APPENDIX B

Exercise 4

p. 4-17 - 4-21

STANDARD RATES OF SUPERELEVATION AND MINIMUM LENGTH OF TRANSITION FOR URBAN HIGHWAYS

E MAX=0.04 DESIRABLE

D	R (FT.)	V=20(MPH)				V=30(MPH)				V=40(MPH)				V=50(MPH)				V=60(MPH)			
		* e/f	L(FT.) 2-LN	4-LN	6-LN	* e/f	L(FT.) 2-LN	4-LN	6-LN	* e/f	L(FT.) 2-LN	4-LN	6-LN	* e/f	L(FT.) 2-LN	4-LN	6-LN	* e/f	L(FT.) 2-LN	4-LN	6-LN
0°-15'	22,918	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0
0°-30'	11,459	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0	RC	175	175	215
0°-45'	7,639	NC	0	0	0	NC	0	0	0	NC	0	0	0	RC	150	150	195	RC	175	175	215
1°-00'	5,730	NC	0	0	0	NC	0	0	0	RC	125	130	170	RC	150	150	185	.025	175	180	240
1°-30'	3,820	NC	0	0	0	RC	100	110	145	RC	125	130	170	.024	150	160	215	.029	175	200	265
2°-00'	2,865	NC	0	0	0	RC	100	110	145	.022	125	135	180	.027	150	170	230	.033	175	215	290
2°-30'	2,292	NC	0	0	0	RC	100	110	145	.025	125	145	190	.030	150	180	240	.036	175	225	300
3°-00'	1,910	NC	0	0	0	.020	100	110	145	.027	125	150	200	.033	150	190	255	.039	175	240	315
3°-30'	1,637	NC	0	0	0	.022	100	115	155	.028	125	155	205	.035	150	200	265	.040	175	240	320
4°-00'	1,432	NC	0	0	0	.024	100	120	160	.030	125	160	210	.037	150	210	275	D(MAX)=3°-45'			
5°-00'	1,146	RC	65	100	130	.026	100	125	170	.033	125	170	225	.039	150	215	285				
6°-00'	955	.020	65	100	130	.028	100	130	175	.035	125	175	235	.040	150	220	290				
7°-00'	819	.021	70	105	135	.030	100	135	180	.037	125	180	240	D(MAX)=6°-00							
8°-00'	716	.023	70	105	140	.031	100	140	185	.039	125	190	250								
9°-00	637	.024	75	110	145	.033	100	145	195	.040	130	190	255								
10°-00	573	.025	75	110	145	.034	100	150	195	.040	130	190	255								
11°-00	521	.026	75	110	150	.035	100	150	200	D(MAX)=10°-00'											
12°-00	477	.027	80	115	155	.036	105	155	205												
13°-00'	441	.028	80	120	155	.037	105	155	210												
14°-00'	409	.029	80	120	155	.038	105	160	210												
16°-00'	358	.030	80	120	160	.039	110	160	215												
18°-00	318	.031	85	125	165	.040	110	165	220												
19°-00'	302	.032	85	125	170	.040	110	165	220												
20°-00'	286	.032	85	125	170	D(MAX)=19°-00'															
24°-00'	239	.035	90	135	180																
28°-00'	205	.036	90	135	180																
32°-00'	179	.038	95	140	190																
36°-00'	159	.039	95	145	190																
40°-00'	143	.040	100	145	195																
44°-00'	130	.040	100	145	195																
		D(MAX)=45°-00'																			

