RAMSEY COUNTY

I.C.C. PAVEMENT

Job No(2302-2355)

DIETZGEN

ENGINEERS'

FIELD BOOK

No. 403

MATERIALS + TESTS

Distances from Center of Roadway for Cross-Sectioning

Roadway 16 feet wide. Side Slopes 1 on 1.
For Single Track Embankment.

H	0	.1	.2	.3	.4	.5	.6	.7	.8	.9	H
0	8.0	8.1	8.2	8.3	8.4	8.5	8.6	8.7	8.8	8.9	0
1	9.0	9.1	9.2	9.3	9.4	9.5	9.6	9.7	9.8	9.9	1
2	10.0	10.1	10.2	10.3	10.4	10.5	10.6	10.7	10.8	10.9	2
3	11.0	11.1	11.2	11.3	11.4	11.5	11.6	11.7	11.8	11.9	3
4	12.0	12.1	12.2	12.3	12.4	12.5	12.6	12.7	12.8	12.9	4
5	13.0	13.1	13.2	13.3	13.4	13.5	13.6	13.7	13.8	13.9	5
6	14.0	14.1	14.2	14.3	14.4	14.5	14.6	14.7	14.8	14.9	6
7	15.0	15.1	15.2	15.3	15.4	15.5	15.6	15.7	15.8	15.9	7
8	16.0	16.1	16.2	16.3	16.4	16.5	16.6	16.7	16.8	16.9	8
9	17.0	17.1	17.2	17.3	17.4	17.5	17.6	17.7	17.8	17.9	9
10	18.0	18.1	18.2	18.3	18.4	18.5	18.6	18.7	18.8	18.9	10
11	19.0	19.1	19.2	19.3	19.4	19.5	19.6	19.7	19.8	19.9	11
12	20.0	20.1	20.2	20.3	20.4	20.5	20.6	20.7	20.8	20.9	12
13	21.0	21.1	21.2	21.3	21.4	21.5	21.6	21.7	21.8	21.9	13
14	22.0	22.1	22.2	22.3	22.4	22.5	22.6	22.7	22.8	22.9	14
15	23.0	23.1	23.2	23.3	23.4	23.5	23.6	23.7	23.8	23.9	15
16	24.0	24.1	24.2	24.3	24.4	24.5	24.6	24.7	24.8	24.9	16
17	25.0	25.1	25.2	25.3	25.4	25.5	25.6	25.7	25.8	25.9	17
18	26.0	26.1	26.2	26.3	26.4	26.5	26.6	26.7	26.8	26.9	18
19	27.0	27.1	27.2	27.3	27.4	27.5	27.6	27.7	27.8	27.9	19
20	28.0	28.1	28.2	28.3	28.4	28.5	28.6	28.7	28.8	28.9	20
21	29.0	29.1	29.2	29.3	29.4	29.5	29.6	29.7	29.8	29.9	21
22	30.0	30.1	30.2	30.3	30.4	30.5	30.6	30.7	30.8	30.9	22
23	31.0	31.1	31.2	31.3	31.4	31.5	31.6	31.7	31.8	31.9	23
24	32.0	32.1	32.2	32.3	32.4	32.5	32.6	32.7	32.8	32.9	24
25	33.0	33.1	33.2	33.3	33.4	33.5	33.6	33.7	33.8	33.9	25
26	34.0	34.1	34.2	34.3	34.4	34.5	34.6	34.7	34.8	34.9	26
27	35.0	35.1	35.2	35.3	35.4	35.5	35.6	35.7	35.8	35.9	27
28	36.0	36.1	36.2	36.3	36.4	36.5	36.6	36.7	36.8	36.9	28
29	37.0	37.1	37.2	37.3	37.4	37.5	37.6	37.7	37.8	37.9	29
30	38.0	38.1	38.2	38.3	38.4	38.5	38.6	38.7	38.8	38.9	30
31	39.0	39.1	39.2	39.3	39.4	39.5	39.6	39.7	39.8	39.9	31
32	40.0	40.1	40.2	40.3	40.4	40.5	40.6	40.7	40.8	40.9	32
33	41.0	41.1	41.2	41.3	41.4	41.5	41.6	41.7	41.8	41.9	33
34	42.0	42.1	42.2	42.3	42.4	42.5	42.6	42.7	42.8	42.9	34
35	43.0	43.1	43.2	43.3	43.4	43.5	43.6	43.7	43.8	43.9	35
36	44.0	44.1	44.2	44.3	44.4	44.5	44.6	44.7	44.8	44.9	36
37	45.0	45.1	45.2	45.3	45.4	45.5	45.6	45.7	45.8	45.9	37
38	46.0	46.1	46.2	46.3	46.4	46.5	46.6	46.7	46.8	46.9	38
39	47.0	47.1	47.2	47.3	47.4	47.5	47.6	47.7	47.8	47.9	39
40	48.0	48.1	48.2	48.3	48.4	48.5	48.6	48.7	48.8	48.9	40

Example—If point is 22.6 ft. above grade, how far should it be from center line to be a slope stake point? Ans. from Table 30.6. For same slopes but other widths of roadbed, correct above figures by one-half difference in width of roadbed; thus in example above, for 20 ft. roadbed distance will be 30.6+(20—16)÷2 or 2 ft. added to 30.6 =32.6. For slopes of 1 on 1½ see inside of back cover.

Hanlon & Oakes - Contractors
Job Let - 5/21/23
Grading Started -
Paving Started -
Shoulders " -

Grading Completed
Paving "
Shoulders "

Cement Received

Date Reed & Reported	Car Initial	Car No	No Bbls	Source or Brand	Tested by
6/19/23	C+NW	170,464	253	Mason City Lehigh	Quinlan Hall
"	B+O	107,990	235	"	"
6/20/23	FDD+S	6042	173	"	"
"	C+N.W	143,274	227	"	"
6/21/23	L.V?	75139	173	"	"
"	Penn	534587	308	"	"
"	Penn	15,584	308	"	"
6/22-23	Soo	33,076	244	"	"
6/27/23	N.Y.C.	241,317	238	"	"
"	C.G.W	36,056	173	"	"
6/28/23	C.N.W	114,820	250	"	"
7/9/23	C.G.W	21592	173	"	"
"	"	35474	"	"	"
7/11	"	35552 OK	"	"	"
7/12	P+M	41797	"	"	"
7/13/23	I.C	34,167	260	"	"
"	M+St.L	12362	173	"	"
7/14/23	Penn	538060	265	"	"
7/16/23	C.M+St.P	58254	173	"	"
"	SLSE	21126	173	"	"
7/16/23	FD.D+S	7522	173	"	"
7/19/23	CM+St.P	203,449	231	"	"
	M.C.	35,259	"	"	"
7/5/23	Penn	863,437	"	"	No Test
"	IC	312,444	"	"	"

Remarks

Approved for Payment	Test Report Recd	28 Day	Remarks
9/6/23 ✓	✓ 6/28/23	✓	
9/6/23 ✓	✓ 6/28/23	✓	QA Halls No = B40 170,990
9/6/23 ✓	6/29/23 ✓ Also tested by highway Dept	✓	
9/6/23 ✓	✓ 6/29/23	✓	
9/6/23 ✓	✓ 7/2/23	✓	
9/6/23 ✓	✓ 6/30/23	✓	
9/6/23 ✓	✓ 7/2/23	✓	
9/6/23 ✓	✓ 6/29/23	✓	
9/6/23 ✓	✓ 〃	✓	
9/6/23 ✓	✓ 7/6/23	✓	
9/6/23 ✓	7/8/23	✓	Also Tested by Minn Highway Dept
9/6/23	7/17/23	✓	
9/6/23	7/17/23	✓	Note - QA Halls Car No - CGW 35474
9/6/23	7/17/23	✓	Note QA Halls Car No given as CGW 25552
9/6/23	7/18/23	✓	
9/6/23	7/20/23 ✓		QA Halls reports I.C. 341,674 - Correct
9/6/23	7/20/23 ✓		
9/6/23	7/21/23 ✓		
9/6/23	7/24/23 ✓		
9/6/23	7/24/23 ✓		QA Hall reports Frisco 31,176
9/6/23	7/24/23 ✓		
9/6/23	7/25/23 ✓		
9/6/23	7/25/23 ✓		

Note - No tests were obtained on these cars

Cement Received

Date Recd Reported	Car Initial	Car No	No Bbls	Source or Brand	Tested by
7/20/23	N.Y.C.	256,194	231	Lehigh	G.A. Hall
"	NKP	27,485	231 ✓	"	"
7/23/23	MLI	35249	260 ✓	"	"
	HTC	11546	260 ✓	"	"
7/24/23	DRGW	62483	231 ✓	"	"
7/25/23	P.M	70313	235 ✓	"	"
7/26/23	Erie	93,862	234	"	"
	CNW	132308	236 ✓	"	"
7/28/23	Penn	540224	260 ✓	"	"
7/30/23	PMcK	81476	260 ✓	"	"
7/31/23	N.P.	39329	250	"	"
8/1/23	Penn	510007	231 ✓	"	"
"	"	92656	231 ✓	"	"
8/2/23	M.P.	30962	173 ✓	"	"
"	M&St.L	4688	231 ✓	"	"
8/3/23	C B & Q	100605	246 ✓	"	"
~~8/4/23~~	~~U.P.~~	~~84768~~			
8/6/23	M&St.L	19786	245 ✓	"	"
	Penn	24612	231 ✓	"	"
	"	531152	260 ✓	"	"
8/8/23	B&O	196486	238 ✓	"	"
	Soo	38957	231 ✓		
8/10/23	M&St.L.	19486	244 ✓	"	"
	N.Y.C	242547	231 ✓	"	"

Test Reports Received	Approved for Payment	Remarks.
~~Approved for Payment~~	~~Tests Report Recd.~~	Remarks
7/27/23 ✓	9/6/23	
7/27/23 ✓	9/6/23	
7/28/23 ✓	9/6/23	
7/28/23 ✓	9/6/23	
7/31/23 ✓	9/6/23	
7/31/23 ✓	9/6/23	
7/27/23 ✓	9/6/23	
7/31/23 ✓	9/6/23	
8/1/23 ✓	9/6/23	
8/2/23 ✓	9/6/23	
8/7/23 ✓	9/6/23	
8/2/23 ✓	9/6/23	
8/2/23 ✓	9/6/23	
8/13/23 ✓	9/6/23	
8/19/23 ✓	9/6/23	
8/13/23 ✓	9/6/23	
8/13/23 ✓	9/6/23	
8/15/23 ✓	✓7/27/23	
8/15/23 ✓	✓9/27/23	
8/15/23 ✓	✓9/27/23	
8/15/23 ✓	9/27/23	
8/16/23 ✓	✓9/27/23	
8/16/23 ✓	✓9/27/23	

Cement Received

Date Reed & Reported	Car Initial	Car No	No Bbls	Source or Brand	Tested by
8/11/23	CB&Q	117573	247 ✓	Lehigh	QA Hall
8/13/23	Soo	36036	243 ✓	"	"
8/17/23	N.Y.C	245547	231 ✓	"	"
8/18/23	B&O	204450	231 ✓	"	"
	N.Y.C	191707	231 ①	"	"
8/19/23	N.W.	120365	28 60 ✓	"	
8/20/23	C.G.W	22756	(231)	"	"
8/21/23	N.Y.C.	208707	231 ✓	"	
8/28/23	Penn	19326	231 ✓	"	
"	R.I	155741	231 ✓	"	"
8/31/23	Erie	88396	234	"	"
	R.I	44706	(231)	"	"
	N.P	100518	240	"	"
9/15/23	I.C	224350	234 ✓	"	"
9/17/23	I.C	141021	260 ✓	"	"
9/19/23	I.C	170476	236 ✓	"	"
9/20/23	I.C	340584	260 ✓	"	"
	I.C	26515	231 ✓	"	"
	M St P	500959	239 ✓	"	"
9/22/23	Wabash	79793	231 ✓	"	"
	I.C	24545	243 ✓	"	"
9/24/23	S.L.S.F	130108	231 ✓	"	"
	Penn	67376	231 ✓	"	"
	Soo	24780	187 193	"	"

Test Report Rec'd Approved for Payment	Approved for Payment Tests Reports Received	Remarks
8/16/23 ✓	9/27/23	
8/17/23 ✓	9/27/23	
8/19/23 ✓	9/27/23	
8/22/23 ✓	9/27/23	
8/29/23 ✓	9/27/23	
8/27/23 ✓	9/27/23	
8/27/23 ✓	9/27/23	
9/17/23	9/27/23	
9/4/23 ✓	9/27/23	
9/5/23 ✓	9/27/23	
9/7/23 ✓	9/27/23	
9/6/23 ✓	9/27/23	
9/19/23 ✓	10/26/23	
9/21/23 ✓	10/26/23	
9/21/23 ✓	10/26/23	
9/27/23 ✓	10/26/23	
9/20/23 ✓	10/26/23	
9/19/23 ✓	10/26/23	
9/24/23 ✓	10/26/23	
9/20/23 ✓	10/26/23	
10/2/23 ✓	10/26/23	
10/2/23 ✓	10/26/23	QA Hall reports Penn 673 26 - 231 bbls.
10/2/23 ✓	10/26/23	

Date Recd & Reported	Car Initial	Car Number	No Bbls	Source & Brand	Tested by
9/25/23	C.A	38971	260 ✓	Lehigh	G.A Hall
	ATSF	19246	144 ✓	"	"
9/27/23	So:	37588	173 ✓	"	"
	I C	25098	231	"	"
9/29/23	M&St.L.	19728	244 ✓	"	"
	Penn.	18540	231 ✓	"	"
	I C	172538	236 ✓	"	"
9/30/23	cc&stL.	52393	231 ✓	"	"
	I.C.	245,628	232 ✓	"	"

7 Day Report	28 Day Report	Approved for Payment	
10/12/23	10/19/23	10/26/23	
10/12/23	10/19/23	10/26/23	
9/29/23	10/22/23	10/26/23	
10/12/23	10/22/23	10/26/23	231 bbls Q A Hall reports IC 29598
10/1/23	10/23/23	10/26/23	
10/4/23	10/19/23	10/26/23	
10/1/23	10/19/23	10/26/23	
10/1/23	10/23/23	10/26/23	
10/12/23	10/27/23	10/26/23	

Sand Received on Job.

