

**FDM 11-10 Exhibit 5.1 Superelevation Tables (emax = 4% and 6%)**

**August 16, 2022**

(Refer to following Tables)

e<sub>max</sub> = 4%

This chart is for: 1-lane ramps regardless of rotation point and 2-lane undivided highways w/ rotation about CL.

Number of lanes rotated (n<sub>1</sub>) = 1

Adjustment factor (b<sub>w</sub>) = 1.00

Multiple of runoff length relative to 1-lane rotated (n<sub>1</sub> x b<sub>w</sub>) = 1.00

e (%)	Design Speed																												e (%)				
	25mph				30mph				35mph				40mph				45mph				50mph				55mph					60mph			
	R	L	X	T	R	L	X	T	R	L	X	T	R	L	X	T	R	L	X	T	R	L	X	T	R	L	X	T		R	L	X	T
NC	2,050	0	0	0	2,830	0	0	0	3,730	0	0	0	4,770	0	0	0	5,930	0	0	0	7,220	0	0	0	8,650	0	0	0	10,300	0	0	0	NC
RC (2.0%)	1,340	34	34	68	1,880	36	36	72	2,490	39	39	78	3,220	41	41	82	4,040	44	44	88	4,940	48	48	96	5,950	51	51	102	7,080	53	53	106	RC (2.0%)
2.1%	1,220	36	34	70	1,720	38	36	74	2,300	41	39	80	2,990	43	41	84	3,750	47	45	92	4,600	50	48	98	5,590	54	51	105	6,620	56	53	109	2.1%
2.2%	1,110	38	35	73	1,580	40	36	76	2,120	43	39	82	2,760	46	42	88	3,480	49	45	94	4,280	53	48	101	5,180	56	51	107	6,190	59	54	113	2.2%
2.3%	971	39	34	73	1,430	42	37	79	1,940	45	39	84	2,550	48	42	90	3,230	51	44	95	3,980	55	48	103	4,860	59	51	110	5,790	61	53	114	2.3%
2.4%	838	41	34	75	1,270	44	37	81	1,760	46	38	84	2,340	50	42	92	2,980	53	44	97	3,690	58	48	106	4,500	61	51	112	5,410	64	53	117	2.4%
2.5%	733	43	34	77	1,120	45	36	81	1,570	48	38	86	2,130	52	42	94	2,730	56	45	101	3,410	60	48	108	4,210	64	51	115	5,050	67	54	121	2.5%
2.6%	650	45	35	80	1,000	47	36	83	1,420	50	38	88	1,930	54	42	96	2,490	58	45	103	3,130	62	48	110	3,870	66	51	117	4,700	69	53	122	2.6%
2.7%	581	46	34	80	901	49	36	85	1,280	52	39	91	1,760	56	41	97	2,280	60	44	104	2,880	65	48	113	3,600	69	51	120	4,360	72	53	125	2.7%
2.8%	524	48	34	82	817	51	36	87	1,170	54	39	93	1,620	58	41	99	2,100	62	44	106	2,660	67	48	115	3,310	71	51	122	4,060	75	54	129	2.8%
2.9%	475	50	34	84	744	53	37	90	1,070	56	39	95	1,490	60	41	101	1,940	64	44	108	2,460	70	48	118	3,100	74	51	125	3,780	77	53	130	2.9%
3.0%	433	51	34	85	681	55	37	92	982	58	39	97	1,370	62	41	103	1,800	67	45	112	2,290	72	48	120	2,860	77	51	128	3,530	80	53	133	3.0%
3.1%	395	53	34	87	625	56	36	92	905	60	39	99	1,270	64	41	105	1,660	69	45	114	2,120	74	48	122	2,690	79	51	130	3,300	83	54	137	3.1%
3.2%	363	55	34	89	576	58	36	94	835	62	39	101	1,180	66	41	107	1,550	71	44	115	1,980	77	48	125	2,490	82	51	133	3,090	85	53	138	3.2%
3.3%	333	57	35	92	531	60	36	96	772	64	39	103	1,090	68	41	109	1,440	73	44	117	1,840	79	48	127	2,340	84	51	135	2,890	88	53	141	3.3%
3.4%	307	58	34	92	490	62	36	98	714	66	39	105	1,010	70	41	111	1,340	76	45	121	1,720	82	48	130	2,170	87	51	138	2,700	91	54	145	3.4%
3.5%	282	60	34	94	452	64	37	101	660	68	39	107	935	72	41	113	1,240	78	45	123	1,600	84	48	132	2,040	89	51	140	2,520	93	53	146	3.5%
3.6%	259	62	34	96	416	65	36	101	610	70	39	109	865	74	41	115	1,150	80	44	124	1,480	86	48	134	1,880	92	51	143	2,350	96	53	149	3.6%
3.7%	237	63	34	97	382	67	36	103	561	72	39	111	797	77	42	119	1,060	82	44	126	1,370	89	48	137	1,760	94	51	145	2,180	99	54	153	3.7%
3.8%	215	65	34	99	348	69	36	105	512	74	39	113	730	79	42	121	970	84	44	128	1,260	91	48	139	1,600	97	51	148	2,010	101	53	154	3.8%
3.9%	193	67	34	101	312	71	36	107	460	75	38	113	657	81	42	123	875	87	45	132	1,140	94	48	142	1,460	100	51	151	1,830	104	53	157	3.9%
4.0%	154	69	35	104	250	73	37	110	371	77	39	116	533	83	42	125	711	89	45	134	926	96	48	144	1,190	102	51	153	1,500	107	54	161	4.0%

Adapted from Table 3-8, page 3-42, and Table 3-16a, pages 3-66 thru 3-67, 2018 GDHS

**Legend**

**R** = Minimum curve radius for a given superelevation rate and design speed (**feet**)

**L** = Superelevation runoff minimum length (**feet**)

**X** = Tangent Runout (**feet**)

**T** = Superelevation transition = tangent runout + runoff length = X + L (**feet**)

**e** = Rate of superelevation (**percent**)

**NC** = Normal crown slope (assumed 2.0%)

**RC (2.0%)** = Remove adverse crown, superelevate at 2.0%

**Notes**

(1) The R-values in the above table represent the minimum radius for which the corresponding superelevation rate can be used. For example, if the design speed is 60 mph then a 3.0% rate can be used for any radius value from 3530 to 3779 feet (inclusive) - if the radius is 3529 feet then use 3.1%; if the radius is 3780 feet then use 2.9%.

**Do not interpolate superelevation rates.** For example, if the design speed is 60 mph and the radius is 3655 feet then use 3.0% - NOT 2.95%.

(2) On high-type facilities (freeways, expressways and other divided highways) a small increase in runoff length may be appropriate to facilitate drainage needs or to increase the smoothness in the traveled way edge profiles.

(3) Curves whose radius is less than the minimum shown for NC superelevation but more than the minimum shown for RC (2.0%) superelevation shall be provided with RC (2.0%) superelevation.

(4) See equations and example on the last 2 sheets of this Attachment

**emax= 4%**

This chart is for: 3-lane TWLTL w/ rotation about CL

Number of lanes rotated ( $n_1$ ) = 1.5

Adjustment factor ( $b_w$ ) = 0.83

Multiple of runoff length relative to 1-lane rotated ( $n_1 \times b_w$ ) = 1.25

		Design Speed																																			
		25mph				30mph				35mph				40mph				45mph				50mph				55mph				60mph							
e (%)		R	L	X	T	R	L	X	T	R	L	X	T	R	L	X	T	R	L	X	T	R	L	X	T	R	L	X	T	R	L	X	T	e (%)			
<b>NC</b>		2,050	0	0	0	2,830	0	0	0	3,730	0	0	0	4,770	0	0	0	5,930	0	0	0	7,220	0	0	0	8,650	0	0	0	10,300	0	0	0			<b>NC</b>	
<b>RC (2.0%)</b>		1,340	43	43	86	1,880	45	45	90	2,490	48	48	96	3,220	52	52	104	4,040	56	56	112	4,940	60	60	120	5,950	64	64	128	7,080	67	67	134			<b>RC (2.0%)</b>	
<b>2.1%</b>		1,220	45	43	88	1,720	48	46	94	2,300	51	49	100	2,990	54	51	105	3,750	58	55	113	4,600	63	60	123	5,590	67	64	131	6,620	70	67	137			<b>2.1%</b>	
<b>2.2%</b>		1,110	47	43	90	1,580	50	45	95	2,120	53	48	101	2,760	57	52	109	3,480	61	55	116	4,280	66	60	126	5,180	70	64	134	6,190	73	66	139			<b>2.2%</b>	
<b>2.3%</b>		971	49	43	92	1,430	52	45	97	1,940	56	49	105	2,550	59	51	110	3,230	64	56	120	3,980	69	60	129	4,860	73	63	136	5,790	77	67	144			<b>2.3%</b>	
<b>2.4%</b>		838	51	43	94	1,270	55	46	101	1,760	58	48	106	2,340	62	52	114	2,980	67	56	123	3,690	72	60	132	4,500	77	64	141	5,410	80	67	147			<b>2.4%</b>	
<b>2.5%</b>		733	54	43	97	1,120	57	46	103	1,570	60	48	108	2,130	65	52	117	2,730	69	55	124	3,410	75	60	135	4,210	80	64	144	5,050	83	66	149			<b>2.5%</b>	
<b>2.6%</b>		650	56	43	99	1,000	59	45	104	1,420	63	48	111	1,930	67	52	119	2,490	72	55	127	3,130	78	60	138	3,870	83	64	147	4,700	87	67	154			<b>2.6%</b>	
<b>2.7%</b>		581	58	43	101	901	61	45	106	1,280	65	48	113	1,760	70	52	122	2,280	75	56	131	2,880	81	60	141	3,600	86	64	150	4,360	90	67	157			<b>2.7%</b>	
<b>2.8%</b>		524	60	43	103	817	64	46	110	1,170	68	49	117	1,620	72	51	123	2,100	78	56	134	2,660	84	60	144	3,310	89	64	153	4,060	93	66	159			<b>2.8%</b>	
<b>2.9%</b>		475	62	43	105	744	66	46	112	1,070	70	48	118	1,490	75	52	127	1,940	81	56	137	2,460	87	60	147	3,100	93	64	157	3,780	97	67	164			<b>2.9%</b>	
<b>3.0%</b>		433	64	43	107	681	68	45	113	982	73	49	122	1,370	78	52	130	1,800	83	55	138	2,290	90	60	150	2,860	96	64	160	3,530	100	67	167			<b>3.0%</b>	
<b>3.1%</b>		395	66	43	109	625	70	45	115	905	75	48	123	1,270	80	52	132	1,660	86	55	141	2,120	93	60	153	2,690	99	64	163	3,300	103	66	169			<b>3.1%</b>	
<b>3.2%</b>		363	69	43	112	576	73	46	119	835	77	48	125	1,180	83	52	135	1,550	89	56	145	1,980	96	60	156	2,490	102	64	166	3,090	107	67	174			<b>3.2%</b>	
<b>3.3%</b>		333	71	43	114	531	75	45	120	772	80	48	128	1,090	85	52	137	1,440	92	56	148	1,840	99	60	159	2,340	105	64	169	2,890	110	67	177			<b>3.3%</b>	
<b>3.4%</b>		307	73	43	116	490	77	45	122	714	82	48	130	1,010	88	52	140	1,340	94	55	149	1,720	102	60	162	2,170	109	64	173	2,700	113	66	179			<b>3.4%</b>	
<b>3.5%</b>		282	75	43	118	452	80	46	126	660	85	49	134	935	91	52	143	1,240	97	55	152	1,600	105	60	165	2,040	112	64	176	2,520	117	67	184			<b>3.5%</b>	
<b>3.6%</b>		259	77	43	120	416	82	46	128	610	87	48	135	865	93	52	145	1,150	100	56	156	1,480	108	60	168	1,880	115	64	179	2,350	120	67	187			<b>3.6%</b>	
<b>3.7%</b>		237	79	43	122	382	84	45	129	561	90	49	139	797	96	52	148	1,060	103	56	159	1,370	111	60	171	1,760	118	64	182	2,180	123	66	189			<b>3.7%</b>	
<b>3.8%</b>		215	81	43	124	348	86	45	131	512	92	48	140	730	98	52	150	970	106	56	162	1,260	114	60	174	1,600	121	64	185	2,010	127	67	194			<b>3.8%</b>	
<b>3.9%</b>		193	84	43	127	312	89	46	135	460	94	48	142	657	101	52	153	875	108	55	163	1,140	117	60	177	1,460	124	64	188	1,830	130	67	197			<b>3.9%</b>	
<b>4.0%</b>		154	86	43	129	250	91	46	137	371	97	49	146	533	103	52	155	711	111	56	167	926	120	60	180	1,190	128	64	192	1,500	133	67	200			<b>4.0%</b>	