E MAX=0.06 ALLOWABLE

D	R FT.	V=20(MPH)				V=30(MPH)				V=40(MPH)				V=50(MPH)				V=60(MPH)				V=70(MPH)			
		* e/f	L(FT.) 2-LN	4-LN	6-LN	* e/f	L(FT.) 2-LN	4-LN	6-LN	* e/f	L(FT.) 2-LN	4-LN	6-LN	* e/f	L(FT.) 2-LN	4-LN	6-LN	* e/f	L(FT.) 2-LN	4-LN	6-LN	* e/f	L(FT.) 2-LN	4-LN	6-LN
0°-15'	22,918	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0
0°-30'	11,459	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0
0°-45'	7,638	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0	.021	175	175	220
1°-00'	5,730	NC	0	0	0	NC	0	0	0	NC	0	0	0	RC	125	130	170	.022	150	150	195	.027	175	190	255
1°-30'	3,820	NC	0	0	0	RC	100	110	145	.020	125	130	170	.028	150	175	235	.033	175	230	305	.040	200	300	400
2°-00'	2,865	NC	0	0	0	RC	100	110	145	.026	125	145	190	.035	150	200	265	.045	175	260	350	.055	225	340	450
2°-30'	2,292	NC	0	0	0	.020	100	110	145	.031	125	155	205	.040	150	220	290	.054	190	285	380	.065	240	360	475
3°-00'	1,910	RC	65	100	130	.023	100	120	155	.034	125	165	220	.045	150	235	315	.059	200	305	400	D(MAX)=2°-45'			
3°-30'	1,637	RC	65	100	130	.026	100	125	170	.038	125	185	245	.048	165	245	330	.068	210	315	420				
4°-00'	1,432	RC	65	100	130	.029	100	135	180	.041	130	195	260	.053	175	260	350	.060	215	325	435				
5°-00'	1,146	.020	65	100	130	.034	100	150	195	.046	140	210	280	.056	190	275	365	D(MAX)=4°-15'							
6°-00'	955	.023	70	105	140	.038	105	160	210	.050	150	225	295	.059	195	285	380								
7°-00'	819	.028	75	110	145	.041	110	165	220	.053	155	235	310	D(MAX)=5°-45											
8°-00'	716	.029	80	120	160	.043	115	175	230	.056	160	240	320												
9°-00'	637	.031	85	125	165	.046	120	180	240	.058	165	250	330												
10°-00'	573	.032	88	130	170	.048	125	185	245	.059	170	255	335												
11°-00'	521	.035	90	135	180	.050	130	190	255	.060	170	255	340												
12°-00'	477	.037	95	140	185	.052	130	195	260	D(MAX)=11°-15															
13°-00'	441	.038	95	140	190	.054	135	200	270																
14°-00'	409	.039	95	145	190	.055	135	205	270																
16°-00'	358	.041	100	150	200	.058	145	215	285																
18°-00	318	.044	105	155	205	.059	145	215	285																
20°-00'	286	.046	110	160	215	.060	145	220	290																
21°-00'	273	.047	110	165	215	.060	145	220	290																
24°-00'	239	.049	115	170	225	D(MAX)=21°-00'																			
28°-00'	205	.052	120	175	235																				
32°-00'	179	.055	120	180	240																				
36°-00'	159	.057	125	185	250																				
40°-00'	143	.059	130	190	255																				
44°-00'	130	.060	130	195	260																				
48°-00'	119	.060	130	195	260																				
		D(MAX)=49°-15																							

LEGEND

D	DEGREE OF CURVE
R	RADIUS OF CURVE
V	ASSUMED DESIGN SPEED
e	RATE OF SUPERELEVATION
L	MINIMUM LENGTH OF TRANSITION
NC	NORMAL CROWN
RC	REMOVE ADVERSE CROWN, SUPERELEVATE AT NORMAL CROWN SLOPE

GENERAL NOTES

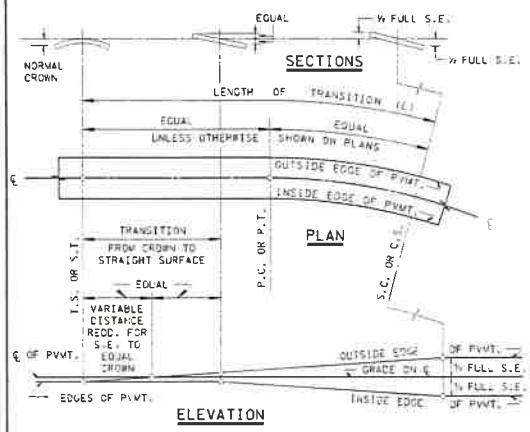
(A) ALL HORIZONTAL CURVES SHALL BE SUPERELEVATED IN ACCORDANCE WITH THIS TABULATION, UNLESS OTHERWISE SHOWN ON THE PLANS.