Date Recd & Reported	Car Initial	Car No	No Cu. Yds	Source	Tested by
6/18/23	C+A	12560		Mpls Wonders	Lab
"	Soo	9291		"	"
6/20/23	Soo	9253		"	Wasgatt
"	M.St.P+SSM	9269		"	"
"	"	9255		"	"
6/21/23	I.C.	203,445		"	"
	Soo	9217		"	"
	"	2405		"	"
	"	3257		"	"
	"	9103		"	"
	"	9057		"	"
6/22/23	B+L.E	12,889		"	Christleib
"	C+N.W	15338		"	"
6	Soo	9257		"	"
6/22/23	C+NW	15334		"	"
"	Soo	9093		"	"
"	Soo	9117		"	"
6/25/23	"	9095		"	"
6/27/23	"			"	
6/29/23	C+A	40915		"	"
6/30/23	Soo	9093		"	"
"	"	9137		"	"
7/2/23	"	9117		"	"

Remarks

S 2301
S 2302

Sand Received on Job

Date Reed & Reported	Car Initial	Car No	No Cu. Yds	Source	Tested by
7/3/23	Soo	9257		John Wonder	Chriestleeb
7/5/23	"	65421		"	"
	"	3597		"	"
	"	9221		"	"
7/6/23	"	9291		"	"
7/10/23	NYC	332,045		"	Burmingham "
7/12/23	Soo	9115		"	"
~~7/13/23~~	~~I.C.~~	~~34,167~~			
7/13/23	P&LE	1556		"	"
7/14/23	CEI	13415		"	"
"	Penn	316,839		"	"
7/17/23	by Truck		60	"	"
7/18/23	WLE	72889		"	"
	B&O	251227		"	"
	Soo	3527		"	"
	"	3073		"	"
	TOC	23839		"	"
7/19/23	GN.	70241		Lander Morrison & Christenson Mpls	"
	"	70514			"
	"	71121			"
	Soo	9137		Wonder,	"
7/20/23	GN	70103		Landers Morrison Christenson	"
"	"	70773		"	"
"	"	71257		"	"
"	"	70,008		"	"

Sand Received on Job

Date Reed & Reported	Car Initial	Car No	No Cu. Yds	Source	Tested by
7/20/23	GN.	70008		Landers Morrison	Bermimham
"	Soo	66507		John Wonders	"
"	CCC&StL	70465		"	"
"	NYC	332412		"	"
7/21/23	Soo	66419		"	"
	"	9113		"	"
	Penn.	316839		"	"
	GN.	70,438		Landers Morrison	"
	"	71051		"	"
7/23/23	CCC&StL	377110		John Wonders	"
	Penn	870410		"	"
	I.C.	129169		"	"
7/24/23	Soo	3321		"	"
	"	6000		"	"
	NW	92805		"	"
	ICC	3838		"	"
	Soo	3073		"	"
	"	9609		"	"
	See report # 39 and 40				

Sand Received on Job

Date Rec'd & Reported	Car Initial	Car No	No Cu. Yds	Source	Tested by

Rock Received on Job.

Date Reed & Reported	Car Initial	Car No	No Cu. Yds	Source	Tested by
6/15/23	I. C.	312,444		Dresser Junction	W.S. Mack
"	Penn	270,006		"	"
"	P & R	28,986		"	"
"	T & O.C	24,904		"	"
"	K.C.S.	27,697		"	"
"	M.St.P.&S.M	9203		"	"
6/18/23	S.L & S.F	70,125		"	No Test
"	NIC	12,754		"	Wasgatt
"	Soo	9071			"
"	M.P.	72,467		"	"
"	Montour	7356		"	"
"	Penn	356,243		"	No Tests
"	Soo	9137		"	"
"	NW	90750		"	"
"	Penn	335,007		"	Wasgatt
"	P	59565		"	"
"	B&O	236,668		"	No Test
"	Soo	9199		"	"
"	"	9223		"	"
"	Penn	285,507		"	"
6/19/23	P & R	7336		"	Wasgatt
"	M.P	70,206		"	"
"	L & N	62471		"	"
"	Penn	863,644		"	"

Rock Received on Job

Date Recd & Reported	Car Initial	Car No	No Cu. Yds	Source	Tested by
~~CRI~~ 6/19/23	C R R	85040		Dresser Junction	Wasgatt
6/20/23	NW	49350		"	"
"	N&W	49836		"	"
"	CC&St.L	77,627		"	"
6/21/23	Soo	9291		"	C.A. Olson at Dresser Junction
	"	9271		"	"
	"	9149		"	"
6/22/23	MSS&M MST.P	3597		"	Wasgatt
"	EJ&E	22605		"	"
"	Soo	65389		"	"
"	Erie	A1741		"	C.A. Olson Dresser Jct
"	Penn	335,805		"	"
"	Penn	853,437		"	"
	C&A	22171		"	"
	L&N	32,607		"	"
	Soo	9137		"	"
6/23/23	Penn	820717		"	"
	Soo of N.Y.	277,634		"	"
6/24/23	C.RR	85,040		"	Christie
"	Penn.	270,006		"	Dresser Jct
"	~~RR~~ P&R	28,986		"	"
"	I.C.	123,381		"	"
6/26/23	Soo	60,005		"	"
	N.Y.C.	345537		"	"

Rock Received on Job

Date Recd & Reported	Car Initial	Car No	No Cu. Yds.	Source	Tested by
6/26/23	Soo	65,389		Dresser Junction	C.A. Olson Dres. Jct.
"	"	9115		"	"
"	"	66,321		"	"
"	"	9197		"	"
6/27/23	"	9223		"	"
"	I.C.	128,128		"	"
"	Penn.	863,644		"	Christie
"	Soo	65,421		"	"
"	"	9221		"	"
"	N&W	49836		"	"
6/28/23	Soo	3597		"	"
"	H.V.	21193		"	"
"	M.P.	62,775		"	"
"	I.C	312,411		"	"
"	Soo	9291		"	"
"	"	9057		"	"
"	L.V.	29631		"	"
6/29/23	L&N	32607		"	"
"	Penn	853437		"	"
"	I.C.	312,444		"	"
7/7/23	Soo	9103		"	"
"	"	9057		"	"
"	C&A	12560		"	"
"	U.RR	5998		"	"

Rock Received on Job

Date Recd & Reported	Car Initial	Car No	No Cu. Yds	Source	Tested by
7/7/23	IC	312,444		Dresser Junction	Christlieb
7/10/23	PRCT	7636		"	Birmingham
"	B.L.E	13052		"	"
"	C&O	37,487		"	"
7/11/23	J.E	22605		"	"
"	BL&E	12889		"	"
	L&N	32607		"	"
7/12/23	PCNN	870717		"	"
"	MP	69423		"	"
"	CE	11511		"	"
"	CINN	15334		"	"
"	D.S.L.	34164		"	"
7/13/23	L.V	29631		"	"
"	Soo	9093		"	"
7/14/23	L&N	62,471		"	"
	IC	312,411		"	"
	Penn	863,644		"	"
7/16/23	FDDS.	7522		"	"
"	NYC	315,414		"	"
"	Wabash	7625		"	"
"	IC	123,223		"	"
7/17/23	N.W	49836		"	"
	IC	88525		"	"
	IC	126,934		"	"

Rock Received on Job

Date Recd & Reported	Car Initial	Car No	No Cu. Yds	Source	Tested by
7/17/23	M.C	13,463		Dresser Junction	Bermingham
7/18/23	Soo	9217		"	"
	IC	200108		"	"
	L&N	79901		"	"
	L&N	34681		"	"
	"	74130		"	"
	NYC	330373		"	"
7/20/23	IC	96221		"	"
7/23/23	HV.	21193		"	"
	CEI	74951		"	"
7/24/23	O.P.	21625		"	"

Rock Received on Job

Date Recd & Reported	Car Initial	Car No	No Cu. Yds	Source	Tested by

Field Tests on Rock

Date	Passing 2 3/4"	Pass 2"	Pass 1"	Pass 1/4	Pass 1/8"
6/15/23	100	95.4	24.1	1.14	0.57
"	100	100.0	23.9	1.20	0.60
"	100	100	31.9	1.10	0.55
"	100	100	31.1	1.10	0.55
"	100	100	27.9	2.3	1.1
6/18/23	100	100	21.25	0.06	0.02
"	100	100	21.25	0.06	0.02
"	100	100	15.0	0.06	0.02
"	100	100	15.0	0.06	0.02
"	100	100	15.0	0.06	0.06
"	100	100	15.0	0.06	0.06
6/19/23	100	100	38.8	2.8	0.7
	100	100	25.0	2.0	0.7
	100	100	18.9	2.8	0.7
	100	100	29.0	2.8	0.7
	100	100	36.0	2.8	0.7
6/20/23	100	100	16.7	2.0	0.7
"	100	100	16.7	2.0	0.7
"	100	100	17.9	2.0	0.7
6/21/23	100	100	46.1	0.15	0.15
6/22/23	100	100	41.0	1.9	0.6
	100	100	22.5	1.8	0.6
	100	94.7	25.6	1.9	0.6

Source of Material	Remarks	
Dresser Junctio	Car No T+O.C. 24,904	To be mixed in stock pile
"	" KCS. 27,697	
"	" P+R 28,986	
"	" Penn 270,006	
"	" I.C. 312,444	
"	" " MC 12,754	* Too Coarse. Before using - will be mixed with finer material now on way from Dresser Junction
"	" Soo 9071	
"	N.P. 72467	
"	Montour 7356	
"	Penn 335,007	
"	P. 59565	
"	P+R 7336	
"	MP 70,206	
"	L+N 62,471	
"	Penn 863,644	
"	CRR. 85040	
"	N+W 49350	
"	N+W 49836	
"	CC+StL. 77,627	
"	Soo 9291	
	MStPSSM 3597	Mixed in stock pile
	EJ+E 22,605	
	Soo 65389	

Field Tests on Rock

Date	Passing 2 3/4	Passing 2"	Pass 1"	Pass 1/4	Pass 1/8"
See 6/18/23	100	100	65	0.5	✓ OK
"	100	100	65	0.5	✓
"	100	100	65	0.5	✓
"	100	100	68	0.5	✓
6/19/23	100	100	63.8	1.3	0+
"	100	100	68.4	1.5	0+
"	100	100	68.4	1.5	0+
"	100	100	67.0	1.4	0+
6/20/23	100	99.4	65.0	1.0	0+
"	100	99.6	65.0	1.0	0+
"	100	100.0	70.0	1.2	0.5
"	100	100.0	69.0	1.2	0.4
6/21/23	100	100	67.6	3.0	1.5
"	100	100	67.8	3.1	1.5
"	100	100	67.8	2.8	1.0
"	100	99.7	67.0	2.8	0.6
6/22/23	100	100	64.8	1.0	0+
"	100	100	65	0.9	0+
"	100	100	64.8	1.0	0+
"	100	100	65.3	1.1	0+
6/23	100	100	68.2	1.0	✓
"	100	100	68.0	1.0	✓
"	100	99	68.0	0.8	✓
"	100	99	66.8	1.0	✓

Source		Remarks.
Dresser Junction	Soo 3597	Inspected at Dresser Junction
"	Penn 853,437	"
"	Penn 335 805	"
"	Erie 41,741	"
"	L&N 32,607	"
"	C&A 22171	"
"	Soo 9291	"
"	" 9137	"
"	Penn 270,006	"
"	P&R 28,986	"
"	I.C. 123,381	"
"	I.C. 128128	"
"	Soo 9223	"
"	" 9197	"
"	" 66321	"
"	" 9115	"
"	" 277,634	"
"	Penn 870,717	"
"	Soo 60,005	"
"	NYC 345,537	"
"	Soo 65389	"
"	3591	"
"	9291	"
"	9057	

This material to be mixed with coarse material as on 1st page of Field Tests Book

Field Tests on Rock

Date	Passing 2 3/4	Pass 2"	Pass 1"	Pass 1/4	Pass 1/8"
6/25/23	100	100	70.2	0.0+	0.0
6/27/23	100	100	75	0.0+	0+
"	100	100	65	0+	0.0+
"	100	100	48	0+	0+
"	100	100	72	0+	0+
6/28/23	100	100	61.9	0+	✓
"	100	100	51.3	0+	✓
"	100	94	60.0	0+	✓
"	100	92	52.6	0+	✓
"	100	100	75.0	0+	✓
"	100	100	55.0	0+	✓
"	100	90.4	47.0	0+	✓
6/29/23	100	100	57.0	0+	✓
"	100	95	57.0	0+	✓
"	100	100	53	0+	✓
7/7/23	100	100	54	0+	✓
"	100	100	45	0+	✓
"	100	100	58	0+	✓
"	100	100	56	0+	✓
"	100	100	50	0+	✓
7/10/23	100	100	45	0+	✓
7/10/23	100	100	45	0+	
"	100	100	44	0	

Source	Remarks
Dresser Junction	CRR of NJ. 85040
"	Penn. 863,644
"	Soo 9221
"	NW 49836
"	Soo 65,421
"	I.C. 312411
"	M.P. 62,775
"	Hocking Valley 21,193
"	Soo 3597
"	" 9291
"	" 9057
"	L.V. 29631
"	L&N 32,607
"	Penn. 853437
"	I.C. 312444
"	Soo 9103
"	" 9057
"	C&I 12560
"	I C 312,444
"	U.RR 5998
	C+O 37,487
	B+L.E 13052
	PRCT 7636

Field Tests on Rock

Date	Pass 2¾"	Pass 2"	Pass 1"	Pass ¼	Pass ⅛"
7/11/23	100	100	57	0 +	0
"	100	100	55	0 +	0
"	100	100	54	0 +	0
7/12/23	100	100	46	0+	✓
"	100	100	49	0+	✓
"	100	100	57	0+	✓
"	100	100	44	0+	✓
"	100	100	65	0+	✓
7/13/23	100	100	61	0+	✓
"	100	100	64	0+	✓
7/14/23	100	100	57	0+	✓
	100	100	55	0+	✓
	100	100	61	0+	✓
7/15/23	100	100	50	0+	✓
"	100	100	53	0+	✓
"	100	100	51	0+	✓
7/17/23	100	100	46	0+	✓
7/17/23	100	100	41	0+	✓
	100	100	41	0+	✓
	100	100	33	0+	✓
7/18/23	100	100	56	0+	✓
	100	100	51	0+	✓
	100	100	54	0+	✓
	100	100	57	0+	✓