Adapted from Table 3-8, page 3-42, and Table 3-16a, pages 3-66 thru 3-67, 2018 GDHS

**Legend**

**R** = Minimum curve radius for a given superelevation rate and design speed (**feet**)

**L** = Superelevation runoff minimum length (**feet**)

**X** = Tangent Runout (**feet**)

**T** = Superelevation transition = tangent runout + runoff length = X + L (**feet**)

**e** = Rate of superelevation (**percent**)

**NC** = Normal crown slope (assumed 2.0%)

**RC (2.0%)** = Remove adverse crown, superelevate at 2.0%

**Notes**

(1) The R-values in the above table represent the minimum radius for which the corresponding superelevation rate can be used. For example, if the design speed is 60 mph then a 3.0% rate can be used for any radius value from 3530 to 3779 feet (inclusive) - if the radius is 3529 feet then use 3.1%; if the radius is 3780 feet then use 2.9%.

**Do not interpolate superelevation rates.** For example, if the design speed is 60 mph and the radius is 3655 feet then use 3.0% - NOT 2.95%.

(2) On high-type facilities (freeways, expressways and other divided highways) a small increase in runoff length may be appropriate to facilitate drainage needs or to increase the smoothness in the traveled way edge profiles.

(3) Curves whose radius is less than the minimum shown for NC superelevation but more than the minimum shown for RC (2.0%) superelevation shall be provided with RC (2.0%) superelevation.

(4) See equations and example on the last 2 sheets of this Attachment

e<sub>max</sub> = 4%

This chart is for: 2-lane undivided highways w/ rotation about outside edge; 4-lane un-divided highway w/ rotation about CL; and 4-lane divided highway w/ rotation about median edge

Number of lanes rotated (n<sub>1</sub>) = 2

Adjustment factor (b<sub>w</sub>) = 0.75

Multiple of runoff length relative to 1-lane rotated (n<sub>1</sub> x b<sub>w</sub>) = 1.50

Design Speed																																	
25mph				30mph				35mph				40mph				45mph				50mph				55mph				60mph				e (%)	
e (%)	R	L	X	T	R	L	X	T	R	L	X	T	R	L	X	T	R	L	X	T	R	L	X	T	R	L	X	T	R	L	X	T	e (%)
NC	2,050	0	0	0	2,830	0	0	0	3,730	0	0	0	4,770	0	0	0	5,930	0	0	0	7,220	0	0	0	8,650	0	0	0	10,300	0	0	0	NC
RC (2.0%)	1,340	51	51	102	1,880	55	55	110	2,490	58	58	116	3,220	62	62	124	4,040	67	67	134	4,940	72	72	144	5,950	77	77	154	7,080	80	80	160	RC (2.0%)
2.1%	1,220	54	51	105	1,720	57	54	111	2,300	61	58	119	2,990	65	62	127	3,750	70	67	137	4,600	76	72	148	5,590	80	76	156	6,620	84	80	164	2.1%
2.2%	1,110	57	52	109	1,580	60	55	115	2,120	64	58	122	2,760	68	62	130	3,480	73	66	139	4,280	79	72	151	5,180	84	76	160	6,190	88	80	168	2.2%
2.3%	971	59	51	110	1,430	63	55	118	1,940	67	58	125	2,550	71	62	133	3,230	77	67	144	3,980	83	72	155	4,860	88	77	165	5,790	92	80	172	2.3%
2.4%	838	62	52	114	1,270	65	54	119	1,760	70	58	128	2,340	74	62	136	2,980	80	67	147	3,690	86	72	158	4,500	92	77	169	5,410	96	80	176	2.4%
2.5%	733	64	51	115	1,120	68	54	122	1,570	73	58	131	2,130	78	62	140	2,730	83	66	149	3,410	90	72	162	4,210	96	77	173	5,050	100	80	180	2.5%
2.6%	650	67	52	119	1,000	71	55	126	1,420	75	58	133	1,930	81	62	143	2,490	87	67	154	3,130	94	72	166	3,870	100	77	177	4,700	104	80	184	2.6%
2.7%	581	69	51	120	901	74	55	129	1,280	78	58	136	1,760	84	62	146	2,280	90	67	157	2,880	97	72	169	3,600	103	76	179	4,360	108	80	188	2.7%
2.8%	524	72	51	123	817	76	54	130	1,170	81	58	139	1,620	87	62	149	2,100	93	66	159	2,660	101	72	173	3,310	107	76	183	4,060	112	80	192	2.8%
2.9%	475	75	52	127	744	79	54	133	1,070	84	58	142	1,490	90	62	152	1,940	97	67	164	2,460	104	72	176	3,100	111	77	188	3,780	116	80	196	2.9%
3.0%	433	77	51	128	681	82	55	137	982	87	58	145	1,370	93	62	155	1,800	100	67	167	2,290	108	72	180	2,860	115	77	192	3,530	120	80	200	3.0%
3.1%	395	80	52	132	625	85	55	140	905	90	58	148	1,270	96	62	158	1,660	103	66	169	2,120	112	72	184	2,690	119	77	196	3,300	124	80	204	3.1%
3.2%	363	82	51	133	576	87	54	141	835	93	58	151	1,180	99	62	161	1,550	107	67	174	1,980	115	72	187	2,490	123	77	200	3,090	128	80	208	3.2%
3.3%	333	85	52	137	531	90	55	145	772	96	58	154	1,090	102	62	164	1,440	110	67	177	1,840	119	72	191	2,340	126	76	202	2,890	132	80	212	3.3%
3.4%	307	87	51	138	490	93	55	148	714	99	58	157	1,010	106	62	168	1,340	113	66	179	1,720	122	72	194	2,170	130	76	206	2,700	136	80	216	3.4%
3.5%	282	90	51	141	452	95	54	149	660	102	58	160	935	109	62	171	1,240	117	67	184	1,600	126	72	198	2,040	134	77	211	2,520	140	80	220	3.5%
3.6%	259	93	52	145	416	98	54	152	610	105	58	163	865	112	62	174	1,150	120	67	187	1,480	130	72	202	1,880	138	77	215	2,350	144	80	224	3.6%
3.7%	237	95	51	146	382	101	55	156	561	107	58	165	797	115	62	177	1,060	123	66	189	1,370	133	72	205	1,760	142	77	219	2,180	148	80	228	3.7%
3.8%	215	98	52	150	348	104	55	159	512	110	58	168	730	118	62	180	970	127	67	194	1,260	137	72	209	1,600	146	77	223	2,010	152	80	232	3.8%
3.9%	193	100	51	151	312	106	54	160	460	113	58	171	657	121	62	183	875	130	67	197	1,140	140	72	212	1,460	149	76	225	1,830	156	80	236	3.9%
4.0%	154	103	52	155	250	109	55	164	371	116	58	174	533	124	62	186	711	133	67	200	926	144	72	216	1,190	153	77	230	1,500	160	80	240	4.0%

Adapted from Table 3-8, page 3-42, and Table 3-16a, pages 3-66 thru 3-67, 2018 GDHS

**Legend**

**R** = Minimum curve radius for a given superelevation rate and design speed (**feet**)

**L** = Superelevation runoff minimum length (**feet**)

**X** = Tangent Runout (**feet**)

**T** = Superelevation transition = tangent runout + runoff length = X + L (**feet**)

**e** = Rate of superelevation (**percent**)

**NC** = Normal crown slope (assumed 2.0%)

**RC (2.0%)** = Remove adverse crown, superelevate at 2.0%

**Notes**

(1) The R-values in the above table represent the minimum radius for which the corresponding superelevation rate can be used. For example, if the design speed is 60 mph then a 3.0% rate can be used for any radius value from 3530 to 3779 feet (inclusive) - if the radius is 3529 feet then use 3.1%; if the radius is 3780 feet then use 2.9%.

**Do not interpolate superelevation rates.** For example, if the design speed is 60 mph and the radius is 3655 feet then use 3.0% - NOT 2.95%.

(2) On high-type facilities (freeways, expressways and other divided highways) a small increase in runoff length may be appropriate to facilitate drainage needs or to increase the smoothness in the traveled way edge profiles.

(3) Curves whose radius is less than the minimum shown for NC superelevation but more than the minimum shown for RC (2.0%) superelevation shall be provided with RC (2.0%) superelevation.

(4) See equations and example on the last 2 sheets of this Attachment

e<sub>max</sub> = 6%

This chart is for: 1-lane ramps regardless of rotation point and 2-lane undivided highways w/ rotation about CL.

Number of lanes rotated (n<sub>1</sub>) = 1

Adjustment factor (b<sub>w</sub>) = 1.00

Multiple of runoff length relative to 1-lane rotated (n<sub>1</sub> x b<sub>w</sub>) = 1.00