(B) SPIRALS ARE NOT REQUIRED BELOW 50 MPH AND ABOVE THE HEAVY LINE FOR HIGHER SPEEDS.

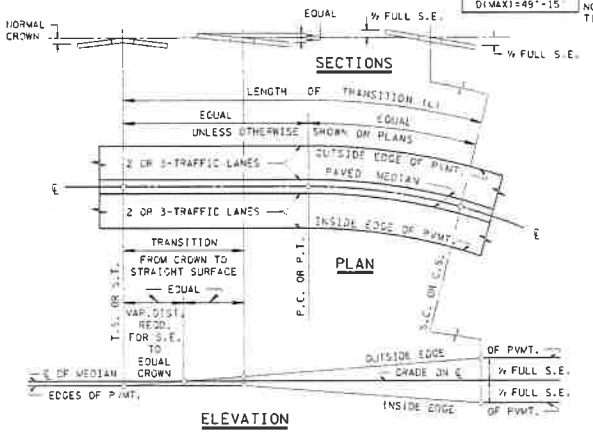
(C) LENGTHS ROUNDED IN MULTIPLES OF 25 OR 50 FEET PERMIT SIMPLER CALCULATIONS.

(D) ALIGNMENT DESIGNS SHOULD BE SO ARRANGED AS TO AVOID SUPERELEVATION TRANSITIONS ON BRIDGE DECKS, IN ORDER TO PREVENT PONDING IN THE AREAS OF ZERO SUPERELEVATION IN THE CROWN CHANGE ZONE.

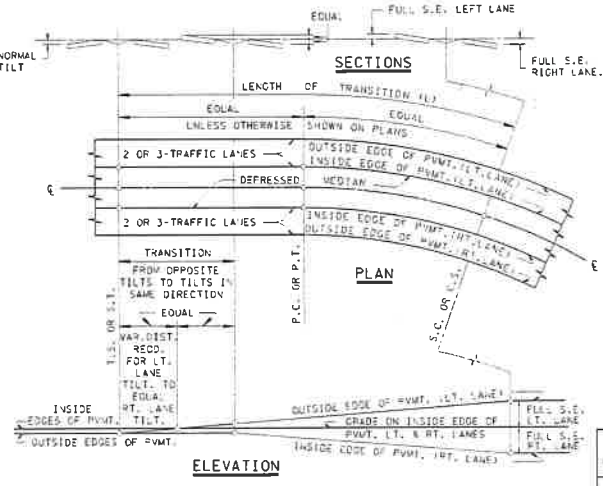
(E) USE RURAL SUPERELEVATION RATES ON ALL URBAN FREEWAYS AND EXPRESSWAYS EXCEPT VIADUCTS.



TYPICAL TRANSITION IN SUPERELEVATION
2-LANE HIGHWAY



TYPICAL TRANSITION IN SUPERELEVATION
4 OR 6-LANE HIGHWAY WITH PAVED MEDIAN



TYPICAL TRANSITION IN SUPERELEVATION
4 OR 6-LANE HIGHWAY WITH DEPRESSED MEDIAN

☐ MINOR REVISION -- FHWA APPROVAL NOT REQUIRED.

STATE OF TENNESSEE
DEPARTMENT OF TRANSPORTATION

URBAN SUPERELEVATION DETAILS

10-15-02 | RD01-SE-2

1-9

REV.: 10-15-02: NEW SHEET. REPLACES RC-SE-3.