Source	Remarks
~~Joh~~ Dresser Junction	JE 22605
"	BL.E 12,889
"	L+N 32,607
"	Penn 870717
"	MP. 69423
"	CE 11511
"	C+NW 15334
"	DSL 34164
"	L.V 29631
"	Soo 9093
"	L+N 62471
"	IC 312411
"	Penn 863,644
	NYC 315414
	Wabash 7625
	IC. 123 223
	N.W 49836
	IC 88525
	Ic 126934
	MC. 13463
	Soo 9217
	IC 200108
	L+N 79901
	L+N 74130

Field Tests on Rock

Date	Passing 2¾"	Passing 2"	Passing 1"	Passing ¼"	Passing ⅛"
7/18/23	100	100	—	0+	✓
7/18/23	100	100	54	0+	✓
7/21/23	100	100	47	0+	✓
7/23/23	100	100	40	0+	✓
"	100	100	46	0+	✓
7/24/23	100	100	54	0+	✓

Source of Material	Remarks
Dressel Junction	NYC 330373
"	L&N 34681
"	I.C. 96221
"	HV. 21193
"	CEI 74951
"	U.P. 21623

Field Tests on Sand

Date	Passing 1/4"	Passing #20	Loss by Elut.	Color Plate	Source
6/20/23	100	50%	✓	✓	John Wondu
"	100	46.9	✓	✓	"
"	100	47.7	✓	✓	"
6/21/23	100	50.0	✓	✓	"
"	100	51.4	✓	✓	"
"	100	49.5	✓	✓	"
"	100	49.5	✓	✓	"
"	100	50.0	✓	✓	"
"	100	45.5	✓	✓	"
6/23/23	100	44.5	✓	✓	"
"	100	37.5	✓	✓	"
"	100	52.6	✓	✓	"
6/24/23	100	49.5	✓	✓	"
"	100	50.5	✓	✓	"
"	100	44.3	✓	✓	"
6/29/23	100	41%	✓	✓	"
6/30/23	100	51	✓	✓	"
"	100	48	✓	✓	"
7/2/23	100	48	✓	✓	"
7/3/23	100	49	✓	✓	"
7/5/23	100	56	✓	✓	"
"	100	50	✓	✓	"
"	100	48	✓	✓	"
7/6/23	100	54	✓	✓	"
7/10/23	100	58	✓	✓	"

Remarks.

Soo	9253
M+St.P+SSM	9269
"	9255
I.C.	203,445
Soo	9217
"	2405
"	3257
"	9103
"	9057
Soo	9257
B+L.E	12,889
CIWN	15338
CIWN	15334
Soo	9093
"	9117
CdA	40915
Soo	9093
"	9137
"	9117
"	9257
"	65421
"	3597
"	9221
"	9291
NYC	332,045

Field Tests on Sand

Date	Passing 1/4"	Pass #20	Loss by Elut.	Color Plate	Sourc
7/12/23	100	58	✓	✓	John Wonde
7/13/23	100	47	✓	✓	✓
7/14/23	100	51	✓	✓	"
	100	41	✓	✓	"
7/18/23	100	41	✓	✓	"
"	100	43	✓	✓	"
"	100	47	✓	✓	"
"	100	43	✓	✓	"
"	100	47	✓	✓	"
7/19/23	100	52	✓	✓	Lande & Chri
"	100	56	✓	✓	"
"	100	49	✓	✓	"
"	100	45	✓	✓	Wond
7/20/23	100	57	✓	✓	Lande Morri
"	100	50	✓	✓	"
"	100	51	✓	✓	"
"	100	48	✓	✓	"
"	100	53	✓	✓	"
"	100	46	✓	✓	John Wonde
"	100	49	✓	✓	"
"	100	46	✓	✓	"
7/21/23	✓	54	✓	✓	"
"	✓	56	✓	✓	"
"	✓	51	✓	✓	"

Remarks

Soo 9115
PHLE 1256
CEI 13,415
Penn 316,839
WLE 72689
3rd 251227
Soo 3527
Soo 3073
TOC 23839
GN. 70514
GN 70241
GN 71121
Soo 9137
GN 70103
" 70773
" 71257
" 70008
" 70552
Soo 66507
CCCStL 70465
NYC 332,412
Soo 66419
Soo 9113
Penn 316,839

Field Tests on Sand

Date	Passing 1/4"	Pass #20	Loss by Elut	Color Plate	Source
7/21/23	(100)? ✓	55	✓	✓	Lander Morrison
"	"	53	✓	✓	"
7/23/23	"	47	✓	✓	John Wonder
	"	55	✓	✓	"
	"	51	✓	✓	"
7/24/23	100	47	✓	✓	"
"	100	52	✓	✓	"
"	100	49	✓	✓	"
"	100	51	✓	✓	"
"	100	50	✓	✓	"
"	100	53	✓	✓	"

500	3321
"	60,000
N.W	92805
I C	93838
500	3073
"	9609

Field Tests on Sand

Date	Passing 1/4"	Pass #20	Loss by Elut.	Color Plate	Source

Remarks

Field Tests on sand

Date	Passing 1/4"	Pass #20	Loss by Elut.	Color Plate	Soure

Remarks

Field Tests on Sand

Date	Passing 1/4"	Pass #20	Loss by Elut.	Color Plate	Source

Field Tests on Sand

Date	Pass 1/4"	Pass #20	Loss by Elut.	Color Plate	Source

Remarks

Concrete Cylinders Made.

Date Made	Station Taken	Sand Used	Rock Used	Date Taken from Job.	Date Sent to Laborato
7/2/23	Culy 40+21	Wonders	Presser Junction	7/3/23	8/3/23
7/3/23	"	"	"	7/5/23	8/3/23
7/9/23	115+70	"	"	7/10/23	
7/11/23	111+35	"	"	7/12/23	
7/13/23	104+00	"	"	7/14/23	
7/16/23	94+00	"	"	7/17/23	
7/18/23	84+00	"	"	7/21/23	
7/20/23	77+00	Landers Morrison Christenson	"	7/21/23	
7/23/23	"	John " Wonders	"	7/24/23	

Concrete Cylinders Made

Date Made	Station	Sand Used	Rock Used	Date Taken from Job	Date sent to Laborat

Misc. Material Samples Sent to Minn. Highway Dept.

Date Sent	Material	Source	M.H.D. Lab. No

Cement Samples Sent to
Minn. Highway Dept.

Date Sent	Source Material	M.H.D. Lab.

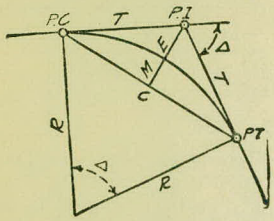
Sand Samples Sent to Minn. Highway Dept. Lab.

Date Sent	Source Material	M.H.D. Lab. No
6/20/23	John Wonder	
6/30/23	"	23163
7/13/23	"	23172

Rock Samples Sent to Minn. Highway Dept. Lab.

Date Sent	Source Material	M.H.D. Lab. No
6/30/23	Dressey Junction	RG2334
7/13/23	"	" 2336

DIETZGEN'S RAILROAD CURVE AND REDUCTION TABLES



CURVE FORMULAS

Radius=R=$\frac{50}{\text{sin. } D/2}$ (1) Degree of Curve=D and sin. $\frac{D}{2}=\frac{50}{R}$ (2)

Tangent=T=R tan $\frac{\Delta}{2}$ (3) Length of Curve=L=100$\frac{\Delta}{D}$ (4)

Middle ordinate=M= R(1—cos. $\frac{\Delta}{2}$) (5) =Rvers $\frac{\Delta}{2}$ (6)

External=E=T tan $\frac{\Delta}{4}$ (7) =R÷cos. $\frac{\Delta}{2}$—R (8)=R exsec $\frac{\Delta}{2}$ (9)

Long Chord=C=2 R sin. $\frac{\Delta}{2}$ (10) Δ=Central Angle

EXPLANATION AND USE OF TABLES

Stations.—Given P. I.=Sta. 161+60.35 to find Sta. of P. C. and P. T. Δ=62° 10′ D=8° 20′. From Table IV for 1° curve T=3454.1 and÷8⅓=414.49 ft. From Table V correction=.36 or T=414.85 ft. P. C.=Sta. P.I.—T=157+45.50. Also from (4) L=746.00 and P. T.=Sta. P. C.+L=164+91.50.

Offsets.—Tangent offsets vary (approximately) directly with D and with square of the distance. Thus tangent offset for Sta. 158 on above curve is 2.16 ft. found as follows. From Table III tangent offset for 100 ft.=7.27 ft. Distance=158—Sta. P. C.=54.50, hence offset=7.27 $(54.50\div100)^2$=2.16 ft. Also square of any distance divided by twice the radius equals (approximately) the distance from tangent to curve. Thus $(54.50)^2\div(2\times688.26)$=2.16 ft.

Deflections.—Deflection angle=½ D for 100 ft., ¼ D for 50 ft., etc. For c ft.=(in minutes) .3 x C x D° or=defl. for 1 ft. from Table III x C. For Sta. 158 of above curve=.3 x 54.5 x 8⅓=136.2′ or 2° 16.2′, or=2.50 x 54.5=136.2′ from Table III. For Sta. 159 deflection angle=2° 16.2′+8° 20′÷2=6° 26.2′, etc.

Externals.—May be found in similar manner to tangents. Thus E for curve above is 91.37. For from Table IV for 1° curve E=960.6 for 8° 20′=960.6÷8⅓=91.27 and from Table V correction=.10 or E=91.37 ft. Or suppose Δ=32° and E is measured and found to be 42 ft. What is D? From Table IV E=230.9 and÷42=5.5 or D=5° 30′.

Table I.—Minutes in Decimals of a Degree.

1′	.0167	11′	.1833	21′	.3500	31′	.5167	41′	.6833	51′	.8500
2	.0333	12	.2000	22	.3667	32	.5333	42	.7000	52	.8667
3	.0500	13	.2167	23	.3833	33	.5500	43	.7167	53	.8833
4	.0667	14	.2333	24	.4000	34	.5667	44	.7333	54	.9000
5	.0833	15	.2500	25	.4167	35	.5833	45	.7500	55	.9167
6	.1000	16	.2667	26	.4333	36	.6000	46	.7667	56	.9333
7	.1167	17	.2833	27	.4500	37	.6167	47	.7833	57	.9500
8	.1333	18	.3000	28	.4667	38	.6333	48	.8000	58	.9667
9	.1500	19	.3167	29	.4833	39	.6500	49	.8167	59	.9833
10	.1667	20	.3333	30	.5000	40	.6667	50	.8333	60	1.0000

Table II.—Inches in Decimals of a Foot.

1–16	3–32	⅛	3–16	¼	5–16	⅜	½	⅝	¾	⅞
.0052	.0078	.0104	.0156	.0208	.0260	.0313	.0417	.0521	.0625	.0729

1	2	3	4	5	6	7	8	9	10	11
.0833	.1667	.2500	.3333	.4167	.5000	.5833	.6667	.7500	.8333	.9167

Table III.—Radii, Ordinates and Deflections.

Deg.	Radius	Mid. Ord.	Tan. Offset	Def. for 1 Foot	Deg.	Radius	Mid. Ord.	Tan Offset	Def. for 1 Foot
0° 10′	34377.5	.036	.145	0.05′	7°	819.02	1.528	6.105	2.10′
20	17188.8	.073	.291	0.10	20′	781.84	1.600	6.395	2.20
30	11459.2	.109	.436	0.15	30	764.49	1.637	6.540	2.25
40	8594.42	.145	.582	0.20	40	747.89	1.673	6.685	2.30
50	6875.55	.182	.727	0.25					
					8	716.78	1.746	6.976	2.40
1	5729.65	.218	.873	0.30	20	688.16	1.819	7.266	2.50
10	4911.15	.255	1.018	0.35	30	674.69	1.855	7.411	2.55
20	4297.28	.291	1.164	0.40	40	661.74	1.892	7.556	2.60
30	3819.83	.327	1.309	0.45					
40	3437.87	.364	1.454	0.50	9	637.28	1.965	7.846	2.70
50	3125.36	.400	1.600	0.55	20	614.56	2.037	8.136	2.80
					30	603.80	2.074	8.281	2.85
2	2864.93	.436	1.745	0.60	40	593.42	2.110	8.426	2.90
10	2644.58	.473	1.891	0.65					
20	2455.70	.509	2.036	0.70	10	573.69	2.183	8.716	3.00
30	2292.01	.545	2.181	0.75	30	546.44	2.292	9.150	3.15
40	2148.79	.582	2.327	0.80	11	521.67	2.402	9.585	3.30
50	2022.41	.618	2.472	0.85	30	499.06	2.511	10.02	3.45
					12	478.34	2.620	10.45	3.60
3	1910.08	.655	2.618	0.90	30	459.28	2.730	10.89	3.75
10	1809.57	.691	2.763	0.95	13	441.68	2.839	11.32	3.90
20	1719.12	.727	2.908	1.00	30	425.40	2.949	11.75	4.05
30	1637.28	.764	3.054	1.05	14	410.28	3.058	12.18	4.20
40	1562.88	.800	3.199	1.10	30	396.20	3.168	12.62	4.35
50	1494.95	.836	3.345	1.15					
					15	383.07	3.277	13.05	4.50
4	1432.69	.873	3.490	1.20	30	370.78	3.387	13.49	4.65
10	1375.40	.909	3.635	1.25	16	359.27	3.496	13.92	4.80
20	1322.53	.945	3.718	1.30	30	348.45	3.606	14.35	4.95
30	1273.57	.982	3.926	1.35	17	338.27	3.716	14.78	5.10
40	1228.11	1.018	4.071	1.40	18	319.62	3.935	15.64	5.40
50	1185.78	1.055	4.217	1.45	19	302.94	4.155	16.51	5.70
5	1146.28	1.091	4.362	1.50	20	287.94	4.374	17.37	6.00
10	1109.33	1.127	4.507	1.55	21	274.37	4.594	18.22	6.30
20	1074.68	1.164	4.653	1.60	22	262.04	4.814	19.08	6.60
30	1042.14	1.200	4.798	1.65	23	250.79	5.035	19.94	6.90
40	1011.51	1.237	4.943	1.70	24	240.49	5.255	20.79	7.20
50	982.64	1.273	5.088	1.75					
					25	231.01	5.476	21.64	7.50
6	955.37	1.309	5.234	1.80	26	222.27	5.697	22.50	7.80
10	929.57	1.346	5.379	1.85	27	214.18	5.918	23.35	8.10
20	905.13	1.382	5.524	1.90	28	206.68	6.139	24.19	8.40
30	881.95	1.418	5.669	1.95	29	199.70	6.360	25.04	8.70
40	859.92	1.455	5.814	2.00	30	193.18	6.583	25.88	9.00

Note. Chord Deflection=2 times tangent deflection.