		Design Speed																												e (%)												
		25mph				30mph				35mph				40mph				45mph				50mph				55mph					60mph				65mph				70mph			
e (%)		R	L	X	T	R	L	X	T	R	L	X	T	R	L	X	T	R	L	X	T	R	L	X	T	R	L	X	T	R	L	X	T	R	L	X	T	R	L	X	T	e (%)
NC		2,290	0	0	0	3,130	0	0	0	4,100	0	0	0	5,230	0	0	0	6,480	0	0	0	7,870	0	0	0	9,410	0	0	0	11,100	0	0	0	12,600	0	0	0	14,100	0	0	0	NC
RC (2.0%)		1,630	34	34	68	2,240	36	36	72	2,950	39	39	78	3,770	41	41	82	4,680	44	44	88	5,700	48	48	96	6,820	51	51	102	8,060	53	53	106	9,130	56	56	112	10,300	60	60	120	RC (2.0%)
2.1%		1,540	36	34	70	2,120	38	36	74	2,780	41	39	80	3,560	43	41	84	4,430	47	45	92	5,390	50	48	98	6,450	54	51	105	7,610	56	53	109	8,670	59	56	115	9,720	63	60	123	2.1%
2.2%		1,450	38	35	73	2,000	40	36	76	2,630	43	39	82	3,370	46	42	88	4,190	49	45	94	5,100	53	48	101	6,110	56	51	107	7,230	59	54	113	8,200	61	55	116	9,240	66	60	126	2.2%
2.3%		1,370	39	34	73	1,890	42	37	79	2,490	45	39	84	3,190	48	42	90	3,970	51	44	95	4,840	55	48	103	5,800	59	51	110	6,850	61	53	114	7,820	64	56	120	8,780	69	60	129	2.3%
2.4%		1,300	41	34	75	1,790	44	37	81	2,360	46	38	84	3,030	50	42	92	3,770	53	44	97	4,600	58	48	106	5,520	61	51	112	6,540	64	53	117	7,430	67	56	123	8,380	72	60	132	2.4%
2.5%		1,230	43	34	77	1,700	45	36	81	2,240	48	38	86	2,880	52	42	94	3,590	56	45	101	4,380	60	48	108	5,250	64	51	115	6,210	67	54	121	7,100	70	56	126	7,990	75	60	135	2.5%
2.6%		1,170	45	35	80	1,610	47	36	83	2,130	50	38	88	2,740	54	42	96	3,420	58	45	103	4,170	62	48	110	5,020	66	51	117	5,950	69	53	122	6,770	73	56	129	7,660	78	60	138	2.6%
2.7%		1,110	46	34	80	1,530	49	36	85	2,030	52	39	91	2,610	56	41	97	3,260	60	44	104	3,980	65	48	113	4,780	69	51	120	5,660	72	53	125	6,490	75	56	131	7,320	81	60	141	2.7%
2.8%		1,050	48	34	82	1,460	51	36	87	1,930	54	39	93	2,490	58	41	99	3,110	62	44	106	3,800	67	48	115	4,580	71	51	122	5,440	75	54	129	6,200	78	56	134	7,030	84	60	144	2.8%
2.9%		995	50	34	84	1,390	53	37	90	1,840	56	39	95	2,380	60	41	101	2,970	64	44	108	3,640	70	48	118	4,380	74	51	125	5,190	77	53	130	5,970	81	56	137	6,740	87	60	147	2.9%
3.0%		944	51	34	85	1,320	55	37	92	1,760	58	39	97	2,270	62	41	103	2,840	67	45	112	3,480	72	48	120	4,200	77	51	128	4,990	80	53	133	5,710	84	56	140	6,490	90	60	150	3.0%
3.1%		896	53	34	87	1,260	56	36	92	1,680	60	39	99	2,170	64	41	105	2,720	69	45	114	3,330	74	48	122	4,020	79	51	130	4,770	83	54	137	5,500	87	56	143	6,230	93	60	153	3.1%
3.2%		850	55	34	89	1,200	58	36	94	1,600	62	39	101	2,080	66	41	107	2,600	71	44	115	3,200	77	48	125	3,860	82	51	133	4,600	85	53	138	5,280	89	56	145	6,010	96	60	156	3.2%
3.3%		805	57	35	92	1,140	60	36	96	1,530	64	39	103	1,990	68	41	109	2,490	73	44	117	3,060	79	48	127	3,700	84	51	135	4,400	88	53	141	5,090	92	56	148	5,780	99	60	159	3.3%
3.4%		761	58	34	92	1,080	62	36	98	1,460	66	39	105	1,900	70	41	111	2,390	76	45	121	2,940	82	48	130	3,560	87	51	138	4,250	91	54	145	4,890	95	56	151	5,580	102	60	162	3.4%
3.5%		717	60	34	94	1,030	64	37	101	1,390	68	39	107	1,820	72	41	113	2,290	78	45	123	2,820	84	48	132	3,410	89	51	140	4,070	93	53	146	4,730	98	56	154	5,380	105	60	165	3.5%
3.6%		673	62	34	96	972	65	36	101	1,320	70	39	109	1,740	74	41	115	2,190	80	44	124	2,710	86	48	134	3,290	92	51	143	3,940	96	53	149	4,540	100	56	156	5,210	108	60	168	3.6%
3.7%		626	63	34	97	918	67	36	103	1,260	72	39	111	1,660	77	42	119	2,100	82	44	126	2,600	89	48	137	3,150	94	51	145	3,770	99	54	153	4,400	103	56	159	5,020	111	60	171	3.7%
3.8%		583	65	34	99	864	69	36	105	1,190	74	39	113	1,590	79	42	121	2,010	84	44	128	2,490	91	48	139	3,040	97	51	148	3,650	101	53	154	4,230	106	56	162	4,860	114	60	174	3.8%
3.9%		545	67	34	101	812	71	36	107	1,130	75	38	113	1,520	81	42	123	1,930	87	45	132	2,390	94	48	142	2,920	100	51	151	3,500	104	53	157	4,100	109	56	165	4,700	117	60	177	3.9%
4.0%		511	69	35	104	766	73	37	110	1,070	77	39	116	1,440	83	42	125	1,840	89	45	134	2,300	96	48	144	2,810	102	51	153	3,390	107	54	161	3,950	112	56	168	4,550	120	60	180	4.0%
4.1%		479	70	34	104	723	75	37	112	1,010	79	39	118	1,370	85	41	126	1,760	91	44	135	2,200	98	48	146	2,690	105	51	156	3,250	109	53	162	3,820	114	56	170	4,400	123	60	183	4.1%
4.2%		452	72	34	106	684	76	36	112	960	81	39	120	1,310	87	41	128	1,680	93	44	137	2,110	101	48	149	2,590	107	51	158	3,140	112	53	165	3,680	117	56	173	4,270	126	60	186	4.2%
4.3%		426	74	34	108	648	78	36	114	912	83	39	122	1,250	89	41	130	1,610	96	45	141	2,020	103	48	151	2,490	110	51	161	3,010	115	53	168	3,570	120	56	176	4,130	129	60	189	4.3%
4.4%		402	75	34	109	615	80	36	116	868	85	39	124	1,190	91	41	132	1,540	98	45	143	1,940	106	48	154	2,400	112	51	163	2,920	117	53	170	3,440	123	56	179	4,010	132	60	192	4.4%
4.5%		381	77	34	111	584	82	36	118	827	87	39	126	1,140	93	41	134	1,470	100	44	144	1,860	108	48	156	2,300	115	51	166	2,800	120	53	173	3,340	126	56	182	3,880	135	60	195	4.5%
4.6%		360	79	34	113	555	84	37	121	788	89	39	128	1,090	95	41	136	1,410	102	44	146	1,780	110	48	158	2,210	117	51	168	2,710	123	53	176	3,220	128	56	184	3,770	138	60	198	4.6%
4.7%		342	81	34	115	528	85	36	121	752	91	39	130	1,040	97	41	138	1,350	104	44	148	1,710	113	48	161	2,120	120	51	171	2,600	125	53	178	3,120	131	56	187	3,650	141	60	201	4.7%



4.8%	324	82	34	116	502	87	36	123	718	93	39	132	995	99	41	140	1,300	107	45	152	1,640	115	48	163	2,050	123	51	174	2,510	128	53	181	3,000	134	56	190	3,550	144	60	204	4.8%
4.9%	308	84	34	118	478	89	36	125	685	95	39	134	952	101	41	142	1,240	109	44	153	1,580	118	48	166	1,970	125	51	176	2,410	131	53	184	2,910	137	56	193	3,430	147	60	207	4.9%
5.0%	292	86	34	120	456	91	36	127	654	97	39	136	911	103	41	144	1,190	111	44	155	1,510	120	48	168	1,890	128	51	179	2,330	133	53	186	2,800	140	56	196	3,330	150	60	210	5.0%
5.1%	278	87	34	121	434	93	36	129	624	99	39	138	871	106	42	148	1,140	113	44	157	1,450	122	48	170	1,820	130	51	181	2,230	136	53	189	2,720	142	56	198	3,220	153	60	213	5.1%
5.2%	264	89	34	123	413	95	37	132	595	101	39	140	833	108	42	150	1,090	116	45	161	1,390	125	48	173	1,750	133	51	184	2,160	139	53	192	2,610	145	56	201	3,120	156	60	216	5.2%
5.3%	250	91	34	125	393	96	36	132	567	103	39	142	795	110	42	152	1,050	118	45	163	1,340	127	48	175	1,670	135	51	186	2,070	141	53	194	2,530	148	56	204	3,010	159	60	219	5.3%
5.4%	237	93	34	127	373	98	36	134	540	105	39	144	759	112	41	153	995	120	44	164	1,280	130	48	178	1,610	138	51	189	1,990	144	53	197	2,420	151	56	207	2,910	162	60	222	5.4%
5.5%	225	94	34	128	354	100	36	136	513	106	39	145	723	114	41	155	949	122	44	166	1,220	132	48	180	1,530	140	51	191	1,900	147	53	200	2,340	153	56	209	2,800	165	60	225	5.5%
5.6%	212	96	34	130	335	102	36	138	487	108	39	147	687	116	41	157	903	124	44	168	1,160	134	48	182	1,470	143	51	194	1,830	149	53	202	2,230	156	56	212	2,700	168	60	228	5.6%
5.7%	199	98	34	132	316	104	36	140	460	110	39	149	650	118	41	159	856	127	45	172	1,100	137	48	185	1,390	146	51	197	1,730	152	53	205	2,140	159	56	215	2,580	171	60	231	5.7%
5.8%	186	99	34	133	296	105	36	141	431	112	39	151	611	120	41	161	806	129	44	173	1,040	139	48	187	1,320	148	51	199	1,650	155	53	208	2,020	162	56	218	2,460	174	60	234	5.8%
5.9%	171	101	34	135	273	107	36	143	399	114	39	153	567	122	41	163	749	131	44	175	965	142	48	190	1,230	151	51	202	1,530	157	53	210	1,900	165	56	221	2,310	177	60	237	5.9%
6.0%	144	103	34	137	231	109	36	145	340	116	39	155	485	124	41	165	643	133	44	177	833	144	48	192	1,060	153	51	204	1,330	160	53	213	1,660	167	56	223	2,040	180	60	240	6.0%

Adapted from Table 3-9, page 3-43, and Table 3-16a, pages 3-66 thru 3-67, 2018 GDHS

**Legend**

**R** = Minimum curve radius for a given superelevation rate and design speed (feet)

**L** = Superelevation runoff minimum length (feet)

**X** = Tangent Runout (feet)

**T** = Superelevation transition = tangent runout + runoff length = X + L (feet)

**e** = Rate of superelevation (percent)

**NC** = Normal crown slope (assumed 2.0%)

**RC (2.0%)** = Remove adverse crown, superelevate at 2.0%

**Notes**

(1) The R-values in the above table represent the minimum radius for which the corresponding superelevation rate can be used. For example, if the design speed is 70 mph then a 5.5% rate can be used for any radius value from 2800 to 2909 feet (inclusive) - if the radius is 2799 feet then use 5.6%; if the radius is 2910 feet then use 5.4%.

**Do not interpolate superelevation rates.** For example, if the design speed is 70 mph and the radius is 2865 feet then use 5.5% - NOT 5.44%.

(2) On high-type facilities (freeways, expressways and other divided highways) a small increase in runoff length may be appropriate to facilitate drainage needs or to increase the smoothness in the traveled way edge profiles.

(3) Curves whose radius is less than the minimum shown for NC superelevation but more than the minimum shown for RC (2.0%) superelevation shall be provided with RC (2.0%) superelevation.

