

Slopes for Skewed Culvert Sections

THESE TABLES ARE BASED ON THE FOLLOWING FORMULA:

- θ = SKEW ANGLE
 S = SKEWED SLOPE
 $R = \frac{\text{SECANT } \theta}{R \pm (0.016 \text{ TANG } \theta)}$
 G = % OF GRADE AT SHLDR.
 $S = \frac{R}{G}$
 $R = \frac{1}{\text{NORMAL ROWY. SLOPE}}$
 $G = \% \text{ OF GRADE AT SHLDR.}$
 USE + SIGN FOR DOWN GRADE
 SIDE OF SKEW SECT.
 USE - SIGN FOR UP GRADE
 SIDE OF SKEW SECT.

IF SKEWED SECTION IS ON A VERTICAL CURVE, THE "G" ABOVE MAY BE OBTAINED BY THE FOLLOWING FORMULA:

$$G = G_d \pm \left(\frac{Y}{K}\right)$$

- G = % OF GRADE AT SHOULDER
 G_d = % OF GRADE BACK FROM P.C. OF VERTICAL CURVE.
 (USE THE ALGEBRAIC SIGN OF THIS GRADE)
 Y = DISTANCE IN FEET FROM P.C. OF VERTICAL CURVE TO THE POINT WHERE THE SKEWED SECT INTERSECTS THE SHOULDER.
 USE + SIGN FOR A + VERTICAL CURVE
 USE - SIGN FOR A - VERTICAL CURVE

EXPLANATION OF TABLE

- THE SLOPES FOR ANY GRADE MAY BE OBTAINED BY INTERPOLATION.
 SLOPES IN COLUMNS "U" ARE TO BE USED ON THE SIDE OF SECTION WHICH IS UP GRADE.
 SLOPES IN COLUMNS "D" ARE TO BE USED ON THE SIDE OF SECTION WHICH IS DOWN GRADE.
 FOR NORMAL SLOPES OTHER THAN THOSE SHOWN OR ODD SKEW ANGLES - USE FORMULA.