TABLE IV.—TANGENTS AND EXTERNALS TO A 1° CURVE.

Central Angle	Tangent	External	Central Angle	Tangent	External	Central Angle	Tangent	External
1°	50.00	.22	11°	551.70	26.50	21°	1061.9	97.57
10′	58.34	.30	10′	560.11	27.31	10′	1070.6	99.16
20	66.67	.39	20	568.53	28.14	20	1079.2	100.75
30	75.01	.49	30	576.95	28.97	30	1087.8	102.35
40	83.34	.61	40	585.36	29.82	40	1096.4	103.97
50	91.68	.73	50	593.79	30.68	50	1105.1	105.60
2	100.01	.87	12	602.21	31.56	22	1113.7	107.24
10	108.35	1.02	10	610.64	32.45	10	1122.4	108.90
20	116.68	1.19	20	619.07	33.35	20	1131.0	110.57
30	125.02	1.36	30	627.50	34.26	30	1139.7	112.25
40	133.36	1.55	40	635.93	35.18	40	1148.4	113.95
50	141.70	1.75	50	644.37	36.12	50	1157.0	115.66
3	150.04	1.96	13	652.81	37.07	23	1165.7	117.38
10	158.38	2.19	10	661.25	38.03	10	1174.4	119.12
20	166.72	2.43	20	669.70	39.01	20	1183.1	120.87
30	175.06	2.67	30	678.15	39.99	30	1191.8	122.63
40	183.40	2.93	40	686.60	40.99	40	1200.5	124.41
50	191.74	3.21	50	695.06	42.00	50	1209.2	126.20
4	200.08	3.49	14	703.51	43.03	24	1217.9	128.00
10	208.43	3.79	10	711.97	44.07	10	1226.6	129.82
20	216.77	4.10	20	720.44	45.12	20	1235.3	131.65
30	225.12	4.42	30	728.90	46.18	30	1244.0	133.50
40	233.47	4.76	40	737.37	47.25	40	1252.8	135.35
50	241.81	5.10	50	745.85	48.34	50	1261.5	137.23
5	250.16	5.46	15	754.32	49.44	25	1270.2	139.11
10	258.51	5.83	10	762.80	50.55	10	1279.0	141.01
20	266.86	6.21	20	771.29	51.68	20	1287.7	142.93
30	275.21	6.61	30	779.77	52.89	30	1296.5	144.85
40	283.57	7.01	40	788.26	53.97	40	1305.3	146.79
50	291.92	7.43	50	796.75	55.13	50	1314.0	148.75
6	300.28	7.86	16	805.25	56.31	26	1322.8	150.71
10	308.64	8.31	10	813.75	57.50	10	1331.6	152.69
20	316.99	8.76	20	822.25	58.70	20	1340.4	154.69
30	325.35	9.23	30	830.76	59.91	30	1349.2	156.70
40	333.71	9.71	40	839.27	61.14	40	1358.0	158.72
50	342.08	10.20	50	847.78	62.38	50	1366.8	160.76
7	350.44	10.71	17	856.30	63.63	27	1375.6	162.81
10	358.81	11.22	10	864.82	64.90	10	1384.4	164.86
20	367.17	11.75	20	873.35	66.18	20	1393.2	166.95
30	375.54	12.29	30	881.88	67.47	30	1402.0	169.04
40	383.91	12.85	40	890.41	68.77	40	1410.9	171.15
50	392.28	13.41	50	898.95	70.09	50	1419.7	173.27
8	400.66	13.99	18	907.49	71.42	28	1428.6	175.41
10	409.03	14.58	10	916.03	72.76	10	1437.4	177.55
20	417.41	15.18	20	924.58	74.12	20	1446.3	179.72
30	425.79	15.80	30	933.13	75.49	30	1455.1	181.89
40	434.17	16.43	40	941.69	76.86	40	1464.0	184.08
50	442.55	17.07	50	950.25	78.26	50	1472.9	186.29
9	450.93	17.72	19	958.81	79.67	29	1481.8	188.51
10	459.32	18.38	10	967.38	81.09	10	1490.7	190.74
20	467.71	19.06	20	975.96	82.53	20	1499.6	192.99
30	476.10	19.75	30	984.53	83.97	30	1508.5	195.25
40	484.49	20.45	40	993.12	85.43	40	1517.4	197.53
50	492.88	21.16	50	1001.7	86.90	50	1526.3	199.82
10	501.28	21.89	20	1010.3	88.39	30	1535.3	202.12
10	509.68	22.62	10	1018.9	89.89	10	1544.2	204.44
20	518.08	23.38	20	1027.5	91.40	20	1553.1	206.77
30	526.48	24.14	30	1036.1	92.92	30	1562.1	209.12
40	534.89	24.91	40	1044.7	94.46	40	1571.0	211.48
50	543.29	25.70	50	1053.3	96.01	50	1580.0	213.86

Table IV.—Tangents and Externals to a 1° Curve.

Central Angle	Tangent	External	Central Angle	Tangent	External	Central Angle	Tangent	External
31°	1589.0	216.3	41°	2142.2	387.4	51°	2732.9	618.4
10′	1598.0	218.7	10′	2151.7	390.7	10′	2743.1	622.8
20	1606.9	221.1	20	2161.2	394.1	20	2753.4	627.2
30	1615.9	223.5	30	2170.8	397.4	30	2763.7	631.7
40	1624.9	226.0	40	2180.3	400.8	40	2773.9	636.2
50	1633.9	228.4	50	2189.9	404.2	50	2784.2	640.7
32	1643.0	230.9	42	2199.4	407.6	52	2794.5	645.2
10	1652.0	233.4	10	2209.0	411.1	10	2804.9	649.7
20	1661.0	235.9	20	2218.6	414.5	20	2815.2	654.3
30	1670.0	238.4	30	2228.1	418.0	30	2825.6	658.8
40	1679.1	241.0	40	2237.7	421.4	40	2835.9	663.4
50	1688.1	243.5	50	2247.3	425.0	50	2846.3	668.0
33	1697.2	246.1	43	2257.0	428.5	53	2856.7	672.7
10	1706.3	248.7	10	2266.6	432.0	10	2867.1	677.3
20	1715.3	251.3	20	2276.2	435.6	20	2877.5	682.0
30	1724.4	253.9	30	2285.9	439.2	30	2888.0	686.7
40	1733.5	256.5	40	2295.6	442.8	40	2898.4	691.4
50	1742.6	259.1	50	2305.2	446.4	50	2908.9	696.1
34	1751.7	261.8	44	2314.9	450.0	54	2919.4	700.9
10	1760.8	264.5	10	2324.6	453.6	10	2929.9	705.7
20	1770.0	267.2	20	2334.3	457.3	20	2940.4	710.5
30	1779.1	269.9	30	2344.1	461.0	30	2951.0	715.3
40	1788.2	272.6	40	2353.8	464.6	40	2961.5	720.1
50	1797.4	275.3	50	2363.5	468.4	50	2972.1	725.0
35	1806.6	278.1	45	2373.3	472.1	55	2982.7	729.9
10	1815.7	280.8	10	2383.1	475.8	10	2993.3	734.8
20	1824.9	283.6	20	2392.8	479.6	20	3003.9	739.7
30	1834.1	286.4	30	2402.6	483.8	30	3014.5	744.6
40	1843.3	289.2	40	2412.4	487.2	40	3025.2	749.6
50	1852.5	292.0	50	2422.3	491.0	50	3035.8	754.6
36	1861.7	294.9	46	2432.1	494.8	56	3046.5	759.6
10	1870.9	297.7	10	2441.9	498.7	10	3057.2	764.6
20	1880.1	300.6	20	2451.8	502.5	20	3067.9	769.7
30	1889.4	303.5	30	2461.7	506.4	30	3078.7	774.7
40	1898.6	306.4	40	2471.5	510.3	40	3089.4	779.8
50	1907.9	309.3	50	2481.4	514.3	50	3100.2	784.9
37	1917.1	312.2	47	2491.3	518.2	57	3110.9	790.1
10	1926.4	315.2	10	2501.2	522.2	10	3121.7	795.2
20	1935.7	318.1	20	2511.2	526.1	20	3132.6	800.4
30	1945.0	321.1	30	2521.1	530.1	30	3143.4	805.6
40	1954.3	324.1	40	2531.1	534.2	40	3154.2	810.9
50	1963.6	327.1	50	2541.0	538.2	50	3165.1	816.1
38	1972.9	330.2	48	2551.0	542.2	58	3176.0	821.4
10	1982.2	333.2	10	2561.0	546.3	10	3186.9	826.7
20	1991.5	336.3	20	2571.0	550.4	20	3197.8	832.0
30	2000.9	339.3	30	2581.0	554.5	30	3208.8	837.3
40	2010.2	342.4	40	2591.0	558.6	40	3219.7	842.7
50	2019.6	345.5	50	2601.1	562.8	50	3230.7	848.1
39	2029.0	348.6	49	2611.2	566.9	59	3241.7	853.5
10	2038.4	351.8	10	2621.2	571.1	10	3252.7	858.9
20	2047.8	354.9	20	2631.3	575.3	20	3263.7	864.3
30	2057.2	358.1	30	2641.4	579.5	30	3274.8	869.8
40	2066.6	361.3	40	2651.5	583.8	40	3285.8	875.3
50	2076.0	364.5	50	2661.6	588.0	50	3296.9	880.8
40	2085.4	367.7	50	2671.8	592.3	60	3308.0	886.4
10	2094.9	371.0	10	2681.9	596.6	10	3319.1	892.0
20	2104.3	374.2	20	2692.1	600.9	20	3330.3	897.5
30	2113.8	377.5	30	2702.3	605.3	30	3341.4	903.2
40	2123.3	380.8	40	2712.5	609.6	40	3352.6	908.8
50	2132.7	384.1	50	2722.7	614.0	50	3363.8	914.5

Table IV.—Tangents and Externals to a 1° Curve.

Central Angle	Tangent	External	Central Angle	Tangent	External	Central Angle	Tangent	External
61°	3375.0	920.2	71°	4086.9	1308.2	81°	4893.6	1805.3
10′	3386.3	925.9	10′	4099.5	1315.6	10′	4908.0	1814.7
20	3397.5	931.6	20	4112.1	1322.9	20	4922.5	1824.1
30	3408.8	937.3	30	4124.8	1330.3	30	4937.0	1833.6
40	3420.1	943.1	40	4137.4	1337.7	40	4951.5	1843.1
50	3431.4	948.9	50	4150.1	1345.1	50	4966.1	1852.6
62	3442.7	954.8	72	4162.8	1352.6	82	4980.7	1862.2
10	3454.1	960.6	10	4175.6	1360.1	10	4995.4	1871.8
20	3465.4	966.5	20	4188.5	1367.6	20	5010.0	1881.5
30	3476.8	972.4	30	4201.2	1375.2	30	5024.8	1891.2
40	3488.3	978.3	40	4214.0	1382.8	40	5039.5	1900.9
50	3499.7	984.3	50	4226.8	1390.4	50	5054.3	1910.7
63	3511.1	990.2	73	4239.7	1398.0	83	5069.2	1920.5
10	3522.6	996.2	10	4252.6	1405.7	10	5084.0	1930.4
20	3534.1	1002.3	20	4265.6	1413.5	20	5099.0	1940.3
30	3545.6	1008.3	30	4278.5	1421.2	20	5113.9	1950.3
40	3557.2	1014.4	40	4291.5	1429.0	40	5128.9	1960.2
50	3568.7	1020.5	50	4304.6	1436.8	50	5143.9	1970.3
64	3580.3	1026.6	74	4317.6	1444.6	84	5159.0	1980.4
10	3591.9	1032.8	10	4330.7	1452.5	10	5174.1	1990.5
20	3603.5	1039.0	20	4343.8	1460.4	20	5189.3	2000.6
30	3615.1	1045.2	30	4356.9	1468.4	30	5204.4	2010.8
40	3626.8	1051.4	40	4370.1	1476.4	40	5219.7	2021.1
50	3638.5	1057.7	50	4383.3	1484.4	50	5234.9	2031.4
65	3650.2	1063.9	75	4396.5	1492.4	85	5250.3	2041.7
10	3661.9	1070.2	10	4409.8	1500.5	10	5265.6	2052.1
20	3673.7	1076.6	20	4423.1	1508.6	20	5281.0	2062.5
30	3685.4	1082.9	30	4436.4	1516.7	30	5296.4	2073.0
40	3697.2	1089.3	40	4449.7	1524.9	40	5311.9	2083.5
50	3709.0	1095.7	50	4463.1	1533.1	50	5327.4	2094.1
66	3720.9	1102.2	76	4476.5	1541.4	86	5343.0	2104.7
10	3732.7	1108.6	10	4489.9	1549.7	10	5358.6	2115.3
20	3744.6	1115.1	20	4503.4	1558.0	20	5374.2	2126.0
30	3756.5	1121.7	30	4516.9	1566.3	30	5389.9	2136.7
40	3768.5	1128.2	40	4530.4	1574.7	40	5405.6	2147.5
50	3780.4	1134.8	50	4544.0	1583.1	50	5421.4	2158.4
67	3792.4	1141.4	77	4557.6	1591.6	87	5437.2	2169.2
10	3804.4	1148.0	10	4571.2	1600.1	10	5453.1	2180.2
20	3816.4	1154.7	20	4584.8	1608.6	20	5469.0	2191.1
30	3828.4	1161.3	30	4598.5	1617.1	30	5484.9	2202.2
40	3840.5	1168.1	40	4612.2	1625.7	40	5500.9	2213.2
50	3852.6	1174.8	50	4626.0	1634.4	50	5517.0	2224.3
68	3864.7	1181.6	78	4639.8	1643.0	88	5533.1	2235.5
10	3876.8	1188.4	10	4653.6	1651.7	10	5549.2	2246.7
20	3889.0	1195.2	20	4667.4	1660.5	20	5565.4	2258.0
30	3901.2	1202.0	30	4681.3	1669.2	30	5581.6	2269.3
40	3913.4	1208.9	40	4695.2	1678.1	40	5597.8	2280.6
50	3925.6	1215.8	50	4709.2	1686.9	50	5614.2	2292.0
69	3937.9	1222.7	79	4723.2	1695.8	89	5630.5	2303.5
10	3950.2	1229.7	10	4737.2	1704.7	10	5646.9	2315.0
20	3962.5	1236.7	20	4751.2	1713.7	20	5663.4	2326.6
30	3974.8	1243.7	30	4765.3	1722.7	30	5679.9	2338.2
40	3987.2	1250.8	40	4779.4	1731.7	40	5696.4	2349.8
50	3999.5	1257.9	50	4793.6	1740.8	50	5713.0	2361.5
70	4011.9	1265.0	80	4807.7	1749.9	90	5729.7	2373.3
10	4024.4	1272.1	10	4822.0	1759.0	10	5746.3	2385.1
20	4036.8	1279.3	20	4836.2	1768.2	20	5763.1	2397.0
30	4049.3	1286.5	30	4850.5	1777.4	30	5779.9	2408.9
40	4061.8	1293.6	40	4864.8	1786.7	40	5796.7	2420.9
50	4074.4	1300.9	50	4879.2	1796.0	50	5813.6	2432.9