(4) See equations and example on the last 2 sheets of this Attachment

emax= 6%

This chart is for: 3-lane TWLTL w/ rotation about CL

Number of lanes rotated (n<sub>1</sub>) = 2 - 1.5

Adjustment factor (b<sub>w</sub>) = 3 - 0.83

Multiple of runoff length relative to 1-lane rotated (n<sub>1</sub> x b<sub>w</sub>) = 4 - 1.25

		Design Speed																												e (%)																
		25mph				30mph				35mph				40mph				45mph				50mph				55mph						60mph				65mph				70mph						
e (%)		R	L	X	T	R	L	X	T	R	L	X	T	R	L	X	T	R	L	X	T	R	L	X	T	R	L	X	T	R	L	X	T	R	L	X	T	R	L	X	T	R	L	X	T	e (%)
NC		2,290	0	0	0	3,130	0	0	0	4,100	0	0	0	5,230	0	0	0	6,480	0	0	0	7,870	0	0	0	9,410	0	0	0	11,100	0	0	0	12,600	0	0	0	14,100	0	0	0	NC				
RC (2.0%)		1,630	43	43	86	2,240	45	45	90	2,950	48	48	96	3,770	52	52	104	4,680	56	56	112	5,700	60	60	120	6,820	64	64	128	8,060	67	67	134	9,130	70	70	140	10,300	75	75	150	RC (2.0%)				
2.1%		1,540	45	43	88	2,120	48	46	94	2,780	51	49	100	3,560	54	51	105	4,430	58	55	113	5,390	63	60	123	6,450	67	64	131	7,610	70	67	137	8,670	73	70	143	9,720	79	75	154	2.1%				
2.2%		1,450	47	43	90	2,000	50	45	95	2,630	53	48	101	3,370	57	52	109	4,190	61	55	116	5,100	66	60	126	6,110	70	64	134	7,230	73	66	139	8,200	77	70	147	9,240	82	75	157	2.2%				
2.3%		1,370	49	43	92	1,890	52	45	97	2,490	56	49	105	3,190	59	51	110	3,970	64	56	120	4,840	69	60	129	5,800	73	63	136	6,850	77	67	144	7,820	80	70	150	8,780	86	75	161	2.3%				
2.4%		1,300	51	43	94	1,790	55	46	101	2,360	58	48	106	3,030	62	52	114	3,770	67	56	123	4,600	72	60	132	5,520	77	64	141	6,540	80	67	147	7,430	84	70	154	8,380	90	75	165	2.4%				
2.5%		1,230	54	43	97	1,700	57	46	103	2,240	60	48	108	2,880	65	52	117	3,590	69	55	124	4,380	75	60	135	5,250	80	64	144	6,210	83	66	149	7,100	87	70	157	7,990	94	75	169	2.5%				
2.6%		1,170	56	43	99	1,610	59	45	104	2,130	63	48	111	2,740	67	52	119	3,420	72	55	127	4,170	78	60	138	5,020	83	64	147	5,950	87	67	154	6,770	91	70	161	7,660	97	75	172	2.6%				
2.7%		1,110	58	43	101	1,530	61	45	106	2,030	65	48	113	2,610	70	52	122	3,260	75	56	131	3,980	81	60	141	4,780	86	64	150	5,660	90	67	157	6,490	94	70	164	7,320	101	75	176	2.7%				
2.8%		1,050	60	43	103	1,460	64	46	110	1,930	68	49	117	2,490	72	51	123	3,110	78	56	134	3,800	84	60	144	4,580	89	64	153	5,440	93	66	159	6,200	98	70	168	7,030	105	75	180	2.8%				
2.9%		995	62	43	105	1,390	66	46	112	1,840	70	48	118	2,380	75	52	127	2,970	81	56	137	3,640	87	60	147	4,380	93	64	157	5,190	97	67	164	5,970	101	70	171	6,740	109	75	184	2.9%				
3.0%		944	64	43	107	1,320	68	45	113	1,760	73	49	122	2,270	78	52	130	2,840	83	55	138	3,480	90	60	150	4,200	96	64	160	4,990	100	67	167	5,710	105	70	175	6,490	113	75	188	3.0%				
3.1%		896	66	43	109	1,260	70	45	115	1,680	75	48	123	2,170	80	52	132	2,720	86	55	141	3,330	93	60	153	4,020	99	64	163	4,770	103	66	169	5,500	108	70	178	6,230	116	75	191	3.1%				
3.2%		850	69	43	112	1,200	73	46	119	1,600	77	48	125	2,080	83	52	135	2,600	89	56	145	3,200	96	60	156	3,860	102	64	166	4,600	107	67	174	5,280	112	70	182	6,010	120	75	195	3.2%				
3.3%		805	71	43	114	1,140	75	45	120	1,530	80	48	128	1,990	85	52	137	2,490	92	56	148	3,060	99	60	159	3,700	105	64	169	4,400	110	67	177	5,090	115	70	185	5,780	124	75	199	3.3%				
3.4%		761	73	43	116	1,080	77	45	122	1,460	82	48	130	1,900	88	52	140	2,390	94	55	149	2,940	102	60	162	3,560	109	64	173	4,250	113	66	179	4,890	119	70	189	5,580	128	75	203	3.4%				
3.5%		717	75	43	118	1,030	80	46	126	1,390	85	49	134	1,820	91	52	143	2,290	97	55	152	2,820	105	60	165	3,410	112	64	176	4,070	117	67	184	4,730	122	70	192	5,380	131	75	206	3.5%				
3.6%		673	77	43	120	972	82	46	128	1,320	87	48	135	1,740	93	52	145	2,190	100	56	156	2,710	108	60	168	3,290	115	64	179	3,940	120	67	187	4,540	126	70	196	5,210	135	75	210	3.6%				
3.7%		626	79	43	122	918	84	45	129	1,260	90	49	139	1,660	96	52	148	2,100	103	56	159	2,600	111	60	171	3,150	118	64	182	3,770	123	66	189	4,400	129	70	199	5,020	139	75	214	3.7%				
3.8%		583	81	43	124	864	86	45	131	1,190	92	48	140	1,590	98	52	150	2,010	106	56	162	2,490	114	60	174	3,040	121	64	185	3,650	127	67	194	4,230	133	70	203	4,860	143	75	218	3.8%				
3.9%		545	84	43	127	812	89	46	135	1,130	94	48	142	1,520	101	52	153	1,930	108	55	163	2,390	117	60	177	2,920	124	64	188	3,500	130	67	197	4,100	136	70	206	4,700	146	75	221	3.9%				
4.0%		511	86	43	129	766	91	46	137	1,070	97	49	146	1,440	103	52	155	1,840	111	56	167	2,300	120	60	180	2,810	128	64	192	3,390	133	67	200	3,950	140	70	210	4,550	150	75	225	4.0%				
4.1%		479	88	43	131	723	93	45	138	1,010	99	48	147	1,370	106	52	158	1,760	114	56	170	2,200	123	60	183	2,690	131	64	195	3,250	137	67	204	3,820	143	70	213	4,400	154	75	229	4.1%				
4.2%		452	90	43	133	684	95	45	140	960	102	49	151	1,310	109	52	161	1,680	117	56	173	2,110	126	60	186	2,590	134	64	198	3,140	140	67	207	3,680	147	70	217	4,270	158	75	233	4.2%				
4.3%		426	92	43	135	648	98	46	144	912	104	48	152	1,250	111	52	163	1,610	119	55	174	2,020	129	60	189	2,490	137	64	201	3,010	143	67	210	3,570	150	70	220	4,130	161	75	236	4.3%				
4.4%		402	94	43	137	615	100	45	145	868	106	48	154	1,190	114	52	166	1,540	122	55	177	1,940	132	60	192	2,400	140	64	204	2,920	147	67	214	3,440	153	70	223	4,010	165	75	240	4.4%				
4.5%		381	96	43	139	584	102	45	147	827	109	48	157	1,140	116	52	168	1,470	125	56	181	1,860	135	60	195	2,300	144	64	208	2,800	150	67	217	3,340	157	70	227	3,880	169	75	244	4.5%				
4.6%		360	99	43	142	555	105	46	151	788	111	48	159	1,090	119	52	171	1,410	128	56	184	1,780	138	60	198	2,210	147	64	211	2,710	153	67	220	3,220	160	70	230	3,770	173	75	248	4.6%				

FDM 11-10 Exhibit 5.1 Superelevation Tables (emax = 4% and 6%)

4.7%	342	101	43	144	528	107	46	153	752	114	49	163	1,040	122	52	174	1,350	131	56	187	1,710	141	60	201	2,120	150	64	214	2,600	157	67	224	3,120	164	70	234	3,650	176	75	251	4.7%
4.8%	324	103	43	146	502	109	45	154	718	116	48	164	995	124	52	176	1,300	133	55	188	1,640	144	60	204	2,050	153	64	217	2,510	160	67	227	3,000	167	70	237	3,550	180	75	255	4.8%
4.9%	308	105	43	148	478	111	45	156	685	119	49	168	952	127	52	179	1,240	136	56	192	1,580	147	60	207	1,970	156	64	220	2,410	163	67	230	2,910	171	70	241	3,430	184	75	259	4.9%
5.0%	292	107	43	150	456	114	46	160	654	121	48	169	911	129	52	181	1,190	139	56	195	1,510	150	60	210	1,890	160	64	224	2,330	167	67	234	2,800	174	70	244	3,330	188	75	263	5.0%
5.1%	278	109	43	152	434	116	45	161	624	123	48	171	871	132	52	184	1,140	142	56	198	1,450	153	60	213	1,820	163	64	227	2,230	170	67	237	2,720	178	70	248	3,220	191	75	266	5.1%
5.2%	264	111	43	154	413	118	45	163	595	126	48	174	833	134	52	186	1,090	144	55	199	1,390	156	60	216	1,750	166	64	230	2,160	173	67	240	2,610	181	70	251	3,120	195	75	270	5.2%
5.3%	250	114	43	157	393	120	45	165	567	128	48	176	795	137	52	189	1,050	147	55	202	1,340	159	60	219	1,670	169	64	233	2,070	177	67	244	2,530	185	70	255	3,010	199	75	274	5.3%
5.4%	237	116	43	159	373	123	46	169	540	131	49	180	759	140	52	192	995	150	56	206	1,280	162	60	222	1,610	172	64	236	1,990	180	67	247	2,420	188	70	258	2,910	203	75	278	5.4%
5.5%	225	118	43	161	354	125	45	170	513	133	48	181	723	142	52	194	949	153	56	209	1,220	165	60	225	1,530	176	64	240	1,900	183	67	250	2,340	192	70	262	2,800	206	75	281	5.5%
5.6%	212	120	43	163	335	127	45	172	487	135	48	183	687	145	52	197	903	156	56	212	1,160	168	60	228	1,470	179	64	243	1,830	187	67	254	2,230	195	70	265	2,700	210	75	285	5.6%
5.7%	199	122	43	165	316	130	46	176	460	138	48	186	650	147	52	199	856	158	55	213	1,100	171	60	231	1,390	182	64	246	1,730	190	67	257	2,140	199	70	269	2,580	214	75	289	5.7%
5.8%	186	124	43	167	296	132	46	178	431	140	48	188	611	150	52	202	806	161	56	217	1,040	174	60	234	1,320	185	64	249	1,650	193	67	260	2,020	202	70	272	2,460	218	75	293	5.8%
5.9%	171	126	43	169	273	134	45	179	399	143	48	191	567	153	52	205	749	164	56	220	965	177	60	237	1,230	188	64	252	1,530	197	67	264	1,900	206	70	276	2,310	221	75	296	5.9%
6.0%	144	129	43	172	231	136	45	181	340	145	48	193	485	155	52	207	643	167	56	223	833	180	60	240	1,060	191	64	255	1,330	200	67	267	1,660	209	70	279	2,040	225	75	300	6.0%

Adapted from Table 3-9, page 3-43, and Table 3-16a, pages 3-66 thru 3-67, 2018 GDHS