STANDARD RATES OF SUPERELEVATION AND MINIMUM LENGTH OF TRANSITION FOR RURAL HIGHWAYS

E MAX=0.08 DESIRABLE

D	R (FT.)	V=20(MPH)				V=30(MPH)				V=40(MPH)				V=50(MPH)				V=60(MPH)				V=70(MPH)			
		e/f	L(FT.) 2-LN	4-LN	6-LN	e/f	L(FT.) 2-LN	4-LN	6-LN	e/f	L(FT.) 2-LN	4-LN	6-LN	e/f	L(FT.) 2-LN	4-LN	6-LN	e/f	L(FT.) 2-LN	4-LN	6-LN	e/f	L(FT.) 2-LN	4-LN	6-LN
0°-15'	22,918	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0
0°-30'	11,459	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0	RC	175	175	215	RC	200	200	240
0°-45'	7,639	NC	0	0	0	NC	0	0	0	NC	0	0	0	RC	150	150	195	.022	175	175	225	.026	200	210	290
1°-00'	5,730	NC	0	0	0	NC	0	0	0	RC	125	130	170	.021	150	150	200	.029	175	200	265	.036	200	255	345
1°-30'	3,820	NC	0	0	0	RC	100	110	145	.021	125	130	170	.030	150	180	240	.041	175	245	325	.055	215	320	430
2°-00'	2,865	NC	0	0	0	RC	100	110	145	.027	125	150	200	.038	150	210	280	.051	190	265	350	.069	255	385	510
2°-30'	2,292	NC	0	0	0	.021	100	115	150	.033	125	170	225	.046	160	240	320	.061	220	325	435	.075	285	430	570
3°-00'	1,910	RC	65	100	130	.025	100	125	165	.039	125	185	245	.053	180	265	355	.068	235	355	470	.080	300	450	600
3°-30'	1,637	RC	65	100	130	.028	100	130	175	.043	125	200	265	.058	180	285	375	.074	255	380	505	D(MAX)=3°-00'			
4°-00'	1,432	RC	65	100	130	.031	100	140	185	.047	145	215	285	.063	200	300	400	.078	265	395	525				
5°-00'	1,146	.021	TZ	100	135	.038	105	160	210	.055	160	240	315	.073	220	330	440	D(MAX)=4°-45'							
6°-00'	955	.025	TZ	110	145	.043	115	175	230	.062	175	260	345	.077	235	350	470								
7°-00'	819	.028	80	120	155	.048	125	185	245	.067	185	275	370	.080	240	360	480								
8°-00'	716	.031	85	125	165	.051	135	200	265	.071	195	290	385	D(MAX)=7°-30'											
9°-00'	637	.035	90	135	180	.056	140	210	275	.075	200	300	400												
10°-00'	573	.037	95	140	185	.060	145	220	280	.078	210	310	415												
11°-00'	521	.040	100	145	195	.063	150	225	300	.079	210	315	420												
12°-00'	477	.043	105	155	205	.065	155	230	310	.080	210	315	420												
13°-00'	441	.045	105	160	210	.068	160	240	320	D(MAX)=12°-15'															
14°-00'	409	.047	110	165	215	.070	165	245	325																
16°-00'	358	.051	115	170	230	.074	170	255	340																
18°-00'	318	.054	120	180	240	.077	175	265	350																
20°-00'	286	.057	125	185	250	.079	185	270	360																
22°-00'	260	.060	130	195	260	.080	185	270	360																
24°-00'	239	.062	135	200	265	D(MAX)=22°-45'																			
28°-00'	205	.067	140	210	280																				
32°-00'	179	.070	145	220	290																				
36°-00'	159	.074	155	230	305																				
40°-00'	143	.076	155	235	310																				
44°-00'	130	.078	160	240	315																				
48°-00'	119	.079	160	240	320																				
52°-00'	110	.080	160	240	320																				
		D(MAX)=53°-30'																							