Table IV.—Tangents and Externals to a 1° Curve.

Central Angle	Tangent	External	Central Angle	Tangent	External	Central Angle	Tangent	External
91°	5830.5	2444.9	101°	6950.6	3278.1	111°	8336.7	4386.1
10′	5847.5	2457.1	10′	6971.3	3294.1	10′	8362.7	4407.6
20	5864.6	2469.3	20	6992.0	3310.1	20	8388.9	4429.2
30	5881.7	2481.5	30	7012.7	3326.1	30	8415.1	4450.9
40	5898.8	2493.8	40	7033.6	3342.3	40	8441.5	4472.7
50	5916.0	2506.1	50	7054.5	3358.5	50	8468.0	4494.6
92	5933.2	2518.5	102	7075.5	3374.9	112	8494.6	4516.6
10	5950.5	2531.0	10	7096.6	3391.2	10	8521.3	4538.8
20	5967.9	2543.5	20	7117.8	3407.7	20	8548.1	4561.1
30	5985.3	2556.0	30	7139.0	3424.3	30	8575.0	4583.4
40	6002.7	2568.6	40	7160.3	3440.9	40	8602.1	4606.0
50	6020.2	2581.3	50	7181.7	3457.6	50	8629.3	4628.6
93	6037.8	2594.0	103	7203.2	3474.4	113	8656.6	4651.3
10	6055.4	2606.8	10	7224.7	3491.3	10	8684.0	4674.2
20	6073.1	2619.7	20	7246.3	3508.2	20	8711.5	4697.2
30	6090.8	2632.6	30	7268.0	3525.2	30	8739.2	4720.3
40	6108.6	2645.5	40	7289.8	3542.4	40	8767.0	4743.6
50	6126.4	2658.5	50	7311.7	3559.6	50	8794.9	4766.9
94	6144.3	2671.6	104	7333.6	3576.8	114	8822.9	4790.4
10	6162.6	2684.7	10	7355.6	3594.2	10	8851.0	4814.1
20	6180.2	2697.9	20	7377.8	3611.7	20	8879.3	4837.8
30	6198.3	2711.2	30	7399.9	3629.2	30	8907.7	4861.7
40	6216.4	2724.5	40	7422.2	3646.8	40	8936.3	4885.7
50	6234.6	2737.9	50	7444.6	3664.5	50	8965.0	4909.9
95	6252.8	2751.3	105	7467.0	3682.3	115	8993.8	4934.1
10	6271.1	2764.8	10	7489.6	3700.2	10	9022.7	4958.6
20	6289.4	2778.3	20	7512.2	3718.2	20	9051.7	4983.1
30	6307.9	2792.0	30	7534.9	3736.2	30	9080.9	5007.8
40	6326.3	2805.6	40	7557.7	3754.4	40	9110.3	5032.6
50	6344.8	2819.4	50	7580.5	3772.6	50	9139.8	5057.6
96	6363.4	2833.2	106	7603.5	3791.0	116	9169.4	5082.7
10	6382.1	2847.0	10	7626.6	3809.4	10	9199.1	5107.9
20	6400.8	2861.0	20	7649.7	3827.9	20	9229.0	5133.3
30	6419.5	2875.0	30	7672.9	3846.5	30	9259.0	5158.8
40	6438.4	2889.0	40	7696.3	3865.2	40	9289.2	5184.5
50	6457.3	2903.1	50	7719.7	3884.0	50	9319.5	5210.3
97	6476.2	2917.3	107	7743.2	3902.9	117	9349.9	5236.2
10	6495.2	2931.6	10	7766.8	3921.9	10	9380.5	5262.3
20	6514.3	2945.9	20	7790.5	3940.9	20	9411.3	5288.6
30	6533.4	2960.3	30	7814.3	3960.1	30	9442.2	5315.0
40	6552.6	2974.7	40	7838.1	3979.4	40	9473.2	5341.5
50	6571.9	2989.2	50	7862.1	3998.7	50	9504.4	5368.2
98	6591.2	3003.8	108	7886.2	4018.2	118	9535.7	5395.1
10	6610.6	3018.4	10	7910.4	4037.8	10	9567.2	5422.1
20	6630.1	3033.1	20	7934.6	4057.4	20	9598.9	5449.2
30	6649.6	3047.9	30	7959.0	4077.2	30	9630.7	5476.5
40	6669.2	3062.8	40	7983.5	4097.1	40	9662.6	5504.0
50	6688.8	3077.7	50	8008.0	4117.0	50	9694.7	5531.7
99	6708.6	3092.7	109	8032.7	4137.1	119	9727.0	5559.4
10	6728.4	3107.7	10	8057.4	4157.3	10	9759.4	5587.4
20	6748.2	3122.9	20	8082.3	4177.5	20	9792.0	5615.5
30	6768.1	3138.1	30	8107.3	4197.9	30	9824.8	5643.8
40	6788.1	3153.3	40	8132.3	4218.4	40	9857.7	5672.3
50	5808.2	3168.7	50	8157.5	4239.0	50	9890.8	5700.9
100	6828.3	3184.1	110	8182.8	4259.7	120	9924.0	5729.7
10	6848.5	3199.6	10	8208.2	4280.5	10	9957.5	5758.6
20	6868.8	3215.1	20	8233.7	4301.4	20	9991.0	5787.7
30	6889.2	3230.8	30	8259.3	4322.4	30	10025.0	5817.0
40	6909.6	3246.5	40	8285.0	4343.6	40	10059.0	5846.5
50	6930.1	3262.3	50	8310.8	4364.8	50	10093.0	5876.1

TABLE V.—CORRECTIONS FOR TANGENTS AND EXTERNALS.

These corrections are to be added to the approximate values, found by dividing the tangent, or external, for a 1° curve (Table IV) by the degree of curve, in order to obtain the true tangents, or externals. Intermediate values may be obtained by interpolation.

FOR TANGENTS ADD

Central Angle	DEGREE OF CURVE													
	5°	10°	15°	20°	25°	30°	35°	40°	45°	50°	55°	60°	65°	70°
10°	.03	.06	.09	.13	.16	.19	.22	.25	.28	.31	.34	.38	.42	.46
15°	.04	.10	.14	.19	.24	.29	.34	.39	.45	.51	.53	.58	.63	.68
20°	.06	.13	.19	.26	.32	.39	.45	.51	.58	.65	.72	.79	.84	.90
25°	.08	.16	.24	.33	.40	.49	.58	.67	.75	.83	.90	.99	1.06	1.14
30°	.10	.19	.29	.39	.49	.59	.69	.79	.89	.99	1.09	1.20	1.29	1.39
35°	.11	.22	.34	.47	.58	.69	.70	.81	.92	1.04	1.29	1.42	1.54	1.66
40°	.13	.26	.40	.53	.67	.80	.93	1.06	1.20	1.34	1.49	1.64	1.79	1.94
45°	.15	.30	.44	.60	.76	.91	1.06	1.21	1.37	1.52	1.70	1.87	2.04	2.21
50°	.17	.34	.51	.68	.85	1.02	1.19	1.36	1.54	1.72	1.91	2.10	2.29	2.48
55°	.19	.38	.57	.76	.95	1.14	1.32	1.52	1.72	1.92	2.14	2.35	2.56	2.77
60°	.21	.42	.63	.84	1.05	1.27	1.49	1.71	1.94	2.17	2.38	2.60	2.83	3.07
65°	.23	.46	.69	.93	1.16	1.40	1.64	1.88	2.13	2.38	2.63	2.88	3.13	3.39
70°	.25	.51	.76	1.02	1.28	1.54	1.80	2.06	2.33	2.60	2.88	3.16	3.44	3.72
75°	.27	.56	.83	1.12	1.40	1.69	1.98	2.27	2.57	2.87	3.16	3.47	3.78	4.09
80°	.30	.61	.91	1.22	1.53	1.84	2.15	2.46	2.78	3.10	3.44	3.78	4.12	4.46
85°	.33	.66	1.00	1.33	1.68	2.02	2.36	2.70	3.05	3.40	3.77	4.14	4.55	4.89
90°	.36	.72	1.09	1.45	1.83	2.20	2.57	2.94	3.32	3.70	4.10	4.50	4.91	5.32
95°	.39	.79	1.19	1.55	2.00	2.40	2.80	3.20	3.61	4.02	4.40	4.98	5.38	5.83
100°	.43	.86	1.30	1.74	2.18	2.62	3.06	3.50	3.95	4.40	4.88	5.37	5.85	6.34
110°	.51	1.03	1.56	2.08	2.61	3.14	3.67	4.21	4.76	5.31	5.86	6.43	7.01	7.60
120°	.62	1.25	1.93	2.52	3.16	3.81	4.45	5.11	5.77	6.44	7.12	7.80	8.50	9.22

FOR EXTERNALS ADD

Central Angle.	DEGREE OF CURVE													
	5°	10°	15°	20°	25°	30°	35°	40°	45°	50°	55°	60°	65°	70°
10°	.001	.003	.004	.006	.007	.008	.009	.011	.012	.014	.015	.017	.018	.020
15°	.003	.007	.010	.014	.018	.023	.027	.029	.032	.035	.039	.043	.047	.051
20°	.006	.011	.017	.022	.028	.034	.038	.045	.051	.057	.063	.070	.076	.083
25°	.009	.018	.027	.036	.046	.056	.065	.074	.083	.093	.106	.120	.127	.135
30°	.013	.025	.038	.051	.065	.078	.090	.103	.116	.129	.149	.170	.179	.188
35°	.018	.035	.054	.072	.086	.109	.131	.153	.175	.197	.213	.230	.247	.264
40°	.023	.046	.070	.093	.117	.141	.172	.203	.234	.265	.277	.290	.315	.341
45°	.030	.060	.093	.119	.153	.184	.216	.254	.289	.325	.351	.378	.411	.445
50°	.037	.075	.116	.151	.189	.227	.266	.305	.345	.384	.425	.467	.508	.550
55°	.046	.093	.142	.188	.236	.283	.332	.381	.420	.479	.530	.582	.641	.700
60°	.056	.112	.168	.225	.283	.340	.398	.457	.516	.575	.636	.697	.774	.851
65°	.067	.135	.204	.273	.343	.412	.483	.554	.625	.697	.711	.845	.922	1.01
70°	.080	.159	.240	.321	.403	.485	.568	.652	.735	.819	.906	.994	1.08	1.17
75°	.095	.182	.286	.383	.480	.578	.678	.777	.877	.977	1.07	1.18	1.29	1.39
80°	.110	.220	.332	.445	.558	.671	.787	.903	1.02	1.13	1.25	1.38	1.50	1.62
85°	.128	.259	.391	.524	.657	.790	.926	1.06	1.20	1.34	1.47	1.62	1.76	1.91
90°	.149	.299	.450	.603	.756	.910	1.07	1.22	1.38	1.54	1.70	1.87	2.03	2.20
95°	.174	.350	.522	.706	.985	1.06	1.25	1.43	1.62	1.80	1.99	2.18	2.38	2.58
100°	.200	.401	.604	.809	1.01	1.22	1.43	1.64	1.85	2.06	2.28	2.50	2.73	2.96
110°	.268	.536	.806	1.08	1.35	1.63	1.91	2.20	2.48	2.76	3.05	3.35	3.66	3.96
120°	.360	.721	1.08	1.45	1.82	2.19	2.57	2.95	3.33	3.72	4.11	4.50	4.91	5.32

Table VI.—Corrections for Sub-Chords and Long Chords.