% OF GRADE	SKEW ANGLES																	
	5°		10°		15°		20°		25°		30°		35°		40°		45°	
	U	D	U	D	U	D	U	D	U	D	U	D	U	D	U	D	U	D
0.00	2.01		2.03		2.07		2.13		2.21		2.31		2.44		2.61		2.83	
1.00	2.01	2.00	2.04	2.02	2.08	2.06	2.14	2.11	2.23	2.19	2.34	2.28	2.47	2.41	2.56	2.52	2.68	2.77
2.00	2.01	2.00	2.05	2.02	2.09	2.05	2.16	2.10	2.25	2.17	2.36	2.28	2.51	2.39	2.70	2.53	2.95	2.12
3.00	2.02	2.00	2.05	2.01	2.10	2.04	2.18	2.08	2.27	2.15	2.39	2.23	2.55	2.34	2.75	2.49	3.01	2.67
4.00	2.02	1.99	2.06	2.00	2.12	2.03	2.19	2.07	2.29	2.13	2.42	2.21	2.59	2.31	2.80	2.45	3.07	2.62
5.00	2.03	1.99	2.07	2.00	2.13	2.02	2.21	2.05	2.31	2.11	2.45	2.18	2.63	2.28	2.85	2.41	3.14	2.57
6.00	2.03	1.99	2.07	1.99	2.14	2.01	2.23	2.04	2.34	2.09	2.48	2.16	2.67	2.25	2.90	2.37	3.21	2.53
7.00	2.03	1.98	2.08	1.98	2.15	2.00	2.24	2.03	2.36	2.07	2.51	2.14	2.71	2.22	2.96	2.34	3.29	2.48
8.00	2.04	1.98	2.09	1.98	2.16	1.99	2.26	2.01	2.38	2.05	2.54	2.11	2.75	2.20	3.02	2.30	3.37	2.44
9.00	2.04	1.98	2.10	1.97	2.18	1.98	2.28	2.00	2.41	2.04	2.58	2.09	2.79	2.17	3.08	2.27	3.45	2.40
10.00	2.04	1.97	2.11	1.96	2.19	1.97	2.30	1.98	2.43	2.02	2.61	2.07	2.84	2.14	3.14	2.24	3.54	2.36
11.00	2.05	1.97	2.11	1.96	2.20	1.96	2.31	1.97	2.46	2.00	2.65	2.05	2.88	2.12	3.20	2.20	3.63	2.32
12.00	2.05	1.97	2.12	1.95	2.21	1.95	2.33	1.96	2.48	1.98	2.68	2.03	2.93	2.09	3.27	2.17	3.72	2.28
0.00	3.31		3.05		3.11		3.19		3.31		3.46		3.66		3.92		4.24	
1.00	3.07	3.00	3.06	3.03	3.13	3.08	3.22	3.16	3.36	3.26	3.53	3.40	3.74	3.59	4.02	3.82	4.37	4.12
2.00	3.03	3.00	3.08	3.01	3.16	3.06	3.26	3.12	3.41	3.22	3.60	3.35	3.82	3.52	4.12	3.73	4.51	4.00
3.00	3.04	2.99	3.10	3.00	3.18	3.03	3.30	3.09	3.46	3.18	3.66	3.29	3.91	3.45	4.23	3.64	4.66	3.89
4.00	3.04	2.98	3.11	2.98	3.21	3.01	3.34	3.06	3.51	3.13	3.72	3.24	4.00	3.38	4.35	3.56	4.82	3.79
5.00	3.05	2.97	3.13	2.97	3.24	2.99	3.38	3.03	3.56	3.09	3.79	3.19	4.09	3.31	4.49	3.48	4.99	3.69
6.00	3.06	2.96	3.15	2.95	3.26	2.96	3.42	3.00	3.61	3.05	3.87	3.14	4.19	3.25	4.61	3.40	5.17	3.60
7.00	3.07	2.96	3.16	2.94	3.29	2.94	3.46	2.97	3.67	3.01	3.94	3.09	4.29	3.19	4.75	3.33	5.37	3.51
8.00	3.08	2.95	3.18	2.93	3.32	2.92	3.50	2.94	3.73	2.98	4.02	3.04	4.40	3.14	4.90	3.26	5.58	3.42
9.00	3.08	2.94	3.20	2.91	3.35	2.90	3.54	2.91	3.79	2.94	4.10	3.00	4.52	3.08	5.06	3.19	5.81	3.35
10.00	3.09	2.93	3.22	2.89	3.38	2.87	3.58	2.88	3.85	2.90	4.19	2.95	4.64	3.02	5.23	3.13	6.06	3.26
11.00	3.10	2.93	3.23	2.88	3.41	2.85	3.63	2.85	3.91	2.87	4.28	2.91	4.76	2.97	5.42	3.07	6.33	3.19
12.00	3.11	2.92	3.25	2.86	3.44	2.83	3.67	2.82	3.98	2.83	4.37	2.87	4.90	2.92	5.61	3.01	6.63	3.12