**Legend**

**R** = Minimum curve radius for a given superelevation rate and design speed (feet)

**L** = Superelevation runoff minimum length (feet)

**X** = Tangent Runout (feet)

**T** = Superelevation transition = tangent runout + runoff length = X + L (feet)

**e** = Rate of superelevation (percent)

**NC** = Normal crown slope (assumed 2.0%)

**RC (2.0%)** = Remove adverse crown, superelevate at 2.0%

**Notes**

- (1) The R-values in the above table represent the minimum radius for which the corresponding superelevation rate can be used. For example, if the design speed is 70 mph then a 5.5% rate can be used for any radius value from 2800 to 2909 feet (inclusive) - if the radius is 2799 feet then use 5.6%; if the radius is 2910 feet then use 5.4%.  
**Do not interpolate superelevation rates.** For example, if the design speed is 70 mph and the radius is 2865 feet then use 5.5% - NOT 5.44%.
- (2) On high-type facilities (freeways, expressways and other divided highways) a small increase in runoff length may be appropriate to facilitate drainage needs or to increase the smoothness in the traveled way edge profiles.
- (3) Curves whose radius is less than the minimum shown for NC superelevation but more than the minimum shown for RC (2.0%) superelevation shall be provided with RC (2.0%) superelevation.
- (4) See equations and example on the last 2 sheets of this Attachment

e<sub>max</sub> = 6%

This chart is for: 2-lane undivided highways w/ rotation about outside edge; 4-lane un-divided highway w/ rotation about CL; and 4-lane divided highway w/ rotation about median edge

Number of lanes rotated (n<sub>1</sub>) = 2

Adjustment factor (b<sub>w</sub>) = 0.75

Multiple of runoff length relative to 1-lane rotated (n<sub>1</sub> x b<sub>w</sub>) = 1.50

		Design Speed																												e (%)																
		25mph				30mph				35mph				40mph				45mph				50mph				55mph						60mph				65mph				70mph						
e (%)		R	L	X	T	R	L	X	T	R	L	X	T	R	L	X	T	R	L	X	T	R	L	X	T	R	L	X	T	R	L	X	T	R	L	X	T	R	L	X	T	R	L	X	T	e (%)
NC		2,290	0	0	0	3,130	0	0	0	4,100	0	0	0	5,230	0	0	0	6,480	0	0	0	7,870	0	0	0	9,410	0	0	0	11,100	0	0	0	12,600	0	0	0	14,100	0	0	0	NC				
RC (2.0%)		1,630	51	51	102	2,240	55	55	110	2,950	58	58	116	3,770	62	62	124	4,680	67	67	134	5,700	72	72	144	6,820	77	77	154	8,060	80	80	160	9,130	84	84	168	10,300	90	90	180	RC (2.0%)				
2.1%		1,540	54	51	105	2,120	57	54	111	2,780	61	58	119	3,560	65	62	127	4,430	70	67	137	5,390	76	72	148	6,450	80	76	156	7,610	84	80	164	8,670	88	84	172	9,720	94	90	184	2.1%				
2.2%		1,450	57	52	109	2,000	60	55	115	2,630	64	58	122	3,370	68	62	130	4,190	73	66	139	5,100	79	72	151	6,110	84	76	160	7,230	88	80	168	8,200	92	84	176	9,240	99	90	189	2.2%				
2.3%		1,370	59	51	110	1,890	63	55	118	2,490	67	58	125	3,190	71	62	133	3,970	77	67	144	4,840	83	72	155	5,800	88	77	165	6,850	92	80	172	7,820	96	83	179	8,780	104	90	194	2.3%				
2.4%		1,300	62	52	114	1,790	65	54	119	2,360	70	58	128	3,030	74	62	136	3,770	80	67	147	4,600	86	72	158	5,520	92	77	169	6,540	96	80	176	7,430	100	83	183	8,380	108	90	198	2.4%				
2.5%		1,230	64	51	115	1,700	68	54	122	2,240	73	58	131	2,880	78	62	140	3,590	83	66	149	4,380	90	72	162	5,250	96	77	173	6,210	100	80	180	7,100	105	84	189	7,990	113	90	203	2.5%				
2.6%		1,170	67	52	119	1,610	71	55	126	2,130	75	58	133	2,740	81	62	143	3,420	87	67	154	4,170	94	72	166	5,020	100	77	177	5,950	104	80	184	6,770	109	84	193	7,660	117	90	207	2.6%				
2.7%		1,110	69	51	120	1,530	74	55	129	2,030	78	58	136	2,610	84	62	146	3,260	90	67	157	3,980	97	72	169	4,780	103	76	179	5,660	108	80	188	6,490	113	84	197	7,320	122	90	212	2.7%				
2.8%		1,050	72	51	123	1,460	76	54	130	1,930	81	58	139	2,490	87	62	149	3,110	93	66	159	3,800	101	72	173	4,580	107	76	183	5,440	112	80	192	6,200	117	84	201	7,030	126	90	216	2.8%				
2.9%		995	75	52	127	1,390	79	54	133	1,840	84	58	142	2,380	90	62	152	2,970	97	67	164	3,640	104	72	176	4,380	111	77	188	5,190	116	80	196	5,970	121	83	204	6,740	131	90	221	2.9%				
3.0%		944	77	51	128	1,320	82	55	137	1,760	87	58	145	2,270	93	62	155	2,840	100	67	167	3,480	108	72	180	4,200	115	77	192	4,990	120	80	200	5,710	126	84	210	6,490	135	90	225	3.0%				
3.1%		896	80	52	132	1,260	85	55	140	1,680	90	58	148	2,170	96	62	158	2,720	103	66	169	3,330	112	72	184	4,020	119	77	196	4,770	124	80	204	5,500	130	84	214	6,230	140	90	230	3.1%				
3.2%		850	82	51	133	1,200	87	54	141	1,600	93	58	151	2,080	99	62	161	2,600	107	67	174	3,200	115	72	187	3,860	123	77	200	4,600	128	80	208	5,280	134	84	218	6,010	144	90	234	3.2%				
3.3%		805	85	52	137	1,140	90	55	145	1,530	96	58	154	1,990	102	62	164	2,490	110	67	177	3,060	119	72	191	3,700	126	76	202	4,400	132	80	212	5,090	138	84	222	5,780	149	90	239	3.3%				
3.4%		761	87	51	138	1,080	93	55	148	1,460	99	58	157	1,900	106	62	168	2,390	113	66	179	2,940	122	72	194	3,560	130	76	206	4,250	136	80	216	4,890	142	84	226	5,580	153	90	243	3.4%				
3.5%		717	90	51	141	1,030	95	54	149	1,390	102	58	160	1,820	109	62	171	2,290	117	67	184	2,820	126	72	198	3,410	134	77	211	4,070	140	80	220	4,730	147	84	231	5,380	158	90	248	3.5%				
3.6%		673	93	52	145	972	98	54	152	1,320	105	58	163	1,740	112	62	174	2,190	120	67	187	2,710	130	72	202	3,290	138	77	215	3,940	144	80	224	4,540	151	84	235	5,210	162	90	252	3.6%				
3.7%		626	95	51	146	918	101	55	156	1,260	107	58	165	1,660	115	62	177	2,100	123	66	189	2,600	133	72	205	3,150	142	77	219	3,770	148	80	228	4,400	155	84	239	5,020	167	90	257	3.7%				
3.8%		583	98	52	150	864	104	55	159	1,190	110	58	168	1,590	118	62	180	2,010	127	67	194	2,490	137	72	209	3,040	146	77	223	3,650	152	80	232	4,230	159	84	243	4,860	171	90	261	3.8%				
3.9%		545	100	51	151	812	106	54	160	1,130	113	58	171	1,520	121	62	183	1,930	130	67	197	2,390	140	72	212	2,920	149	76	225	3,500	156	80	236	4,100	163	84	247	4,700	176	90	266	3.9%				
4.0%		511	103	52	155	766	109	55	164	1,070	116	58	174	1,440	124	62	186	1,840	133	67	200	2,300	144	72	216	2,810	153	77	230	3,390	160	80	240	3,950	167	84	251	4,550	180	90	270	4.0%				
4.1%		479	105	51	156	723	112	55	167	1,010	119	58	177	1,370	127	62	189	1,760	137	67	204	2,200	148	72	220	2,690	157	77	234	3,250	164	80	244	3,820	172	84	256	4,400	185	90	275	4.1%				
4.2%		452	108	51	159	684	115	55	170	960	122	58	180	1,310	130	62	192	1,680	140	67	207	2,110	151	72	223	2,590	161	77	238	3,140	168	80	248	3,680	176	84	260	4,270	189	90	279	4.2%				
4.3%		426	111	52	163	648	117	54	171	912	125	58	183	1,250	133	62	195	1,610	143	67	210	2,020	155	72	227	2,490	165	77	242	3,010	172	80	252	3,570	180	84	264	4,130	194	90	284	4.3%				
4.4%		402	113	51	164	615	120	55	175	868	128	58	186	1,190	137	62	199	1,540	147	67	214	1,940	158	72	230	2,400	169	77	246	2,920	176	80	256	3,440	184	84	268	4,010	198	90	288	4.4%				
4.5%		381	116	52	168	584	123	55	178	827	131	58	189	1,140	140	62	202	1,470	150	67	217	1,860	162	72	234	2,300	172	76	248	2,800	180	80	260	3,340	188	84	272	3,880	203	90	293	4.5%				
4.6%		360	118	51	169	555	125	54	179	788	134	58	192	1,090	143	62	205	1,410	153	67	220	1,780	166	72	238	2,210	176	77	253	2,710	184	80	264	3,220	193	84	277	3,770	207	90	297	4.6%				

FDM 11-10 Exhibit 5.1 Superelevation Tables (emax = 4% and 6%)

4.7%	342	121	51	172	528	128	54	182	752	136	58	194	1,040	146	62	208	1,350	157	67	224	1,710	169	72	241	2,120	180	77	257	2,600	188	80	268	3,120	197	84	281	3,650	212	90	302	4.7%
4.8%	324	123	51	174	502	131	55	186	718	139	58	197	995	149	62	211	1,300	160	67	227	1,640	173	72	245	2,050	184	77	261	2,510	192	80	272	3,000	201	84	285	3,550	216	90	306	4.8%
4.9%	308	126	51	177	478	134	55	189	685	142	58	200	952	152	62	214	1,240	163	67	230	1,580	176	72	248	1,970	188	77	265	2,410	196	80	276	2,910	205	84	289	3,430	221	90	311	4.9%
5.0%	292	129	52	181	456	136	54	190	654	145	58	203	911	155	62	217	1,190	167	67	234	1,510	180	72	252	1,890	191	76	267	2,330	200	80	280	2,800	209	84	293	3,330	225	90	315	5.0%
5.1%	278	131	51	182	434	139	55	194	624	148	58	206	871	158	62	220	1,140	170	67	237	1,450	184	72	256	1,820	195	76	271	2,230	204	80	284	2,720	213	84	297	3,220	230	90	320	5.1%
5.2%	264	134	52	186	413	142	55	197	595	151	58	209	833	161	62	223	1,090	173	67	240	1,390	187	72	259	1,750	199	77	276	2,160	208	80	288	2,610	218	84	302	3,120	234	90	324	5.2%
5.3%	250	136	51	187	393	145	55	200	567	154	58	212	795	164	62	226	1,050	177	67	244	1,340	191	72	263	1,670	203	77	280	2,070	212	80	292	2,530	222	84	306	3,010	239	90	329	5.3%
5.4%	237	139	51	190	373	147	54	201	540	157	58	215	759	168	62	230	995	180	67	247	1,280	194	72	266	1,610	207	77	284	1,990	216	80	296	2,420	226	84	310	2,910	243	90	333	5.4%
5.5%	225	141	51	192	354	150	55	205	513	160	58	218	723	171	62	233	949	183	67	250	1,220	198	72	270	1,530	211	77	288	1,900	220	80	300	2,340	230	84	314	2,800	248	90	338	5.5%
5.6%	212	144	51	195	335	153	55	208	487	163	58	221	687	174	62	236	903	187	67	254	1,160	202	72	274	1,470	214	76	290	1,830	224	80	304	2,230	234	84	318	2,700	252	90	342	5.6%
5.7%	199	147	52	199	316	155	54	209	460	165	58	223	650	177	62	239	856	190	67	257	1,100	205	72	277	1,390	218	76	294	1,730	228	80	308	2,140	239	84	323	2,580	257	90	347	5.7%
5.8%	186	149	51	200	296	158	54	212	431	168	58	226	611	180	62	242	806	193	67	260	1,040	209	72	281	1,320	222	77	299	1,650	232	80	312	2,020	243	84	327	2,460	261	90	351	5.8%
5.9%	171	152	52	204	273	161	55	216	399	171	58	229	567	183	62	245	749	197	67	264	965	212	72	284	1,230	226	77	303	1,530	236	80	316	1,900	247	84	331	2,310	266	90	356	5.9%
6.0%	144	154	51	205	231	164	55	219	340	174	58	232	485	186	62	248	643	200	67	267	833	216	72	288	1,060	230	77	307	1,330	240	80	320	1,660	251	84	335	2,040	270	90	360	6.0%