FOR SUB-CHORDS ADD										Excess of arc per 100 ft.	LONG CHORDS				
D	10	20	30	40	50	60	70	80	90		D	200	300	400	500
4°	.00	.00	.01	.01	.01	.01	.01	.01	.00	.02	1	199.99	299.97	399.92	499.85
6	.00	.01	.01	.02	.02	.02	.02	.01	.01	.05	2	199.97	299.88	399.70	499.39
8	.01	.02	.02	.03	.03	.03	.03	.02	.01	.08	3	199.93	299.73	399.32	498.63
10	.01	.02	.03	.04	.05	.05	.05	.04	.02	.13	4	199.88	299.51	398.78	497.57
12	.02	.04	.05	.06	.07	.07	.07	.05	.03	.18	5	199.81	299.24	398.10	496.20
14	.02	.05	.07	.08	.09	.10	.09	.07	.04	.25	6	199.73	298.90	397.26	494.53
16	.03	.06	.09	.11	.12	.12	.12	.09	.05	.33	7	199.63	298.51	396.28	492.57
18	.04	.08	.11	.14	.15	.16	.15	.12	.07	.41	8	199.51	298.05	395.14	490.31
20	.05	.10	.14	.17	.19	.20	.18	.15	.09	.51	9	199.38	297.54	393.86	487.75
22	.06	.12	.17	.21	.23	.24	.22	.18	.10	.62	10	199.24	296.96	392.42	484.90
24	.07	.14	.20	.25	.28	.28	.26	.21	.12	.74	12	198.90	295.63	389.12	478.34
26	.09	.17	.24	.29	.32	.33	.31	.25	.15	.86	14	198.51	294.06	385.22	470.65
28	.10	.19	.27	.34	.37	.38	.36	.29	.17	1.00	16	198.05	292.25	380.76	461.86
30	.11	.22	.31	.39	.43	.44	.41	.33	.19	1.15	18	197.54	290.21	375.74	452.02
32	.13	.25	.36	.44	.49	.50	.47	.38	.22	1.31	20	196.96	287.94	370.17	441.15
34	.15	.28	.40	.50	.55	.57	.53	.43	.25	1.48	22	196.32	285.44	364.06	429.30
36	.17	.32	.45	.56	.62	.64	.59	.48	.28	1.66	24	195.63	282.71	357.43	416.53
38	.18	.36	.51	.62	.70	.71	.66	.53	.31	1.86	26	194.87	279.76	350.30	402.89
40	.21	.40	.56	.69	.77	.79	.73	.59	.35	2.06	28	194.06	276.59	342.69	388.43
42	.23	.44	.62	.76	.85	.87	.81	.65	.38	2.28	30	193.18	273.20	334.61	373.20
44	.25	.48	.68	.84	.94	.96	.89	.72	.42	2.50	32	192.25	269.61	326.08	357.28
46	.27	.52	.75	.92	1.02	1.05	.98	.78	.46	2.74	34	191.26	265.81	317.12	340.73
48	.30	.57	.81	1.00	1.12	1.14	1.06	.86	.50	2.99	36	190.21	261.80	307.77	323.61
50	.32	.62	.89	1.09	1.21	1.24	1.15	.93	.55	3.24	38	189.10	257.60	298.03	305.99
52	.35	.67	.96	1.18	1.31	1.35	1.25	1.01	.59	3.52	40	187.94	253.21	287.94	287.94
54	.38	.73	1.04	1.28	1.42	1.46	1.35	1.09	.64	3.80	42	186.72	248.63	277.51	269.54
56	.41	.78	1.12	1.38	1.53	1.57	1.46	1.17	.69	4.09	44	185.44	243.87	266.78	250.85
58	.44	.84	1.20	1.48	1.65	1.69	1.57	1.26	.74	4.40	46	184.10	239.93	255.78	231.95
60	.47	.91	1.29	1.59	1.76	1.81	1.68	1.35	.80	4.72	48	182.71	233.83	244.51	212.92

Note.—When a chord of less than 100 ft. is used the corrections given in the above table should be added to the nominal length of chord to get the length which should be used in order that the 100 ft. points will check with those obtained by using the standard 100 ft. chord. Thus in locating a 14° curve by 25 ft. chords measure 25′.06 for each chord. Long chords are useful in passing obstacles.

Table VII.—Middle Ordinates for Rails in Feet.

Deg. of Curve	LENGTH OF RAILS							Deg. of Curve	LENGTH OF RAILS.						
	32	30	28	26	24	22	20		32	30	28	26	24	22	20
1°	.022	.020	.016	.013	.011	.009	.008	16°	.356	.313	.273	.236	.200	.170	.139
2	.045	.038	.034	.029	.025	.021	.017	17	.378	.333	.290	.252	.213	.180	.148
3	.037	.058	.051	.044	.037	.031	.026	18	.400	.351	.306	.265	.225	.190	.156
4	.089	.079	.069	.060	.050	.042	.035	19	.423	.371	.324	.280	.238	.201	.165
5	.112	.099	.086	.074	.063	.053	.044	20	.445	.392	.341	.296	.250	.212	.174
6	.134	.117	.102	.088	.076	.064	.052	21	.466	.410	.357	.309	.262	.222	.182
7	.156	.137	.120	.104	.088	.074	.061	22	.487	.430	.375	.325	.275	.233	.191
8	.179	.158	.137	.119	.100	.085	.070	23	.509	.450	.390	.338	.287	.243	.199
9	.201	.175	.153	.133	.112	.095	.078	24	.531	.469	.408	.354	.299	.253	.208
10	.223	.196	.171	.148	.125	.106	.087	25	.552	.486	.424	.367	.311	.263	.216
11	.245	.216	.188	.163	.139	.117	.096	26	.573	.506	.441	.382	.323	.274	.225
12	.268	.236	.206	.179	.151	.128	.105	27	.594	.524	.457	.396	.335	.284	.233
13	.290	.254	.222	.192	.163	.138	.113	28	.618	.545	.475	.411	.348	.294	.242
14	.312	.275	.239	.207	.175	.148	.122	29	.638	.564	.491	.424	.361	.303	.250
15	.334	.295	.257	.223	.188	.159	.131	30	.660	.583	.508	.438	.374	.313	.259

SLOPE REDUCTIONS.

When distances are measured on a slope they may be reduced to the equivalent horizontal distance by the following approximate rule:—subtract from the slope distance the square of the rise divided by twice the slope distance. Thus for a slope distance of 250.3 ft. and a rise of 15 ft. correction$=15^2 \div 2\times 250.3=.45$ (by slide rule) or horizontal distance$=250.3-.45=249.85$. When vertical angle=V. A. is measured horizontal distance=slope distance—slope distance (1—Cos. V. A.). Thus for slope distance of 248.7 ft. and V. A. of 4° 20′ from Table VIII Cos=.99714 and correction$=1-.99714=.00286$ per foot or total of $.286\times 2\frac{1}{2}$ (near enough)=.57 and horizontal distance$=248.7-.57=248.13$ ft.

TRIGONOMETRICAL FORMULAS.

See fig. (a).

sin. $A=\frac{a}{c}$

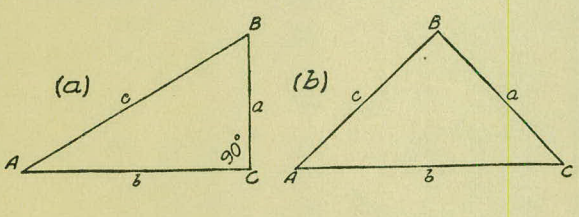
cos. $A=\frac{b}{c}$

tan. $A=\frac{a}{b}$

cot. $A=\frac{b}{a}$

sec. $A=\frac{c}{b}$

cosec. $A=\frac{c}{a}$



Formula for Solving Triangles.

Given	Sought.	Right triangles. See fig. (a).
a, c	A, B, b	$\sin. A=\frac{a}{c}$, $\cos. B=\frac{a}{c}$, $b=\sqrt{(c+a)(c-a)}$
a, b	A, B, c	$\tan. A=\frac{a}{b}$, $\cot. B=\frac{a}{b}$, $c=\sqrt{a^2+b^2}$.
A, a	B, b, c	$B=90°-A$, $b=a \cot. A$, $c=\frac{a}{\sin. A}$.
A, b	B, a, c	$B=90°-A$, $a=b \tan. A$, $c=\frac{b}{\cos. A}$.
A, c	B, a, b	$B=90°-A$, $a=c \sin. A$, $b=c \cos. A$
Given	**Sought.**	**Oblique triangles. See fig. (b).**
A, B, a	b	$b=\frac{a \sin. B}{\sin. A}$
A, a, b	B	$\sin. B=\frac{b \sin. A}{a}$
a, b, C	$A-B$	$\tan. \frac{1}{2}(A-B)=\frac{(a-b) \tan. \frac{1}{2}(A+B)}{a+b}$
a, b, c	A	If $s=\frac{1}{2}(a+b+c)$, $\sin. \frac{1}{2}A=\sqrt{\frac{(s-b)(s-c)}{bc}}$, $\cos. \frac{1}{2}A=\sqrt{\frac{s(s-a)}{bc}}$, $\tan. \frac{1}{2}A=\sqrt{\frac{(s-b)(s-c)}{s(s-a)}}$, $\sin. A=\frac{2\sqrt{(s-a)(s-b)(s-c)s}}{bc}$
A, B, C, a	area	$\text{area}=\frac{a^2 \sin. B \sin. C}{2 \sin. A}$
A, b, c	area	$\text{area}=\frac{1}{2} b c \sin. A$
a, b, c	area	$s=\frac{1}{2}(a+b+c)$, $\text{area}=\sqrt{s(s-a)(s-b)(s-c)}$

Table VIII.—Natural Trigonometrical Functions.

Angle	Sine.	Tan.	Cotg.	Cosin.		Angle	Sine.	Tan.	Cotg.	Cosin.	
o/						o/					
0	0	0	00	1	90	8	.1392	.1405	7.115	.99027	82
10	.0029	.0029	343.8	I	50	10	.1421	.1435	6.968	.98986	50
20	.0058	.0058	171.9	.99998	40	20	.1449	.1465	6.827	.98944	40
30	.0087	.0087	114.6	.99996	30	30	.1478	.1495	6.691	.98902	30
40	.0116	.0116	85.94	.99993	20	40	.1507	.1524	6.561	.98858	20
50	.0145	.0145	68.75	.99989	10	50	.1536	.1554	6.435	.98814	10
1	.0175	.0175	57.29	.99985	89	9	.1564	.1584	6.314	.98769	81
10	.0204	.0204	49.10	.99979	50	10	.1593	.1614	6.197	.98723	50
20	.0233	.0233	42.96	.99973	40	20	.1622	.1644	6.084	.98676	40
30	.0262	.0262	38.19	.99966	30	30	.1650	.1673	5.976	.98629	30
40	.0291	.0291	34.37	.99958	20	40	.1679	.1703	5.871	.98580	20
50	.0320	.0320	31.24	.99949	10	50	.1708	.1733	5.769	.98531	10
2	.0349	.0349	28.64	.99939	88	10	.1736	.1763	5.671	.98481	80
10	.0378	.0378	26.43	.99929	50	10	.1765	.1793	5.576	.98430	50
20	.0407	.0407	24.54	.99917	40	20	.1794	.1823	5.485	.98378	40
30	.0436	.0437	22.90	.99905	30	30	.1822	.1853	5.396	.98325	30
40	.0465	.0466	21.47	.99892	20	40	.1851	.1883	5.309	.98272	20
50	.0494	.0495	20.21	.99878	10	50	.1880	.1914	5.226	.98218	10
3	.0523	.0524	19.08	.99863	87	11	.1908	.1944	5.145	.98163	79
10	.0552	.0553	18.07	.99847	50	10	.1937	.1974	5.066	.98107	50
20	.0581	.0582	17.17	.99831	40	20	.1965	.2004	4.989	.98050	40
30	.0610	.0612	16.35	.99813	30	30	.1994	.2035	4.915	.97992	30
40	.0640	.0641	15.60	.99795	20	40	.2022	.2065	4.843	.97934	20
50	.0669	.0670	14.92	.99776	10	50	.2051	.2095	4.773	.97875	10
4	.0698	.0699	14.30	.99756	86	12	.2079	.2126	4.705	.97815	78
10	.0727	.0729	13.73	.99736	50	10	.2108	.2156	4.638	.97754	50
20	.0756	.0758	13.20	.99714	40	20	.2136	.2186	4.574	.97692	40
30	.0785	.0787	12.71	.99692	30	30	.2164	.2217	4.511	.97630	30
40	.0814	.0816	12.25	.99668	20	40	.2193	.2247	4.449	.97566	20
50	.0843	.0846	11.83	.99644	10	50	.2221	.2278	4.390	.97502	10
5	.0872	.0875	11.43	.99619	85	13	.2250	.2309	4.331	.97437	77
10	.0901	.0904	11.06	.99594	50	10	.2278	.2339	4.275	.97371	50
20	.0929	.0934	10.71	.99567	40	20	.2306	.2370	4.219	.97304	40
30	.0958	.0963	10.39	.99540	30	30	.2334	.2401	4.165	.97237	30
40	.0987	.0992	10.08	.99511	20	40	.2363	.2432	4.113	.97169	20
50	.1016	.1022	9.788	.99482	10	50	.2391	.2462	4.061	.97100	10
6	.1045	.1051	9.514	.99452	84	14	.2419	.2493	4.011	.97030	76
10	.1074	.1080	9.255	.99421	50	10	.2447	.2524	3.962	.96959	50
20	.1103	.1110	9.010	.99390	40	20	.2476	.2555	3.914	.96887	40
30	.1132	.1139	8.777	.99357	30	30	.2504	.2586	3.867	.96815	30
40	.1161	.1169	8.556	.99324	20	40	.2532	.2617	3.821	.96742	20
50	.1190	.1198	8.345	.99290	10	50	.2560	.2648	3.776	.96667	10
7	.1219	.1228	8.144	.99255	83	15	.2588	.2679	3.732	.96593	75
10	.1248	.1257	7.953	.99219	50	10	.2616	.2711	3.689	.96517	50
20	.1276	.1287	7.770	.99182	40	20	.2644	.2742	3.647	.96440	40
30	.1305	.1317	7.596	.99144	30	30	.2672	.2773	3.606	.96363	30
40	.1334	.1346	7.429	.99106	20	40	.2700	.2805	3.566	.96285	20
50	.1363	.1376	7.269	.99067	10	50	.2728	.2836	3.526	.96206	10
					82						74
	Cosin.	Cotg.	Tan.	Sine.	Angle.		Cosin.	Cotg.	Tan.	Sine.	Angle.

Table VIII.—Natural Trigonometrical Functions.