0.00	4.02		4.06		4.14		4.26		4.41		4.62		4.88		5.22		5.66	
1.00	4.03	4.00	4.09	4.03	4.19	4.10	4.32	4.20	4.50	4.33	4.73	4.51	5.02	4.75	5.40	5.05	5.89	5.44
2.00	4.04	3.99	4.12	4.01	4.23	4.05	4.38	4.14	4.58	4.25	4.84	4.41	5.17	4.82	5.60	4.89	6.15	5.24
3.00	4.06	3.97	4.15	3.99	4.28	4.01	4.45	4.08	4.67	4.18	4.96	4.32	5.33	4.50	5.81	4.74	6.43	5.05
4.00	4.07	3.96	4.18	3.95	4.33	3.97	4.52	4.02	4.77	4.11	5.09	4.23	5.50	4.39	6.03	4.60	6.73	4.88
5.00	4.09	3.95	4.21	3.92	4.38	3.93	4.59	3.97	4.87	4.04	5.22	4.14	5.68	4.28	6.27	4.47	7.07	4.71
6.00	4.10	3.93	4.24	3.89	4.43	3.89	4.66	3.91	4.97	3.97	5.36	4.06	5.87	4.18	6.54	4.35	7.44	4.56
7.00	4.12	3.92	4.27	3.87	4.48	3.85	4.74	3.86	5.08	3.90	5.51	3.98	6.07	4.08	6.83	4.23	7.86	4.42
8.00	4.13	3.91	4.30	3.84	4.53	3.81	4.82	3.81	5.19	3.84	5.67	3.90	6.29	3.99	7.14	4.12	8.32	4.29
9.00	4.15	3.89	4.34	3.82	4.58	3.77	4.90	3.76	5.30	3.79	5.83	3.82	6.53	3.90	7.49	4.01	8.84	4.16
10.00	4.16	3.88	4.37	3.79	4.64	3.74	4.98	3.72	5.43	3.72	6.01	3.75	6.76	3.81	7.88	3.91	9.43	4.04
11.00	4.18	3.87	4.40	3.77	4.69	3.70	5.07	3.67	5.56	3.66	6.19	3.68	7.06	3.73	8.28	3.81	10.10	3.93
12.00	4.19	3.85	4.44	3.74	4.75	3.67	5.16	3.62	5.69	3.61	6.39	3.62	7.36	3.65	8.74	3.72	10.68	3.82
0.00	6.02		6.09		6.21		6.39		6.62		6.93		7.32		7.83		8.49	
1.00	6.05	5.99	6.16	6.03	6.31	6.11	6.53	6.25	6.81	6.44	7.18	6.70	7.65	7.03	8.25	7.46	9.03	8.00
2.00	6.09	5.96	6.22	5.97	6.42	6.02	6.68	6.12	7.01	6.27	7.44	6.48	8.00	6.76	8.71	7.12	9.64	7.58
3.00	6.12	5.93	6.29	5.91	6.53	5.93	6.83	5.99	7.23	6.11	7.73	6.28	8.38	6.50	9.23	6.80	10.35	7.19
4.00	6.15	5.90	6.36	5.85	6.64	5.84	7.00	5.87	7.45	5.95	8.04	6.08	8.80	6.27	9.81	6.52	11.16	6.84
5.00	6.19	5.87	6.43	5.79	6.75	5.75	7.17	5.76	7.70	5.81	8.33	5.91	9.27	6.05	10.47	6.26	12.12	6.53
6.00	6.22	5.84	6.51	5.73	6.87	5.67	7.35	5.65	7.96	5.67	8.75	5.74	9.79	5.85	11.22	6.02	13.26	6.24
7.00	6.25	5.81	6.58	5.67	7.00	5.58	7.54	5.54	8.23	5.54	9.15	5.58	10.38	5.66	12.09	5.79	14.63	5.98
8.00	6.29	5.78	6.66	5.62	7.13	5.50	7.74	5.44	8.53	5.41	9.58	5.42	11.03	5.48	13.11	5.58	16.32	5.73
9.00	6.32	5.75	6.73	5.56	7.26	5.43	7.95	5.34	8.85	5.29	10.07	5.28	11.78	5.31	14.32	5.39	18.95	5.51
10.00	6.36	5.72	6.81	5.51	7.40	5.35	8.17	5.24	9.19	5.17	10.60	5.15	12.63	5.18	15.77	5.21	21.21	5.30
11.00	6.39	5.69	6.89	5.46	7.55	5.28	8.40	5.15	9.58	5.06	11.19	5.02	13.62	5.01	17.55	5.04	24.86	5.11
12.00	6.43	5.67	6.98	5.41	7.70	5.21	8.65	5.06	9.97	4.96	11.86	4.89	14.77	4.87	19.79	4.88	30.30	4.93

2:1 NORMAL SLOPE

3:1 NORMAL SLOPE

4:1 NORMAL SLOPE

6:1 NORMAL SLOPE