E MAX=0.10 FOR REHABILITATION AND RESURFACING PROJECTS ONLY

D	R (FT.)	V=20(MPH)				V=30(MPH)				V=40(MPH)				V=50(MPH)				V=60(MPH)				V=70(MPH)			
		e/f	L(FT.) 2-LN	4-LN	6-LN	e/f	L(FT.) 2-LN	4-LN	6-LN	e/f	L(FT.) 2-LN	4-LN	6-LN	e/f	L(FT.) 2-LN	4-LN	6-LN	e/f	L(FT.) 2-LN	4-LN	6-LN	e/f	L(FT.) 2-LN	4-LN	6-LN
0°-15'	22,918	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0
0°-30'	11,459	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0	NC	0	0	0	RC	175	175	215
0°-45'	7,639	NC	0	0	0	NC	0	0	0	NC	0	0	0	RC	150	150	195	.023	175	175	230	.028	200	220	290
1°-00'	5,730	NC	0	0	0	NC	0	0	0	RC	125	130	170	.021	150	150	200	.030	175	200	270	.037	200	260	345
1°-30'	3,820	NC	0	0	0	RC	100	110	145	.021	125	130	175	.031	150	185	245	.043	175	255	340	.054	225	335	445
2°-00'	2,865	NC	0	0	0	RC	100	110	145	.028	125	155	205	.040	150	220	290	.055	200	300	400	.070	270	405	540
2°-30'	2,292	NC	0	0	0	.021	100	115	150	.034	125	175	230	.048	170	255	335	.067	235	350	465	.085	315	475	630
3°-00'	1,910	RC	65	100	130	.025	100	125	165	.040	130	190	255	.057	185	280	370	.077	260	390	520	.098	350	525	702
3°-30'	1,637	RC	65	100	130	.028	100	130	175	.046	140	210	280	.065	205	310	410	.086	285	425	565	.100	390	540	720
4°-00'	1,432	RC	65	100	130	.033	100	145	195	.051	150	225	300	.072	225	335	445	.093	305	455	605	D(MAX)=3°-30'			
5°-00'	1,146	.022	TZ	105	135	.040	110	165	220	.061	175	260	345	.083	250	375	495	.098	315	475	630				
6°-00'	955	.026	TZ	115	150	.046	120	180	240	.070	190	285	380	.092	270	405	540	D(MAX)=5°-15'							
7°-00'	819	.029	85	120	160	.053	135	200	265	.078	210	310	415	.098	285	425	570								
8°-00'	716	.033	85	130	170	.058	145	215	285	.084	220	330	440	.100	290	435	580								
9°-00'	637	.036	90	135	180	.063	150	225	300	.089	230	345	460	D(MAX)=6°-15'											
10°-00'	573	.040	100	145	195	.068	160	240	320	.094	240	360	480												
11°-00'	521	.043	105	155	205	.072	170	255	335	.097	250	370	495												
12°-00'	477	.046	110	160	215	.076	175	260	350	.099	250	375	500												
13°-00'	441	.049	115	170	225	.080	180	270	360	.100	255	380	505												
14°-00'	409	.052	120	175	235	.083	190	280	375	D(MAX)=13°-15'															
16°-00'	358	.057	125	185	250	.089	200	295	395																
18°-00'	318	.062	135	200	265	.093	205	310	410																
20°-00'	286	.066	140	210	280	.097	215	320	425																
22°-00'	260	.070	145	220	290	.099	215	325	430																
24°-00'	239	.073	150	225	300	.100	220	325	435																
28°-00'	205	.079	160	240	320	D(MAX)=24°-45'																			
32°-00'	179	.084	170	250	335																				
36°-00'	159	.089	175	265	350																				
40°-00'	143	.092	180	270	360																				
44°-00'	130	.095	185	280	370																				
48°-00'	119	.098	190	285	380																				
52°-00'	110	.099	195	290	385																				
56°-00'	102	.100	195	290	385																				
		D(MAX)=58°-00																							

LEGEND

D	DEGREE OF CURVE
R	RADIUS OF CURVE
V	ASSUMED DESIGN SPEED
e	RATE OF SUPERELEVATION
L	MINIMUM LENGTH OF TRANSITION
NC	NORMAL CROWN
RC	REMOVE ADVERSE CROWN, SUPERELEVATE AT NORMAL CROWN SLOPE