Angle	Sine.	Tan.	Cotg.	Cosin.	
°					
16	.2756	.2867	3.487	.96126	74
10	.2784	.2899	3.450	.96046	50
20	.2812	.2931	3.412	.95964	40
30	.2840	.2962	3.376	.95882	30
40	.2868	.2994	3.340	.95799	20
50	.2896	.3026	3.305	.95715	10
17	.2924	.3057	3.271	.95615	73
10	.2952	.3089	3.237	.95545	50
20	.2979	.3121	3.204	.95459	40
30	.3007	.3153	3.172	.95372	30
40	.3035	.3185	3.140	.95284	20
50	.3062	.3217	3.108	.95195	10
18	.3090	.3249	3.078	.95106	72
10	.3118	.3281	3.048	.95015	50
20	.3145	.3314	3.018	.94924	40
30	.3173	.3346	2.989	.94832	30
40	.3201	.3378	2.960	.94740	20
50	.3228	.3411	2.932	.94646	10
19	.3256	.3443	2.904	.94552	71
10	.3283	.3476	2.877	.94457	50
20	.3311	.3508	2.850	.94361	40
30	.3338	.3541	2.824	.94264	30
40	.3365	.3574	2.798	.94167	20
50	.3393	.3607	2.773	.94068	10
20	.3420	.3640	2.747	.93969	70
10	.3448	.3673	2.723	.93869	50
20	.3475	.3706	2.669	.93769	40
30	.3502	.3739	2.675	.93667	30
40	.3529	.3772	2.651	.93565	20
50	.3557	.3805	2.628	.93462	10
21	.3584	.3839	2.605	.93358	69
10	.3611	.3872	2.583	.93253	50
20	.3638	.3906	2.560	.93148	40
30	.3665	.3939	2.539	.93042	30
40	.3692	.3973	2.517	.92935	20
50	.3719	.4006	2.496	.92827	10
22	.3746	.4040	2.475	.92718	68
10	.3773	.4074	2.455	.92609	50
20	.3800	.4108	2.434	.92499	40
30	.3827	.4142	2.414	.92388	30
40	.3854	.4176	2.394	.92276	20
50	.3881	.4210	2.375	.92164	10
23	.3907	.4245	2.356	.92050	67
10	.3934	.4279	2.337	.91936	50
20	.3961	.4314	2.318	.91822	40
30	.3987	.4348	2.300	.91706	30
40	.4014	.4383	2.282	.91590	20
50	.4041	.4417	2.264	.91472	10
					66
	Cosin.	Cotg.	Tan.	Sine.	Angle.

Angle	Sine.	Tan.	Cotg.	Cosin.	
°					
24	.4067	.4452	2.246	.91355	66
10	.4094	.4487	2.229	.91236	50
20	.4120	.4522	2.211	.91116	40
30	.4147	.4557	2.194	.90996	30
40	.4173	.4592	2.177	.90875	20
50	.4200	.4628	2.161	.90753	10
25	.4226	.4663	2.145	.90631	65
10	.4253	.4699	2.128	.90507	50
20	.4279	.4734	2.112	.90383	40
30	.4305	.4770	2.097	.90259	30
40	.4331	.4806	2.081	.90133	20
50	.4358	.4841	2.066	.90007	10
26	.4384	.4877	2.050	.89879	64
10	.4410	.4913	2.035	.89752	50
20	.4436	.4950	2.020	.89623	40
30	.4462	.4986	2.006	.89493	30
40	.4488	.5022	1.991	.89363	20
50	.4514	.5059	1.977	.89232	10
27	.4540	.5095	1.963	.89101	63
10	.4566	.5132	1.949	.88968	50
20	.4592	.5169	1.935	.88835	40
30	.4617	.5206	1.921	.88701	30
40	.4643	.5243	1.907	.88566	20
50	.4669	.5280	1.894	.88431	10
28	.4695	.5317	1.881	.88295	62
10	.4720	.5354	1.868	.88158	50
20	.4746	.5392	1.855	.88020	40
30	.4772	.5430	1.842	.87882	30
40	.4797	.5467	1.829	.87743	20
50	.4823	.5505	1.816	.87603	10
29	.4848	.5543	1.804	.87462	61
10	.4874	.5581	1.792	.87321	50
20	.4899	.5619	1.780	.87178	40
30	.4924	.5658	1.767	.87036	30
40	.4950	.5696	1.756	.86892	20
50	.4975	.5735	1.744	.86748	10
30	.5000	.5774	1.732	.86603	60
10	.5025	.5812	1.720	.86457	50
20	.5050	.5851	1.709	.86310	40
30	.5075	.5890	1.698	.86163	30
40	.5100	.5930	1.686	.86015	20
50	.5125	.5969	1.675	.85866	10
31	.5150	.6009	1.664	.85717	59
10	.5175	.6048	1.653	.85567	50
20	.5200	.6088	1.643	.85416	40
30	.5225	.6128	1.632	.85264	30
40	.5250	.6168	1.621	.85112	20
50	.5275	.6208	1.611	.84959	10
					58
	Cosin.	Cotg.	Tan.	Sine.	Angle.

Table VIII.—Natural Trigonometrical Functions.

Angle	Sine.	Tan.	Cotg.	Cosin.		Angle	Sine.	Tan.	Cotg.	Cosin.	
° ′						° ′					
32	.5299	.6249	1.600	.84805	58	30	.6225	.7954	1.257	.78261	30
10	.5324	.6289	1.590	.84650	50	40	.6248	.8002	1.250	.78079	20
20	.5348	.6330	1.580	.84495	40	50	.6271	.8050	1.242	.77897	10
30	.5373	.6371	1.570	.84339	30						
40	.5398	.6412	1.560	.84182	20	39	.6293	.8098	1.235	.77715	51
50	.5422	.6453	1.550	.84025	10	10	.6316	.8146	1.228	.77531	50
						20	.6338	.8195	1.220	.77347	40
33	.5446	.6494	1.540	.83867	57	30	.6361	.8243	1.213	.77162	30
10	.5471	.6536	1.530	.83708	50	40	.6383	.8292	1.206	.76977	20
20	.5495	.6577	1.520	.83549	40	50	.6406	.8342	1.199	.76791	10
30	.5519	.6619	1.511	.83389	30						
40	.5544	.6661	1.501	.83228	20	40	.6428	.8391	1.192	.76604	50
50	.5568	.6703	1.492	.83066	10	10	.6450	.8441	1.185	.76417	50
						20	.6472	.8491	1.178	.76229	40
34	.5592	.6745	1.483	.82904	56	30	.6494	.8541	1.171	.76041	30
10	.5616	.6787	1.473	.82741	50	40	.6517	.8591	1.164	.75851	20
20	.5640	.6830	1.464	.82577	40	50	.6539	.8642	1.157	.75661	10
30	.5664	.6873	1.455	.82413	30						
40	.5688	.6916	1.446	.82248	20	41	.6561	.8693	1.150	.75471	49
50	.5712	.6959	1.437	.82082	10	10	.6583	.8744	1.144	.75280	50
						20	.6604	.8796	1.137	.75088	40
35	.5736	.7002	1.428	.81915	55	30	.6626	.8847	1.130	.74896	30
10	.5760	.7046	1.419	.81748	50	40	.6648	.8899	1.124	.74703	20
20	.5783	.7089	1.411	.81580	40	50	.6670	.8952	1.117	.74509	10
30	.5807	.7133	1.402	.81412	30						
40	.5831	.7177	1.393	.81242	20	42	.6691	.9004	1.111	.74314	48
50	.5854	.7221	1.385	.81072	10	10	.6713	.9057	1.104	.74120	50
						20	.6734	.9110	1.098	.73924	40
36	.5878	.7265	1.376	.80902	54	30	.6756	.9163	1.091	.73728	30
10	.5901	.7310	1.368	.80730	50	40	.6777	.9217	1.085	.73531	20
20	.5925	.7355	1.360	.80558	40	50	.6799	.9271	1.079	.73333	10
30	.5948	.7400	1.351	.80386	30						
40	.5972	.7445	1.343	.80212	20	43	.6820	.9325	1.072	.73135	47
50	.5995	.7490	1.335	.80038	10	10	.6841	.9380	1.066	.72937	50
						20	.6862	.9435	1.060	.72737	40
37	.6018	.7536	1.327	.79864	53	30	.6884	.9490	1.054	.72537	30
10	.6041	.7581	1.319	.79688	50	40	.6905	.9545	1.048	.72337	20
20	.6065	.7627	1.311	.79512	40	50	.6926	.9601	1.042	.72136	10
30	.6088	.7673	1.303	.79335	30						
40	.6111	.7720	1.295	.79158	20	44	.6947	.9657	1.036	.71934	46
50	.6134	.7766	1.288	.78980	10	10	.6967	.6713	1.030	.71732	50
						20	.6988	.9770	1.024	.71529	40
38	.6157	.7813	1.280	.78801	52	30	.7009	.9827	1.018	.71325	30
10	.6180	.7860	1.272	.78622	50	40	.7030	.9884	1.012	.71121	20
20	.6202	.7907	1.265	.78442	40	50	.7050	.9942	1.006	.70916	10
							.7071	1.	1.	.70711	45
											°
	Cosin.	Cotg.	Tan.	Sine.	Angle.		Cosin.	Cotg.	Tan.	Sine.	Angle.

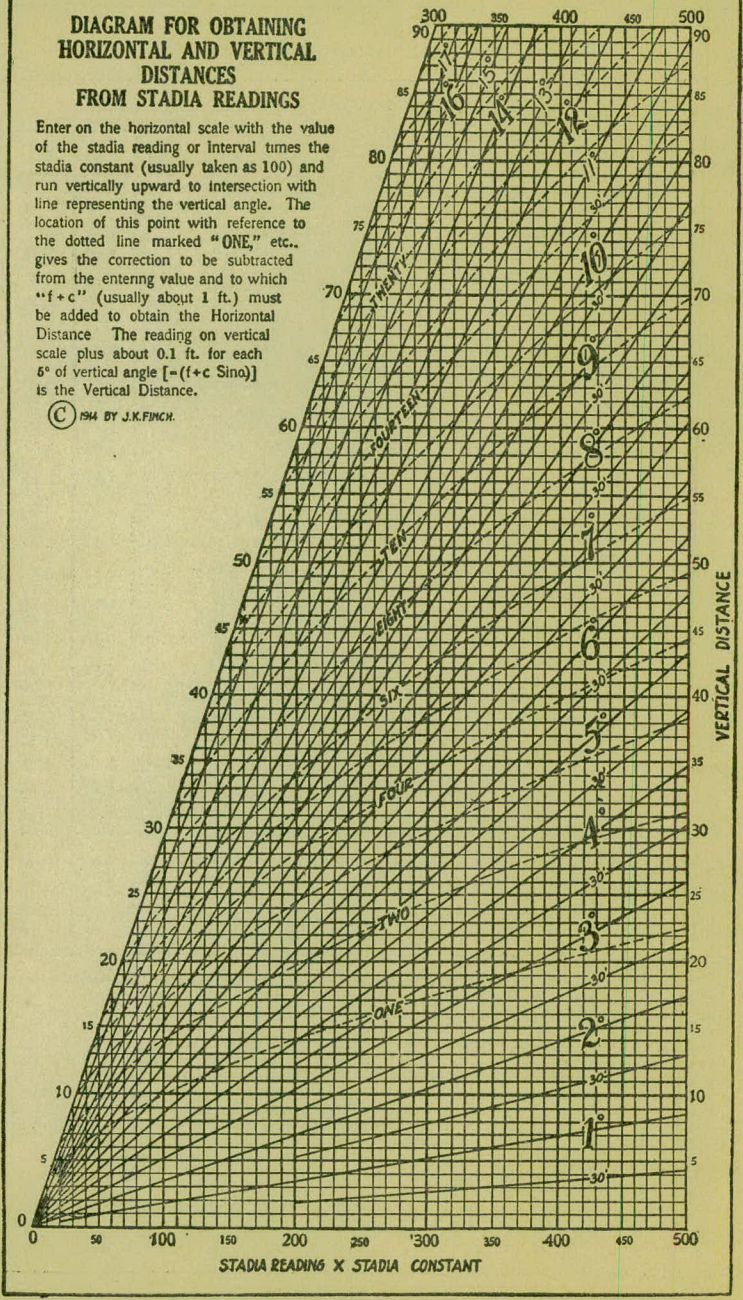
Table IX.—Calculation of Earthwork.