Adapted from Table 3-9, page 3-43, and Table 3-16a, pages 3-66 thru 3-67, 2018 GDHS

**Legend**

**R** = Minimum curve radius for a given superelevation rate and design speed (feet)

**L** = Superelevation runoff minimum length (feet)

**X** = Tangent Runout (feet)

**T** = Superelevation transition = tangent runout + runoff length = X + L (feet)

**e** = Rate of superelevation (percent)

**NC** = Normal crown slope (assumed 2.0%)

**RC (2.0%)** = Remove adverse crown, superelevate at 2.0%

**Notes**

(1) The R-values in the above table represent the minimum radius for which the corresponding superelevation rate can be used. For example, if the design speed is 70 mph then a 5.5% rate can be used for any radius value from 2800 to 2909 feet (inclusive) - if the radius is 2799 feet then use 5.6%; if the radius is 2910 feet then use 5.4%.

**Do not interpolate superelevation rates.** For example, if the design speed is 70 mph and the radius is 2865 feet then use 5.5% - NOT 5.44%.

(2) On high-type facilities (freeways, expressways and other divided highways) a small increase in runoff length may be appropriate to facilitate drainage needs or to increase the smoothness in the traveled way edge profiles.

(3) Curves whose radius is less than the minimum shown for NC superelevation but more than the minimum shown for RC (2.0%) superelevation shall be provided with RC (2.0%) superelevation.

(4) See equations and example on the last 2 sheets of this Attachment

e<sub>max</sub> = 6%

This chart is for: 3-lane TWLTL w/ rotation about outside edge; 6-lane un-divided highway w/ rotation about CL; and 6-lane divided highway w/ rotation about median edge

Number of lanes rotated (n<sub>1</sub>) = 3

Adjustment factor (b<sub>w</sub>) = 0.67

Multiple of runoff length relative to 1-lane rotated (n<sub>1</sub> x b<sub>w</sub>) = 2.00

		Design Speed																												e (%)																				
		25mph				30mph				35mph				40mph				45mph				50mph				55mph						60mph				65mph				70mph										
e (%)		R	L	X	T	R	L	X	T	R	L	X	T	R	L	X	T	R	L	X	T	R	L	X	T	R	L	X	T	R	L	X	T	R	L	X	T	R	L	X	T	R	L	X	T	R	L	X	T	e (%)
NC		2,290	0	0	0	3,130	0	0	0	4,100	0	0	0	5,230	0	0	0	6,480	0	0	0	7,870	0	0	0	9,410	0	0	0	11,100	0	0	0	12,600	0	0	0	14,100	0	0	0	NC								
RC (2.0%)		1,630	69	69	138	2,240	73	73	146	2,950	77	77	154	3,770	83	83	166	4,680	89	89	178	5,700	96	96	192	6,820	102	102	204	8,060	107	107	214	9,130	112	112	224	10,300	120	120	240	RC (2.0%)								
2.1%		1,540	72	69	141	2,120	76	72	148	2,780	81	77	158	3,560	87	83	170	4,430	93	89	182	5,390	101	96	197	6,450	107	102	209	7,610	112	107	219	8,670	117	111	228	9,720	126	120	246	2.1%								
2.2%		1,450	75	68	143	2,000	80	73	153	2,630	85	77	162	3,370	91	83	174	4,190	98	89	187	5,100	106	96	202	6,110	112	102	214	7,230	117	106	223	8,200	123	112	235	9,240	132	120	252	2.2%								
2.3%		1,370	79	69	148	1,890	84	73	157	2,490	89	77	166	3,190	95	83	178	3,970	102	89	191	4,840	110	96	206	5,800	117	102	219	6,850	123	107	230	7,820	128	111	239	8,780	138	120	258	2.3%								
2.4%		1,300	82	68	150	1,790	87	73	160	2,360	93	78	171	3,030	99	83	182	3,770	107	89	196	4,600	115	96	211	5,520	123	103	226	6,540	128	107	235	7,430	134	112	246	8,380	144	120	264	2.4%								
2.5%		1,230	86	69	155	1,700	91	73	164	2,240	97	78	175	2,880	103	82	185	3,590	111	89	200	4,380	120	96	216	5,250	128	102	230	6,210	133	106	239	7,100	140	112	252	7,990	150	120	270	2.5%								
2.6%		1,170	89	68	157	1,610	95	73	168	2,130	101	78	179	2,740	108	83	191	3,420	116	89	205	4,170	125	96	221	5,020	133	102	235	5,950	139	107	246	6,770	145	112	257	7,660	156	120	276	2.6%								
2.7%		1,110	93	69	162	1,530	98	73	171	2,030	105	78	183	2,610	112	83	195	3,260	120	89	209	3,980	130	96	226	4,780	138	102	240	5,660	144	107	251	6,490	151	112	263	7,320	162	120	282	2.7%								
2.8%		1,050	96	69	165	1,460	102	73	175	1,930	108	77	185	2,490	116	83	199	3,110	124	89	213	3,800	134	96	230	4,580	143	102	245	5,440	149	106	255	6,200	156	111	267	7,030	168	120	288	2.8%								
2.9%		995	99	68	167	1,390	105	72	177	1,840	112	77	189	2,380	120	83	203	2,970	129	89	218	3,640	139	96	235	4,380	148	102	250	5,190	155	107	262	5,970	162	112	274	6,740	174	120	294	2.9%								
3.0%		944	103	69	172	1,320	109	73	182	1,760	116	77	193	2,270	124	83	207	2,840	133	89	222	3,480	144	96	240	4,200	153	102	255	4,990	160	107	267	5,710	167	111	278	6,490	180	120	300	3.0%								
3.1%		896	106	68	174	1,260	113	73	186	1,680	120	77	197	2,170	128	83	211	2,720	138	89	227	3,330	149	96	245	4,020	158	102	260	4,770	165	106	271	5,500	173	112	285	6,230	186	120	306	3.1%								
3.2%		850	110	69	179	1,200	116	73	189	1,600	124	78	202	2,080	132	83	215	2,600	142	89	231	3,200	154	96	250	3,860	163	102	265	4,600	171	107	278	5,280	179	112	291	6,010	192	120	312	3.2%								
3.3%		805	113	68	181	1,140	120	73	193	1,530	128	78	206	1,990	137	83	220	2,490	147	89	236	3,060	158	96	254	3,700	169	102	271	4,400	176	107	283	5,090	184	112	296	5,780	198	120	318	3.3%								
3.4%		761	117	69	186	1,080	124	73	197	1,460	132	78	210	1,900	141	83	224	2,390	151	89	240	2,940	163	96	259	3,560	174	102	276	4,250	181	106	287	4,890	190	112	302	5,580	204	120	324	3.4%								
3.5%		717	120	69	189	1,030	127	73	200	1,390	135	77	212	1,820	145	83	228	2,290	156	89	245	2,820	168	96	264	3,410	179	102	281	4,070	187	107	294	4,730	195	111	306	5,380	210	120	330	3.5%								
3.6%		673	123	68	191	972	131	73	204	1,320	139	77	216	1,740	149	83	232	2,190	160	89	249	2,710	173	96	269	3,290	184	102	286	3,940	192	107	299	4,540	201	112	313	5,210	216	120	336	3.6%								
3.7%		626	127	69	196	918	135	73	208	1,260	143	77	220	1,660	153	83	236	2,100	164	89	253	2,600	178	96	274	3,150	189	102	291	3,770	197	106	303	4,400	207	112	319	5,020	222	120	342	3.7%								
3.8%		583	130	68	198	864	138	73	211	1,190	147	77	224	1,590	157	83	240	2,010	169	89	258	2,490	182	96	278	3,040	194	102	296	3,650	203	107	310	4,230	212	112	324	4,860	228	120	348	3.8%								
3.9%		545	134	69	203	812	142	73	215	1,130	151	77	228	1,520	161	83	244	1,930	173	89	262	2,390	187	96	283	2,920	199	102	301	3,500	208	107	315	4,100	218	112	330	4,700	234	120	354	3.9%								
4.0%		511	137	69	206	766	145	73	218	1,070	155	78	233	1,440	166	83	249	1,840	178	89	267	2,300	192	96	288	2,810	204	102	306	3,390	213	107	320	3,950	223	112	335	4,550	240	120	360	4.0%								
4.1%		479	141	69	210	723	149	73	222	1,010	159	78	237	1,370	170	83	253	1,760	182	89	271	2,200	197	96	293	2,690	209	102	311	3,250	219	107	326	3,820	229	112	341	4,400	246	120	366	4.1%								
4.2%		452	144	69	213	684	153	73	226	960	163	78	241	1,310	174	83	257	1,680	187	89	276	2,110	202	96	298	2,590	214	102	316	3,140	224	107	331	3,680	234	111	345	4,270	252	120	372	4.2%								
4.3%		426	147	68	215	648	156	73	229	912	166	77	243	1,250	178	83	261	1,610	191	89	280	2,020	206	96	302	2,490	220	102	322	3,010	229	107	336	3,570	240	112	352	4,130	258	120	378	4.3%								
4.4%		402	151	69	220	615	160	73	233	868	170	77	247	1,190	182	83	265	1,540	196	89	285	1,940	211	96	307	2,400	225	102	327	2,920	235	107	342	3,440	246	112	358	4,010	264	120	384	4.4%								
4.5%		381	154	68	222	584	164	73	237	827	174	77	251	1,140	186	83	269	1,470	200	89	289	1,860	216	96	312	2,300	230	102	332	2,800	240	107	347	3,340	251	112	363	3,880	270	120	390	4.5%								
4.6%		360	158	69	227	555	167	73	240	788	178	77	255	1,090	190	83	273	1,410	204	89	293	1,780	221	96	317	2,210	235	102	337	2,710	245	107	352	3,220	257	112	369	3,770	276	120	396	4.6%								

FDM 11-10 Exhibit 5.1 Superelevation Tables (emax = 4% and 6%)