GENERAL NOTES

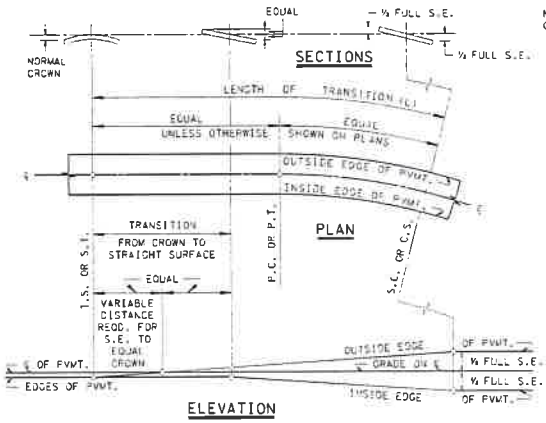
(A) ALL HORIZONTAL CURVES SHALL BE SUPERELEVATED IN ACCORDANCE WITH THIS TABULATION, UNLESS OTHERWISE SHOWN ON THE PLANS.

(B) SPIRALS ARE NOT REQUIRED BELOW 50 MPH AND ABOVE THE HEAVY LINE FOR HIGHER SPEEDS.

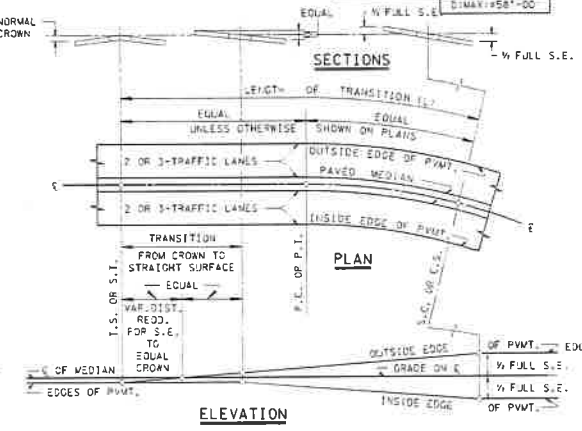
(C) LENGTHS ROUNDED IN MULTIPLES OF 25 OR 50 FEET PERMIT SIMPLER CALCULATIONS.

(D) ALIGNMENT DESIGNS SHOULD BE SO ARRANGED AS TO AVOID SUPERELEVATION TRANSITIONS ON BRIDGE DECKS, IN ORDER TO PREVENT PONDING IN THE AREAS OF ZERO SUPERELEVATION IN THE CROWN CHANGE ZONE.

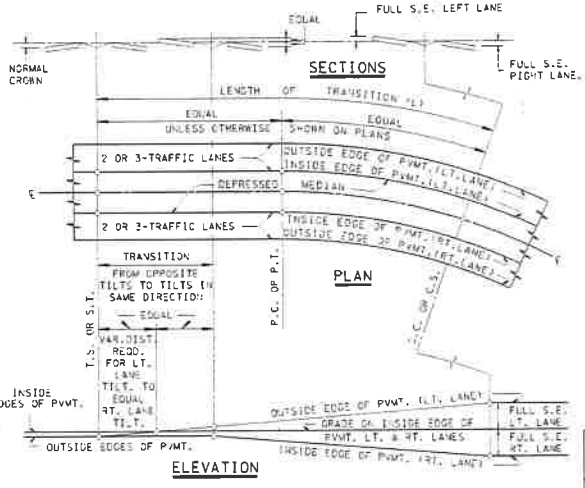
(E) USE RURAL SUPERELEVATION RATES ON ALL URBAN FREEWAYS AND EXPRESSWAYS EXCEPT VIADUCTS.