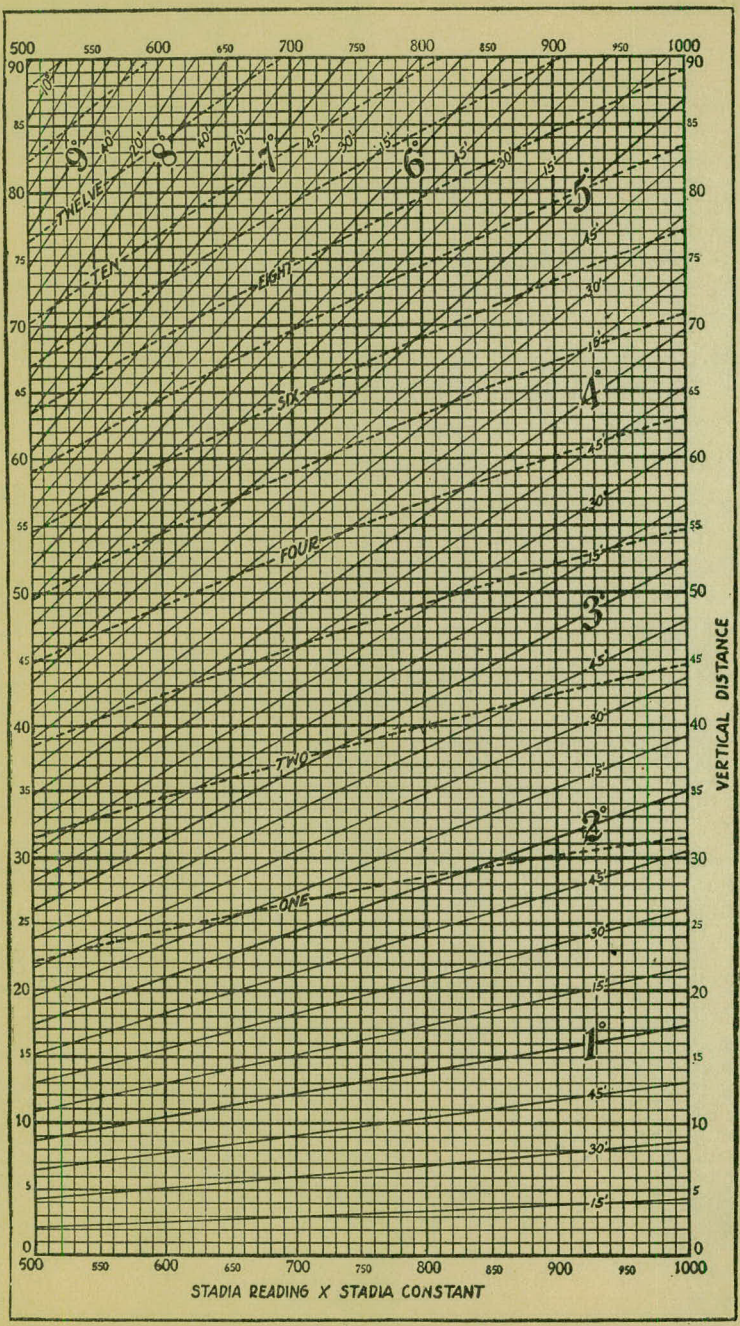
Width	HEIGHT														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	.02	.04	.06	.07	.09	.11	.13	.15	.17	.18	.20	.22	.24	.26	.28
2	.04	.07	.11	.15	.18	.22	.26	.30	.33	.37	.41	.44	.48	.52	.56
3	.06	.11	.17	.22	.28	.33	.39	.44	.50	.56	.61	.67	.72	.78	.83
4	.07	.15	.22	.30	.37	.44	.52	.59	.67	.74	.81	.89	.96	1.04	1.11
5	.09	.19	.28	.37	.46	.56	.65	.74	.83	.93	1.02	1.11	1.20	1.30	1.39
6	.11	.22	.33	.44	.56	.67	.78	.89	1.00	1.11	1.22	1.33	1.44	1.55	1.67
7	.13	.26	.39	.52	.65	.78	.91	1.04	1.16	1.30	1.42	1.55	1.68	1.81	1.94
8	.15	.30	.44	.59	.74	.89	1.04	1.19	1.33	1.48	1.63	1.78	1.92	2.08	2.22
9	.17	.33	.50	.67	.83	1.00	1.17	1.33	1.50	1.67	1.83	2.00	2.17	2.33	2.50
10	.18	.37	.56	.74	.93	1.11	1.30	1.48	1.67	1.85	2.04	2.22	2.41	2.59	2.78
11	.20	.41	.61	.82	1.02	1.22	1.43	1.63	1.83	2.04	2.24	2.44	2.65	2.85	3.06
12	.22	.44	.67	.89	1.11	1.33	1.56	1.78	2.00	2.22	2.44	2.67	2.89	3.11	3.33
13	.24	.48	.72	.96	1.20	1.44	1.68	1.92	2.16	2.41	2.65	2.89	3.13	3.37	3.61
14	.26	.52	.78	1.04	1.30	1.55	1.81	2.08	2.33	2.59	2.85	3.11	3.37	3.63	3.89
15	.28	.56	.83	1.11	1.39	1.67	1.94	2.22	2.50	2.78	3.06	3.33	3.61	3.89	4.17
16	.30	.59	.89	1.18	1.48	1.78	2.07	2.37	2.67	2.96	3.26	3.56	3.85	4.15	4.44
17	.31	.63	.94	1.26	1.57	1.89	2.20	2.52	2.83	3.15	3.46	3.78	4.09	4.41	4.72
18	.33	.67	1.00	1.33	1.67	2.00	2.33	2.67	3.00	3.33	3.67	4.00	4.33	4.67	5.00
19	.35	.70	1.06	1.41	1.76	2.11	2.46	2.82	3.17	3.52	3.87	4.22	4.57	4.92	5.28
20	.37	.74	1.11	1.48	1.85	2.22	2.59	2.96	3.33	3.70	4.07	4.44	4.81	5.18	5.56
21	.39	.78	1.17	1.55	1.94	2.33	2.72	3.11	3.50	3.89	4.28	4.67	5.06	5.44	5.83
22	.41	.81	1.22	1.63	2.04	2.44	2.85	3.26	3.67	4.07	4.48	4.89	5.30	5.70	6.11
23	.43	.85	1.28	1.70	2.13	2.56	2.98	3.41	3.83	4.26	4.68	5.11	5.54	5.96	6.39
24	.44	.89	1.33	1.78	2.22	2.67	3.11	3.56	4.00	4.44	4.89	5.33	5.78	6.22	6.67
25	.46	.92	1.39	1.85	2.31	2.78	3.24	3.70	4.17	4.63	5.09	5.56	6.02	6.48	6.94
26	.48	.96	1.44	1.92	2.41	2.89	3.37	3.85	4.33	4.82	5.30	5.78	6.26	6.74	7.24
27	.50	1.00	1.50	2.00	2.50	3.00	3.50	4.00	4.50	5.00	5.50	6.00	6.50	7.00	7.50
28	.52	1.04	1.55	2.07	2.59	3.11	3.63	4.15	4.67	5.18	5.70	6.22	6.74	7.26	7.78
29	.54	1.07	1.61	2.15	2.68	3.22	3.76	4.30	4.83	5.37	5.91	6.44	6.98	7.52	8.06
30	.56	1.11	1.67	2.22	2.78	3.33	3.89	4.44	5.00	5.55	6.11	6.67	7.22	7.78	8.33
31	.57	1.15	1.72	2.30	2.87	3.44	4.02	4.59	5.17	5.74	6.32	6.89	7.46	8.04	8.61
32	.59	1.18	1.78	2.37	2.96	3.56	4.15	4.74	5.33	5.92	6.52	7.11	7.70	8.30	8.89
33	.61	1.22	1.83	2.44	3.05	3.67	4.28	4.89	5.50	6.11	6.72	7.33	7.94	8.55	9.17
34	.63	1.26	1.89	2.52	3.15	3.78	4.40	5.04	5.67	6.29	6.93	7.56	8.18	8.81	9.44
35	.65	1.30	1.94	2.59	3.24	3.89	4.53	5.18	5.83	6.48	7.13	7.78	8.42	9.08	9.72
36	.67	1.33	2.00	2.67	3.33	4.00	4.66	5.33	6.00	6.67	7.33	8.00	8.67	9.33	10.00
37	.68	1.37	2.06	2.74	3.42	4.11	4.79	5.48	6.17	6.85	7.54	8.22	8.91	9.59	10.28
38	.70	1.41	2.11	2.82	3.52	4.22	4.92	5.63	6.33	7.03	7.74	8.44	9.15	9.85	10.56
39	.72	1.44	2.17	2.89	3.61	4.33	5.05	5.78	6.50	7.22	7.95	8.67	9.39	10.11	10.83
40	.74	1.48	2.22	2.96	3.70	4.44	5.18	5.92	6.67	7.41	8.15	8.89	9.63	10.37	11.11

Table gives cu. yds. in 1 ft. of a triangle of given width and height. Corrections for tenths of width are one tenth the values found under each height considering the widths from 1 to 9 as tenths and similarly the corrections for tenths of height are one tenth the figures opposite width considering the heights from 1 to 9 as tenths. Thus if w =16.2 and h =5.3, cu. yds. =1.48+.028+.089 =1.597 cu. yds. or practically 160 cu. yds. per 100 ft. If w exceeds 40 ft., use one half and multiply result by 2, if both w and h are large use one half of each and multiply result by 4. Any cross-section may be divided into triangles by the following rule. To the triangle of the sum of the outside cuts (or fills) =h, and ½ the roadbed =w, add the triangles formed by taking the distance out to each break in turn (=w's) by the difference between the cuts (or fills) on each side of it (=h's) always subtracting the outer from the inner.

DIAGRAM FOR OBTAINING HORIZONTAL AND VERTICAL DISTANCES FROM STADIA READINGS

Enter on the horizontal scale with the value of the stadia reading or interval times the stadia constant (usually taken as 100) and run vertically upward to intersection with line representing the vertical angle. The location of this point with reference to the dotted line marked "ONE," etc.. gives the correction to be subtracted from the entering value and to which "f + c" (usually about 1 ft.) must be added to obtain the Horizontal Distance The reading on vertical scale plus about 0.1 ft. for each 6° of vertical angle [=(f+c Sinα)] is the Vertical Distance.




500 550 600 650 700 750 800 850 900 950 1000
90 85 80 75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0
TWELVE
TEN
EIGHT
SIX
FOUR
TWO
ONE
9° 40' 20'
8° 40' 20'
7° 45' 30' 15'
6° 45' 30' 15'
5° 45' 30' 15'
4° 45' 30' 15'
3° 45' 30' 15'
2° 45' 30' 15'
1° 45' 30' 15'
VERTICAL DISTANCE
STADIA READING X STADIA CONSTANT

DISTANCES FROM CENTER OF ROADWAY FOR CROSS-SECTIONING.

Roadway 16 feet wide. Side Slopes 1 on 1½.

For Single Track Embankment.

	.1	.2	.3	.4	.5	.6	.7	.8	.9	
0	8.[illegible]	8.2	8.3	8.5	8.6	8.8	8.9	9.1	9.2	9.4	0
1	9.5	9.7	9.8	10.0	10.1	10.3	10.4	10.6	10.7	10.9	1
2	11.0	11.2	11.3	11.5	11.6	11.8	11.9	12.1	12.2	12.4	2
3	12.5	12.7	12.8	13.0	13.1	13.3	13.4	13.6	13.7	13.9	3
4	14.0	14.2	14.3	14.5	14.6	14.8	14.9	15.1	15.2	15.4	4
5	15.5	15.7	15.8	16.0	16.1	16.3	16.4	16.6	16.7	16.9	5
6	17.0	17.2	17.3	17.5	17.6	17.8	17.9	18.1	18.2	18.4	6
7	18.5	18.7	18.8	19.0	19.1	19.3	19.4	19.6	19.7	19.9	7
8	20.0	20.2	20.3	20.5	20.6	20.8	20.9	21.1	21.2	21.4	8
9	21.5	21.7	21.8	22.0	22.1	22.3	22.4	22.6	22.7	22.9	9
10	23.0	23.2	23.3	23.5	23.6	23.8	23.9	24.1	24.2	24.4	10
11	24.5	24.7	24.8	25.0	25.1	25.3	25.4	25.6	25.7	25.9	11
12	26.0	25.2	26.3	26.5	26.6	26.8	26.9	27.1	27.2	27.4	12
13	27.5	27.7	27.8	28.0	28.1	28.3	28.4	28.6	28.7	28.9	13
14	29.0	29.2	29.3	29.5	29.6	29.8	29.9	30.1	30.2	30.4	14
15	30.5	30.7	30.8	31.0	31.1	31.3	31.4	31.6	31.7	31.9	15
16	32.0	32.2	32.3	32.5	32.6	32.8	32.9	33.1	33.2	33.4	16
17	33.5	33.7	33.8	34.0	34.1	34.3	34.4	34.6	34.7	34.9	17
18	35.0	35.2	35.3	35.5	35.6	35.8	35.9	36.1	36.2	36.4	18
19	36.5	36.7	36.8	37.0	37.1	37.3	37.4	37.6	37.7	37.9	19
20	38.0	38.2	38.3	38.5	38.6	38.8	38.9	39.1	39.2	39.4	20
21	39.5	39.7	39.8	40.0	40.1	40.3	40.4	40.6	40.7	40.9	21
22	41.0	41.2	41.3	41.5	41.6	41.8	41.9	42.1	42.2	42.4	22
23	42.5	42.7	42.8	43.0	43.1	43.3	43.4	43.6	43.7	43.9	23
24	44.0	44.2	44.3	44.5	44.6	44.8	44.9	45.1	45.2	45.4	24
25	45.5	45.7	45.8	46.0	46.1	46.3	46.4	46.6	46.7	46.9	25
26	47.0	47.2	47.3	47.5	47.6	47.8	47.9	48.1	48.2	48.4	26
27	48.5	48.7	48.8	49.0	49.1	49.3	49.4	49.6	49.7	49.9	27
28	50.0	50.2	50.3	50.5	50.6	50.8	50.9	51.1	51.2	51.4	28
29	51.5	51.7	51.8	52.0	52.1	52.3	52.4	52.6	52.7	52.9	29
30	53.0	53.2	53.3	53.5	53.6	53.8	53.9	54.1	54.2	54.4	30
31	54.5	54.7	54.8	55.0	55.1	55.3	55.4	55.6	55.7	55.9	31
32	56.0	56.2	56.3	56.5	56.6	56.8	56.9	57.1	57.2	57.4	32
33	57.5	57.7	57.8	58.0	58.1	58.3	58.4	58.6	58.7	58.9	33
34	59.0	59.2	59.3	59.5	59.6	59.8	59.9	60.1	60.2	60.4	34
35	60.5	60.7	60.8	61.0	61.1	61.3	61.4	61.6	61.7	61.9	35
36	62.0	62.2	62.3	62.5	62.6	62.8	62.9	63.1	63.2	63.4	36
37	63.5	63.7	63.8	64.0	64.1	64.3	64.4	64.6	64.7	64.9	37
38	65.0	65.2	65.3	65.5	65.6	65.8	65.9	66.1	66.2	66.4	38
39	66.5	66.7	66.8	67.0	67.1	67.3	67.4	67.6	67.7	67.9	39
40	68.0	68.2	68.3	68.5	68.6	68.8	68.9	69.1	69.2	69.4	40

Example—If point is 22.6 ft. above grade, how far should it be from center line to be a slope stake point? Ans. from Table 41.9. For same slopes but other widths of roadbed correct above figures by one-half difference in width of roadbed; thus in example above for 20 ft. roadbed distance will be 41.9+(20—16)÷2 or 2 ft. added to 41.9 =43.9. For slopes of 1 on 1 see inside of front cover.

Made in Germany.