4.7%	342	161	69	230	528	171	73	244	752	182	77	259	1,040	194	83	277	1,350	209	89	298	1,710	226	96	322	2,120	240	102	342	2,600	251	107	358	3,120	262	111	373	3,650	282	120	402	4.7%
4.8%	324	165	69	234	502	175	73	248	718	186	78	264	995	199	83	282	1,300	213	89	302	1,640	230	96	326	2,050	245	102	347	2,510	256	107	363	3,000	268	112	380	3,550	288	120	408	4.8%
4.9%	308	168	69	237	478	178	73	251	685	190	78	268	952	203	83	286	1,240	218	89	307	1,580	235	96	331	1,970	250	102	352	2,410	261	107	368	2,910	273	111	384	3,430	294	120	414	4.9%
5.0%	292	171	68	239	456	182	73	255	654	194	78	272	911	207	83	290	1,190	222	89	311	1,510	240	96	336	1,890	255	102	357	2,330	267	107	374	2,800	279	112	391	3,330	300	120	420	5.0%
5.1%	278	175	69	244	434	185	73	258	624	197	77	274	871	211	83	294	1,140	227	89	316	1,450	245	96	341	1,820	260	102	362	2,230	272	107	379	2,720	285	112	397	3,220	306	120	426	5.1%
5.2%	264	178	68	246	413	189	73	262	595	201	77	278	833	215	83	298	1,090	231	89	320	1,390	250	96	346	1,750	266	102	368	2,160	277	107	384	2,610	290	112	402	3,120	312	120	432	5.2%
5.3%	250	182	69	251	393	193	73	266	567	205	77	282	795	219	83	302	1,050	236	89	325	1,340	254	96	350	1,670	271	102	373	2,070	283	107	390	2,530	296	112	408	3,010	318	120	438	5.3%
5.4%	237	185	69	254	373	196	73	269	540	209	77	286	759	223	83	306	995	240	89	329	1,280	259	96	355	1,610	276	102	378	1,990	288	107	395	2,420	301	111	412	2,910	324	120	444	5.4%
5.5%	225	189	69	258	354	200	73	273	513	213	77	290	723	228	83	311	949	244	89	333	1,220	264	96	360	1,530	281	102	383	1,900	293	107	400	2,340	307	112	419	2,800	330	120	450	5.5%
5.6%	212	192	69	261	335	204	73	277	487	217	78	295	687	232	83	315	903	249	89	338	1,160	269	96	365	1,470	286	102	388	1,830	299	107	406	2,230	313	112	425	2,700	336	120	456	5.6%
5.7%	199	195	68	263	316	207	73	280	460	221	78	299	650	236	83	319	856	253	89	342	1,100	274	96	370	1,390	291	102	393	1,730	304	107	411	2,140	318	112	430	2,580	342	120	462	5.7%
5.8%	186	199	69	268	296	211	73	284	431	225	78	303	611	240	83	323	806	258	89	347	1,040	278	96	374	1,320	296	102	398	1,650	309	107	416	2,020	324	112	436	2,460	348	120	468	5.8%
5.9%	171	202	68	270	273	215	73	288	399	228	77	305	567	244	83	327	749	262	89	351	965	283	96	379	1,230	301	102	403	1,530	315	107	422	1,900	329	112	441	2,310	354	120	474	5.9%
6.0%	144	206	69	275	231	218	73	291	340	232	77	309	485	248	83	331	643	267	89	356	833	288	96	384	1,060	306	102	408	1,330	320	107	427	1,660	335	112	447	2,040	360	120	480	6.0%

Adapted from Table 3-9, page 3-43, and Table 3-16a, pages 3-66 thru 3-67, 2018 GDHS

**Legend**

**R** = Minimum curve radius for a given superelevation rate and design speed (feet)

**L** = Superelevation runoff minimum length (feet)

**X** = Tangent Runout (feet)

**T** = Superelevation transition = tangent runout + runoff length = X + L (feet)

**e** = Rate of superelevation (percent)

**NC** = Normal crown slope (assumed 2.0%)

**RC (2.0%)** = Remove adverse crown, superelevate at 2.0%

**Notes**

(1) The R-values in the above table represent the minimum radius for which the corresponding superelevation rate can be used. For example, if the design speed is 70 mph then a 5.5% rate can be used for any radius value from 2800 to 2909 feet (inclusive) - if the radius is 2799 feet then use 5.6%; if the radius is 2910 feet then use 5.4%.

**Do not interpolate superelevation rates.** For example, if the design speed is 70 mph and the radius is 2865 feet then use 5.5% - NOT 5.44%.

(2) On high-type facilities (freeways, expressways and other divided highways) a small increase in runoff length may be appropriate to facilitate drainage needs or to increase the smoothness in the traveled way edge profiles.

(3) Curves whose radius is less than the minimum shown for NC superelevation but more than the minimum shown for RC (2.0%) superelevation shall be provided with RC (2.0%) superelevation.

(4) See equations and example on the last 2 sheets of this Attachment



e<sub>max</sub> = 6%

This chart is for: 4-lane un-divided highway w/ rotation about outside edge; 8-lane un-divided highway w/ rotation about CL; and 8-lane divided highway w/ rotation about median edge

Number of lanes rotated (n<sub>1</sub>) = 4

Adjustment factor (b<sub>w</sub>) = 0.63

Multiple of runoff length relative to 1-lane rotated (n<sub>1</sub> x b<sub>w</sub>) = 2.50

		Design Speed																																												
		25mph				30mph				35mph				40mph				45mph				50mph				55mph				60mph				65mph				70mph								
e (%)		R	L	X	T	R	L	X	T	R	L	X	T	R	L	X	T	R	L	X	T	R	L	X	T	R	L	X	T	R	L	X	T	R	L	X	T	R	L	X	T	R	L	X	T	e (%)
NC		2,290	0	0	0	3,130	0	0	0	4,100	0	0	0	5,230	0	0	0	6,480	0	0	0	7,870	0	0	0	9,410	0	0	0	11,100	0	0	0	12,600	0	0	0	14,100	0	0	0	NC				
RC (2.0%)		1,630	86	86	172	2,240	91	91	182	2,950	97	97	194	3,770	103	103	206	4,680	111	111	222	5,700	120	120	240	6,820	128	128	256	8,060	133	133	266	9,130	140	140	280	10,300	150	150	300	RC (2.0%)				
2.1%		1,540	90	86	176	2,120	95	90	185	2,780	102	97	199	3,560	109	104	213	4,430	117	111	228	5,390	126	120	246	6,450	134	128	262	7,610	140	133	273	8,670	147	140	287	9,720	158	150	308	2.1%				
2.2%		1,450	94	85	179	2,000	100	91	191	2,630	106	96	202	3,370	114	104	218	4,190	122	111	233	5,100	132	120	252	6,110	140	127	267	7,230	147	134	281	8,200	153	139	292	9,240	165	150	315	2.2%				
2.3%		1,370	99	86	185	1,890	105	91	196	2,490	111	97	208	3,190	119	103	222	3,970	128	111	239	4,840	138	120	258	5,800	147	128	275	6,850	153	133	286	7,820	160	139	299	8,780	173	150	323	2.3%				
2.4%		1,300	103	86	189	1,790	109	91	200	2,360	116	97	213	3,030	124	103	227	3,770	133	111	244	4,600	144	120	264	5,520	153	128	281	6,540	160	133	293	7,430	167	139	306	8,380	180	150	330	2.4%				
2.5%		1,230	107	86	193	1,700	114	91	205	2,240	121	97	218	2,880	129	103	232	3,590	139	111	250	4,380	150	120	270	5,250	160	128	288	6,210	167	134	301	7,100	174	139	313	7,990	188	150	338	2.5%				
2.6%		1,170	111	85	196	1,610	118	91	209	2,130	126	97	223	2,740	134	103	237	3,420	144	111	255	4,170	156	120	276	5,020	166	128	294	5,950	173	133	306	6,770	181	139	320	7,660	195	150	345	2.6%				
2.7%		1,110	116	86	202	1,530	123	91	214	2,030	131	97	228	2,610	140	104	244	3,260	150	111	261	3,980	162	120	282	4,780	172	127	299	5,660	180	133	313	6,490	188	139	327	7,320	203	150	353	2.7%				
2.8%		1,050	120	86	206	1,460	127	91	218	1,930	135	96	231	2,490	145	104	249	3,110	156	111	267	3,800	168	120	288	4,580	179	128	307	5,440	187	134	321	6,200	195	139	334	7,030	210	150	360	2.8%				
2.9%		995	124	86	210	1,390	132	91	223	1,840	140	97	237	2,380	150	103	253	2,970	161	111	272	3,640	174	120	294	4,380	185	128	313	5,190	193	133	326	5,970	202	139	341	6,740	218	150	368	2.9%				
3.0%		944	129	86	215	1,320	136	91	227	1,760	145	97	242	2,270	155	103	258	2,840	167	111	278	3,480	180	120	300	4,200	191	127	318	4,990	200	133	333	5,710	209	139	348	6,490	225	150	375	3.0%				
3.1%		896	133	86	219	1,260	141	91	232	1,680	150	97	247	2,170	160	103	263	2,720	172	111	283	3,330	186	120	306	4,020	198	128	326	4,770	207	134	341	5,500	216	139	355	6,230	233	150	383	3.1%				
3.2%		850	137	86	223	1,200	145	91	236	1,600	155	97	252	2,080	166	104	270	2,600	178	111	289	3,200	192	120	312	3,860	204	128	332	4,600	213	133	346	5,280	223	139	362	6,010	240	150	390	3.2%				
3.3%		805	141	85	226	1,140	150	91	241	1,530	160	97	257	1,990	171	104	275	2,490	183	111	294	3,060	198	120	318	3,700	211	128	339	4,400	220	133	353	5,090	230	139	369	5,780	248	150	398	3.3%				
3.4%		761	146	86	232	1,080	155	91	246	1,460	165	97	262	1,900	176	104	280	2,390	189	111	300	2,940	204	120	324	3,560	217	128	345	4,250	227	134	361	4,890	237	139	376	5,580	255	150	405	3.4%				
3.5%		717	150	86	236	1,030	159	91	250	1,390	169	97	266	1,820	181	103	284	2,290	194	111	305	2,820	210	120	330	3,410	223	127	350	4,070	233	133	366	4,730	244	139	383	5,380	263	150	413	3.5%				
3.6%		673	154	86	240	972	164	91	255	1,320	174	97	271	1,740	186	103	289	2,190	200	111	311	2,710	216	120	336	3,290	230	128	358	3,940	240	133	373	4,540	251	139	390	5,210	270	150	420	3.6%				
3.7%		626	159	86	245	918	168	91	259	1,260	179	97	276	1,660	191	103	294	2,100	206	111	317	2,600	222	120	342	3,150	236	128	364	3,770	247	134	381	4,400	258	139	397	5,020	278	150	428	3.7%				
3.8%		583	163	86	249	864	173	91	264	1,190	184	97	281	1,590	197	104	301	2,010	211	111	322	2,490	228	120	348	3,040	243	128	371	3,650	253	133	386	4,230	265	139	404	4,860	285	150	435	3.8%				
3.9%		545	167	86	253	812	177	91	268	1,130	189	97	286	1,520	202	104	306	1,930	217	111	328	2,390	234	120	354	2,920	249	128	377	3,500	260	133	393	4,100	272	139	411	4,700	293	150	443	3.9%				
4.0%		511	171	86	257	766	182	91	273	1,070	194	97	291	1,440	207	104	311	1,840	222	111	333	2,300	240	120	360	2,810	255	128	383	3,390	267	134	401	3,950	279	140	419	4,550	300	150	450	4.0%				
4.1%		479	176	86	262	723	186	91	277	1,010	198	97	295	1,370	212	103	315	1,760	228	111	339	2,200	246	120	366	2,690	262	128	390	3,250	273	133	406	3,820	286	140	426	4,400	308	150	458	4.1%				
4.2%		452	180	86	266	684	191	91	282	960	203	97	300	1,310	217	103	320	1,680	233	111	344	2,110	252	120	372	2,590	268	128	396	3,140	280	133	413	3,680	293	140	433	4,270	315	150	465	4.2%				
4.3%		426	184	86	270	648	195	91	286	912	208	97	305	1,250	222	103	325	1,610	239	111	350	2,020	258	120	378	2,490	274	127	401	3,010	287	133	420	3,570	300	140	440	4,130	323	150	473	4.3%				
4.4%		402	189	86	275	615	200	91	291	868	213	97	310	1,190	228	104	332	1,540	244	111	355	1,940	264	120	384	2,400	281	128	409	2,920	293	133	426	3,440	307	140	447	4,010	330	150	480	4.4%				
4.5%		381	193	86	279	584	205	91	296	827	218	97	315	1,140	233	104	337	1,470	250	111	361	1,860	270	120	390	2,300	287	128	415	2,800	300	133	433	3,340	314	140	454	3,880	338	150	488	4.5%				
4.6%		360	197	86	283	555	209	91	300	788	223	97	320	1,090	238	103	341	1,410	256	111	367	1,780	276	120	396	2,210	294	128	422	2,710	307	133	440	3,220	321	140	461	3,770	345	150	495	4.6%				