TYPICAL TRANSITION IN SUPERELEVATION
2-LANE HIGHWAY



TYPICAL TRANSITION IN SUPERELEVATION
4 OR 6-LANE HIGHWAY WITH PAVED MEDIAN



TYPICAL TRANSITION IN SUPERELEVATION
4 OR 6-LANE HIGHWAY WITH DEPRESSED MEDIAN

MINOR REVISION — FINAL APPROVAL NOT REQUIRED.

STATE OF TENNESSEE
DEPARTMENT OF TRANSPORTATION

RURAL SUPERELEVATION DETAILS

10-15-02 | RD01-SE-3

B-2

HORIZONTAL CIRCULAR CURVES

D = Degree of curve, arc definition

D_c = Degree of curve, chord definition

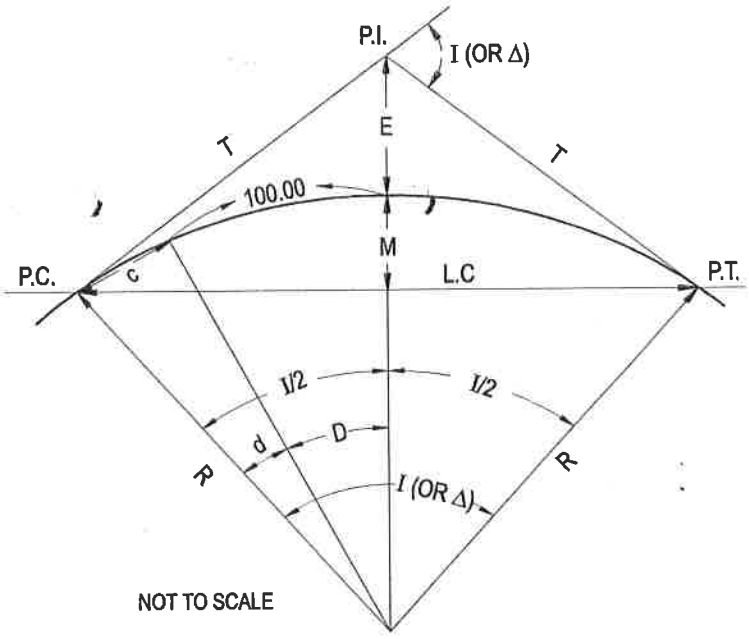
L = Length of curve from P.C. to P.T.

c = Length of sub-chord

ℓ = Length of arc for sub-chord

d = Central angle for sub-chord

I or Δ = Angle of interior or delta



$$D = \frac{5,729.58}{R}$$

Radius by chord definition, $R = \frac{50}{\sin 1/2\, D}$

$$T = R \tan(I/2)$$

$$L = RI\frac{\pi}{180} = \frac{I}{D}(100)$$

$$LC = 2R \sin(I/2)$$

$$c = 2R \sin(d/2)$$

$$d = lD/100$$

$$M = R\left[1 - \cos(I/2)\right]$$

$$E = R\left[\frac{1}{\cos(I/2)} - 1\right]$$

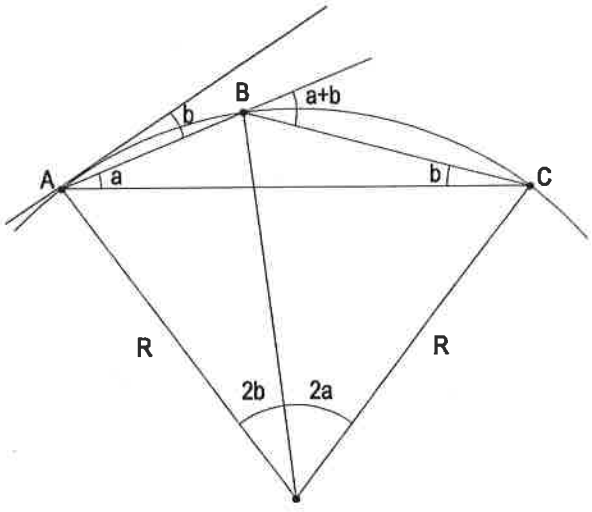
$$\text{Area of sector} = \frac{RL}{2} = \frac{\pi R^2 I}{360}$$

