that has been derived using empirical methods for the various type of roads.

TABLE 4.5: MINIMUM RADIUS

Design Speed (kph)	Minimum Radius (m)		
	e = 0.06	e = 0.08	e = 0.10
120	755	665	595
110	560	500	455
100	435	395	360
90	335	305	275
80	250	230	210
70	195	175	160
60	135	125	115
50	90	80	75
40	55	50	45
30	30	30	25

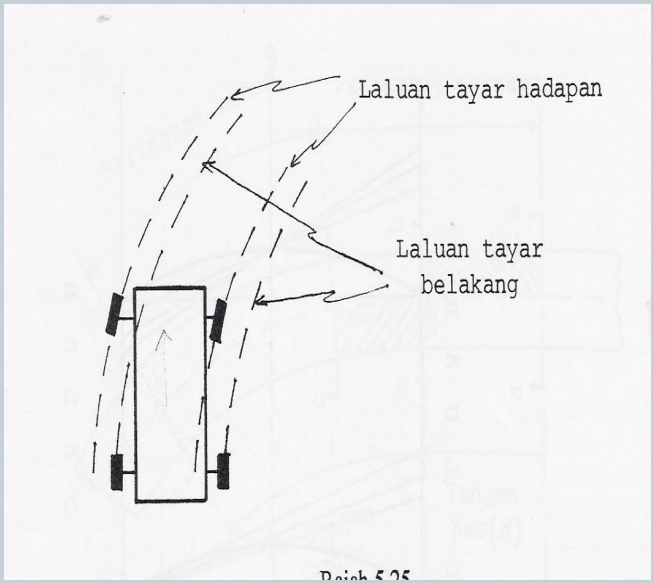
Source: AASHTO – A Policy on Geometric Design of Highways and Street (2001), Exhibit 3-14

JAJARAN MENDATAR

4. *Pavement widening on curves*

- Pelebaran turapan di kawasan selekoh amat diperlukan kerana:

  - Keluasan laluan tayar kenderaan di atas selekoh lebih lebar daripada keluasannya di atas tangen. Ruang ini diperlukan kerana arah laluan tayar belakang dan tayar depan kenderaan tidak sama
  - Apabila berselisih diselekoh, pemandu cenderung untuk mengelak dengan menjauhkan kenderaan daripada kenderaan lawan sejauh mungkin untuk mengelak kemalangan
  - Pemandu akan mengelakkan kenderaannya daripada merapat dekat dengan sisi jalan
  - Pemandu yang tidak berpengalaman menghadapi kesulitan mengemudi kenderaannya supaya benar-benar berada di pertengahan lorong ketika membelok



JAJARAN MENDATAR

- Nilai pelebaran diperlukan bergantung kepada:
  - Radius lengkung
  - Lebar lorong di jalan lurus
  - Panjang & lebar kenderaan
  - *Vehicle clearance*