FDM 11-10 Exhibit 5.1 Superelevation Tables (emax = 4% and 6%)

4.7%	342	201	86	287	528	214	91	305	752	227	97	324	1,040	243	103	346	1,350	261	111	372	1,710	282	120	402	2,120	300	128	428	2,600	313	133	446	3,120	328	140	468	3,650	353	150	503	4.7%
4.8%	324	206	86	292	502	218	91	309	718	232	97	329	995	248	103	351	1,300	267	111	378	1,640	288	120	408	2,050	306	128	434	2,510	320	133	453	3,000	335	140	475	3,550	360	150	510	4.8%
4.9%	308	210	86	296	478	223	91	314	685	237	97	334	952	253	103	356	1,240	272	111	383	1,580	294	120	414	1,970	313	128	441	2,410	327	133	460	2,910	342	140	482	3,430	368	150	518	4.9%
5.0%	292	214	86	300	456	227	91	318	654	242	97	339	911	259	104	363	1,190	278	111	389	1,510	300	120	420	1,890	319	128	447	2,330	333	133	466	2,800	349	140	489	3,330	375	150	525	5.0%
5.1%	278	219	86	305	434	232	91	323	624	247	97	344	871	264	104	368	1,140	283	111	394	1,450	306	120	426	1,820	326	128	454	2,230	340	133	473	2,720	356	140	496	3,220	383	150	533	5.1%
5.2%	264	223	86	309	413	236	91	327	595	252	97	349	833	269	103	372	1,090	289	111	400	1,390	312	120	432	1,750	332	128	460	2,160	347	133	480	2,610	363	140	503	3,120	390	150	540	5.2%
5.3%	250	227	86	313	393	241	91	332	567	256	97	353	795	274	103	377	1,050	294	111	405	1,340	318	120	438	1,670	338	128	466	2,070	353	133	486	2,530	370	140	510	3,010	398	150	548	5.3%
5.4%	237	231	86	317	373	245	91	336	540	261	97	358	759	279	103	382	995	300	111	411	1,280	324	120	444	1,610	345	128	473	1,990	360	133	493	2,420	377	140	517	2,910	405	150	555	5.4%
5.5%	225	236	86	322	354	250	91	341	513	266	97	363	723	284	103	387	949	306	111	417	1,220	330	120	450	1,530	351	128	479	1,900	367	133	500	2,340	384	140	524	2,800	413	150	563	5.5%
5.6%	212	240	86	326	335	255	91	346	487	271	97	368	687	290	104	394	903	311	111	422	1,160	336	120	456	1,470	357	128	485	1,830	373	133	506	2,230	391	140	531	2,700	420	150	570	5.6%
5.7%	199	244	86	330	316	259	91	350	460	276	97	373	650	295	104	399	856	317	111	428	1,100	342	120	462	1,390	364	128	492	1,730	380	133	513	2,140	398	140	538	2,580	428	150	578	5.7%
5.8%	186	249	86	335	296	264	91	355	431	281	97	378	611	300	103	403	806	322	111	433	1,040	348	120	468	1,320	370	128	498	1,650	387	133	520	2,020	405	140	545	2,460	435	150	585	5.8%
5.9%	171	253	86	339	273	268	91	359	399	285	97	382	567	305	103	408	749	328	111	439	965	354	120	474	1,230	377	128	505	1,530	393	133	526	1,900	412	140	552	2,310	442	150	592	5.9%
6.0%	144	257	86	343	231	273	91	364	340	290	97	387	485	310	103	413	643	333	111	444	833	360	120	480	1,060	383	128	511	1,330	400	133	533	1,660	419	140	559	2,040	450	150	600	6.0%

Adapted from Table 3-9, page 3-43, and Table 3-16a, pages 3-66 thru 3-67, 2018 GDHS

**Legend**

**R** = Minimum curve radius for a given superelevation rate and design speed (feet)

**L** = Superelevation runoff minimum length (feet)

**X** = Tangent Runout (feet)

**T** = Superelevation transition = tangent runout + runoff length = X + L (feet)

**e** = Rate of superelevation (percent)

**NC** = Normal crown slope (assumed 2.0%)

**RC (2.0%)** = Remove adverse crown, superelevate at 2.0%

**Notes**

(1) The R-values in the above table represent the minimum radius for which the corresponding superelevation rate can be used. For example, if the design speed is 70 mph then a 5.5% rate can be used for any radius value from 2800 to 2909 feet (inclusive) - if the radius is 2799 feet then use 5.6%; if the radius is 2910 feet then use 5.4%. **Do not interpolate superelevation rates.** For example, if the design speed is 70 mph and the radius is 2865 feet then use 5.5% - NOT 5.44%.

(2) On high-type facilities (freeways, expressways and other divided highways) a small increase in runoff length may be appropriate to facilitate drainage needs or to increase the smoothness in the traveled way edge profiles.

(3) Curves whose radius is less than the minimum shown for NC superelevation but more than the minimum shown for RC (2.0%) superelevation shall be provided with RC (2.0%) superelevation.

(4) See equations and example on the last 2 sheets of this Attachment

**Table – Adjustment Factors for Number of Lanes Rotated**

Number of lanes rotated (n <sub>1</sub> )	Adjustment factor (b <sub>w</sub> )	Length increase relative to 1-lane rotated (=n <sub>1</sub> b <sub>w</sub> )	Applications
1	1.00	1.00	1-lane ramps regardless of rotation point 2-lane undivided highways w/ rotation about CL.
1.5	0.83	1.25	3-lane TWLTL w/ rotation about CL
2	0.75	1.50	2-lane undivided highways w/ rotation about outside edge 4-lane un-divided highway w/ rotation about CL 4-lane divided highway w/ rotation about median edge
2.5	0.70	1.75	5-lane TWLTL w/ rotation about roadway CL
3	0.67	2.00	3-lane TWLTL w/ rotation about outside edge 6-lane un-divided highway w/ rotation about CL 6-lane divided highway w/ rotation about median edge
4	0.63	2.50	4-lane un-divided highway w/ rotation about outside edge 8-lane un-divided highway w/ rotation about CL 8-lane divided highway w/ rotation about median edge
5	0.60	3.00	5-lane TWLTL w/ rotation about outside edge 10-lane un-divided highway w/ rotation about CL 10-lane divided highway w/ rotation about median edge
<b>Adapted from Eqn 3-23, page 3-63, Eqn 3-24, page 3-70, and Eqn 3-30, Page 3-80, 2018 GDHS</b>			

$L$  = Superelevation runoff minimum length (feet) =  $\frac{(wn_1)e_d}{\Delta} (b_w)$  [Eqn 3-23, page 3-63, 2018 GDHS], where

$w$  = Lane width (feet) = 12-ft (use for consistency and practicality even if lane width used does not = 12-ft);

$n_1$  = Number of lanes rotated;

$e_d$  = Design superelevation rate (%);

$b_w$  = Adjustment factor for number of lanes rotated [Table 3-15, page 3-64, 2018 GDHS]

$\Delta$  = Maximum relative gradient (%) [See pages 3-63 thru 3-88, 2018 GDHS]

$X$  = Tangent Runout (feet) =  $\frac{e_{NC}}{e_d} L_r$  [Eqn 3-24, page 3-70, 2018 GDHS], where:

$e_{NC}$  = Normal cross slope rate (%) [2.0% used]

$e_d$  = Design superelevation rate (%);

$L$  = Superelevation runoff minimum length (feet)

$T$  = Superelevation transition = tangent runout + runoff length =  $X + L$

**Example**

**Find**

Required superelevation (e<sub>d</sub>), runoff (L), tangent runout (X), and TRANSITION (T) for a 2865-ft radius curve on a 4-lane divided freeway with 70-mph design speed and 2.0 % normal cross slope.

**1. Use Equations to find solution**

**Solve for e**

1. Go to the table on p.6 of this attachment and use the e<sub>max</sub>= 6.0% table for 2 lanes rotated
2. Use the columns under 70 mph
3. Go down the "R" column until you reach the 1st value that is less than or equal to the 2865-ft radius value (2800-ft in this case)
4. Use the superelevation associated with that radius (e = 5.5%)  
[2865-ft < R<sub>min</sub> for 5.4% and > R<sub>min</sub> for 5.5%. Therefore, e = 5.5%]

**Solve for L for 2-lanes rotated**

From the table on p. 6: L = 248-feet

Check L using equations from p.9 of this attachment

$$L = \frac{(wn_1)e_d}{\Delta} (b_w) = \frac{(12 \times 2)5.5\%}{0.40\%} (0.75) = 247.5\text{-feet}$$

- Also, L for 1-lane rotated = 165-ft. the relative increase for 2-lanes rotated is 1.5.  
Therefore, L = 1.5 x 165 = 247.5-ft.

**Solve for X for 2-lanes rotated**

From the table on p. 6: X = 90-feet

Check L using equations from p.9 of this attachment

$$X = \frac{e_{NC}}{e_d} L_r = \frac{2\%}{5.5\%} 247.5 = 90\text{-ft (note that this is also = 1.5 times the X-value for 1-lane rotated)}$$

**Solve for T for 2-lanes rotated**

From the table on p. 6: T = 338-feet

Check L using equations from p.9 of this attachment

T = tangent runout + runoff length = X + L = 90 + 247.5 = 337.5-ft

**2. Use attached spreadsheet to find solution**

Link to spreadsheet file:

[FDM 11-10 E5.1 File 1](#)

1 Open spreadsheet file by clicking link above.

2 Open sheet "SE comp help"

3 Select design speed

4 Select e<sub>max</sub>

5 Enter a radius value

6 Select number of lanes rotated

INPUT		COMP AREA (DO NOT MODIFY)	
Design Speed (mph)	70	comp row number for formula input	37
e <sub>max</sub> (4% or 6%)	6%	rounding for length values	0
R (ft) - (range = 2,040-ft @ 6% to 14,100-ft @ NC)	2865	comp SE	5.50%
Number of Lanes rotated [n <sub>i</sub> ] (1, 1.5, 2, 2.5, 3, 4, or 5)	2	comp L	165
Design Speed=70 mph ; e <sub>max</sub> =6% ; R=2,865-ft ; number of lanes rotated = 2 ; SE rate=5.5% ; L=248-ft ; X=90-ft ; T=338-ft		comp X	60
		comp T	225
RESULTS		Min. R for e <sub>max</sub>	2040
		Min. R for NC	14100
Degree of Curve (D) (in decimal degrees)	1.9999		
Adjustment Factor (b <sub>w</sub> )	0.750		
Mult. of L rel. to 1-lane rotated (n <sub>i</sub> x b <sub>w</sub> )	1.500		
S.E. rate	5.5%		
L req'd	248		
X req'd	90		
T req'd	338		