$$\text{Area of segment} = \frac{\pi R^2 I}{360} - \frac{R^2 \sin I}{2}$$

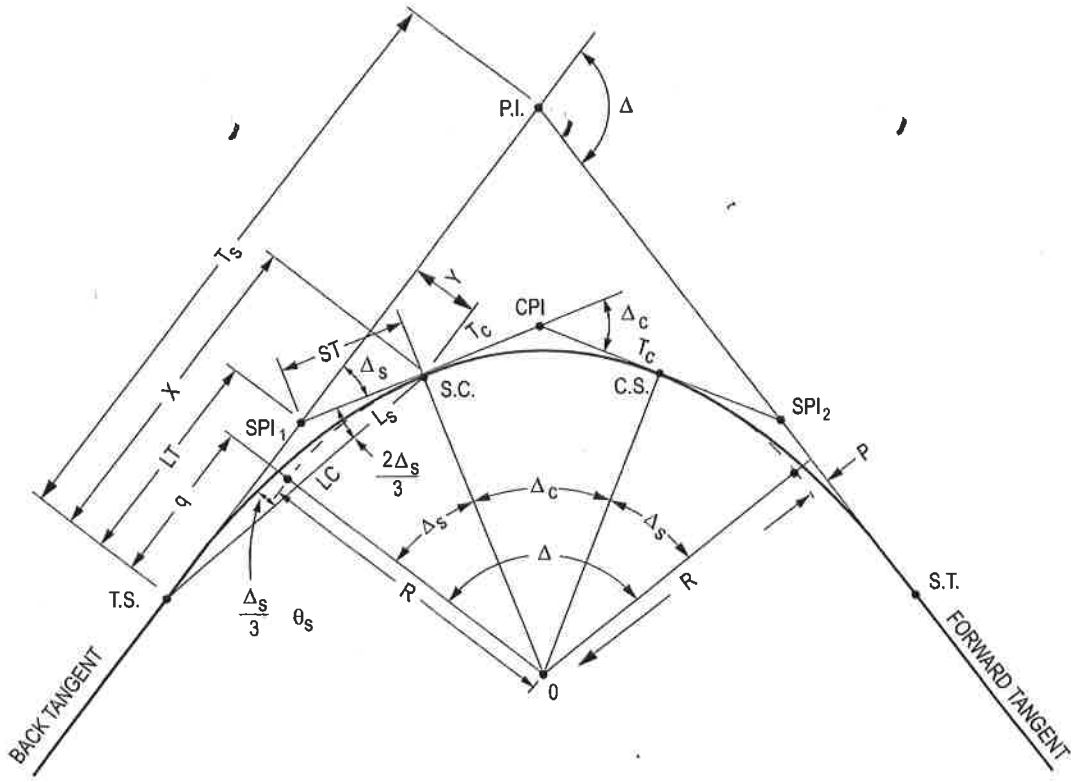
$$\text{Area between curve and tangents} = R(T - L/2)$$

$$R = \frac{AC}{2 \sin(a+b)}$$

Equation of a circle, $X^2 + Y^2 = R^2$



HORIZONTAL SPIRAL CURVES



T.S. – Tangent to spiral

S.C. – Spiral to curve

C.S. – Curve to spiral

S.T. – Spiral to tangent

T_S – Spiral tangent

X – Distance along tangent from T.S. to point at right angle to S.C.

Y – Right angle distance from tangent to S.C.

LT – Long tangent (spiral)

ST – Short tangent (spiral)

L_S – Length of spiral (arc)

LC – Long chord

q – Distance along tangent to a point at right angle to ghost bc (marginally less than $L_S/2$)

P – Distance from tangent that the curve (ghost bc) has been offset

T_C – Circular curve tangent

CPI – Circular curve P.I.

SPI – Spiral curve P.I.

P.I. – Point of intersection of curve tangents

L_C – Length of circular curve

L – Length of curve system – T.S. to S.T.