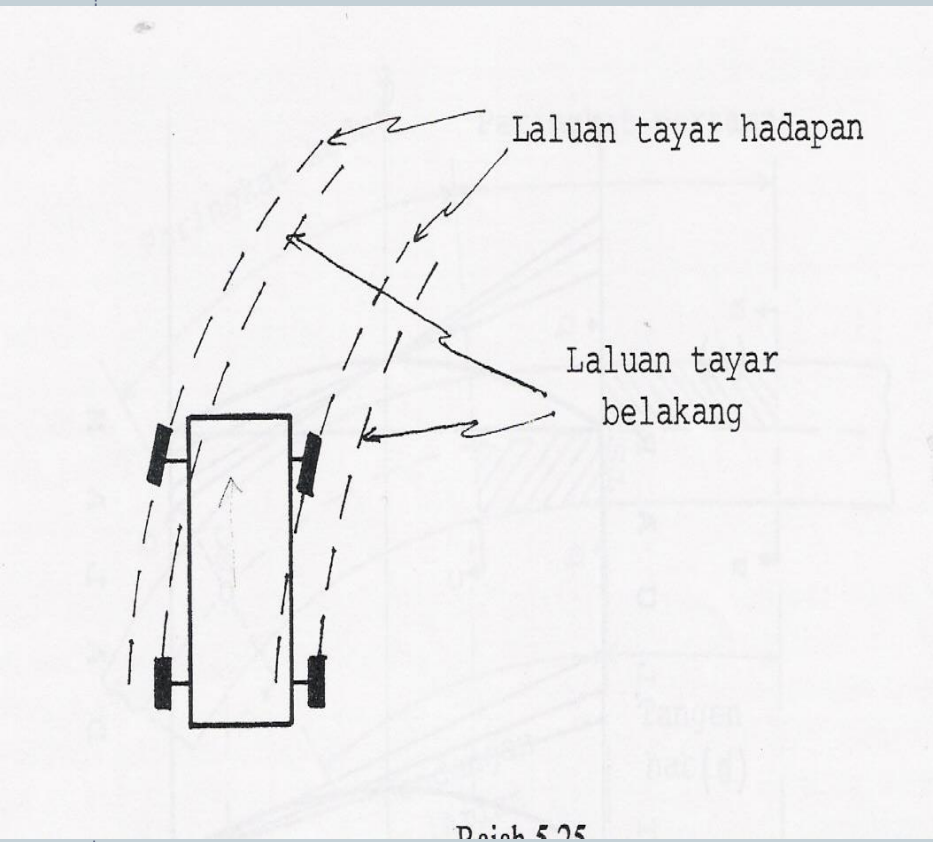


Table 4-9: Pavement Widening on Open Road Curves

TABLE 4.9: PAVEMENT WIDENING ON OPEN ROAD CURVES

Pavement Width (m)	7				6.5				5.5				Required Widening (m)
Design Speed (kph)	80	60	50	40	60	50	40	30	50	40	30	20	
	R ≥ 470	R ≥ 340	R ≥ 280	R ≥ 230	R ≥1100	R ≥ 880	R ≥ 680	R ≥ 520	R ≥ 100	R ≥ 68	R ≥ 52	R ≥ 39	None
	470 > R ≥ 280	340 > R ≥ 180	280 > R ≥ 150	230 > R ≥ 130	1100 > R ≥ 340	880 > R ≥ 280	670 > R ≥ 230	520 > R ≥ 190		68 > R ≥ 60	52 > R ≥ 35	39 > R ≥ 27	0.50
		180 > R ≥ 150	150 > R ≥ 100	130 > R ≥ 130	340 > R ≥ 180	280 > R ≥ 150	230 > R ≥ 130	190 > R ≥ 110				27 > R ≥ 20	0.75
				86 > R ≥ 64	180 > R ≥ 150	150 > R ≥ 100	130 > R ≥ 86	110 > R ≥ 74				20 > R ≥ 16	1.00
				64 > R ≥ 60			86 > R ≥ 65	57 > R ≥ 45				16 > R ≥ 15	1.25
							65 > R ≥ 60	45 > R ≥ 38					1.50
								38 > R ≥ 35					1.75
													2.00

* Note:

R = Radius in m.

Source: REAM GL 2/2002: A Guide on Geometric Design of Roads, Table 4-8

JAJARAN MENDATAR

5. *Sight distance on horizontal curves*

- Jarak pandangan di bahagian dalam lengkung ufuk
- Halangan pandangan - bangunan, cut slope, wall ...

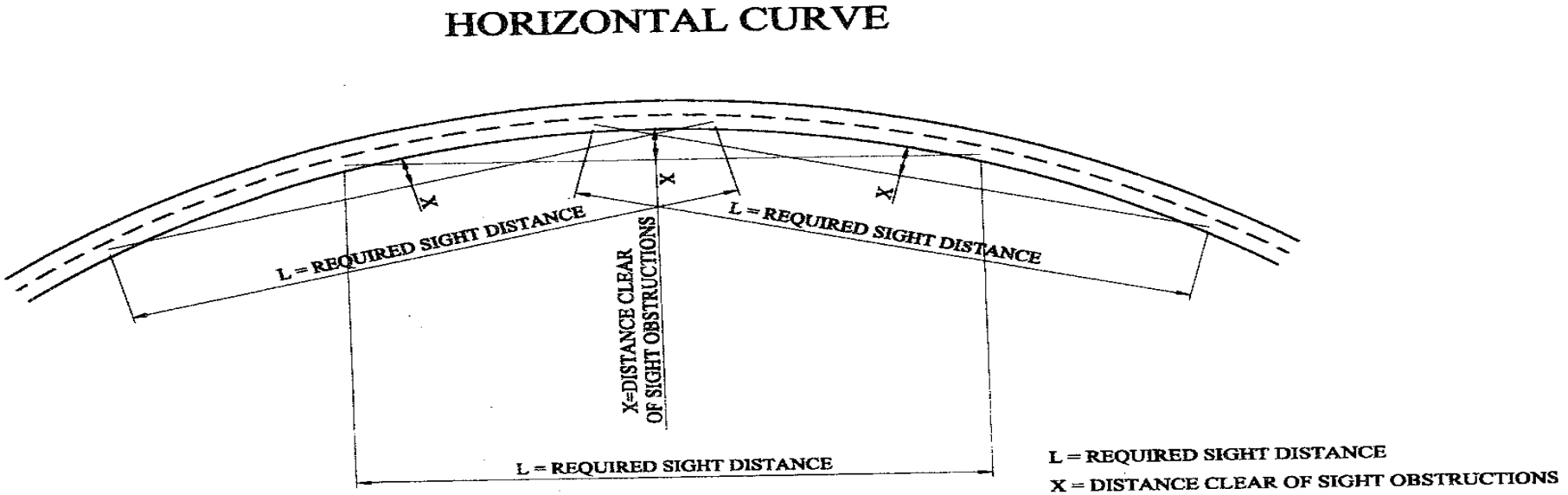


FIGURE 4.1 : MEASURING SIGHT DISTANCE ON PLAN

JAJARAN MENDATAR

6. Kawalan umum bagi jajaran ufuk

- **Jajaran ufuk seharusnya konsistan dengan topografi & mengekalkan pembangunan sedia ada serta nilai komuniti.**
- **Jajaran yang bengkang-bengkok (winding) dengan lengkung yang kecil perlu dielakkan.**
- **Jajaran lurus yang terlalu panjang juga perlu dielakkan (max. 2 minit traveling time).**
- **Contoh untuk halaju 90km/hr = 3km/2minit**
- **Penggunaan radius minimum bagi sesuatu halaju rekabentuk seharusnya dielakkan**

JAJARAN MENDATAR

6. Kawalan umum bagi jajaran ufuk

- **Jajaran yang konsisten adalah perlu. Elak dari menggunakan lengkung yang tajam pada tangen yang panjang**
- **Bagi 'deflection angle' yang kecil, lengkung perlu cukup panjang untuk mengelakkan wujudnya 'kink'. Minimum 150m.**

TERIMA KASIH