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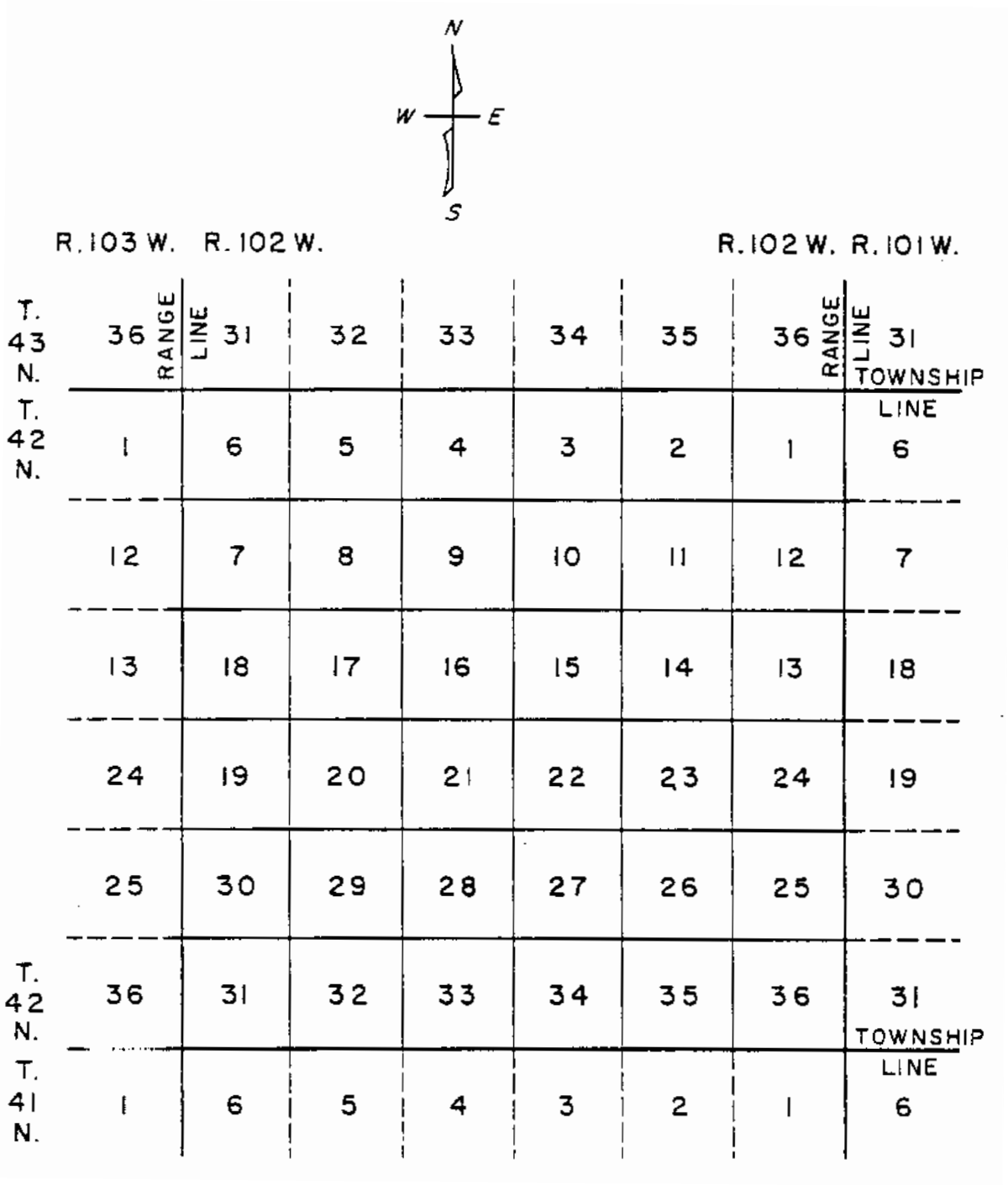
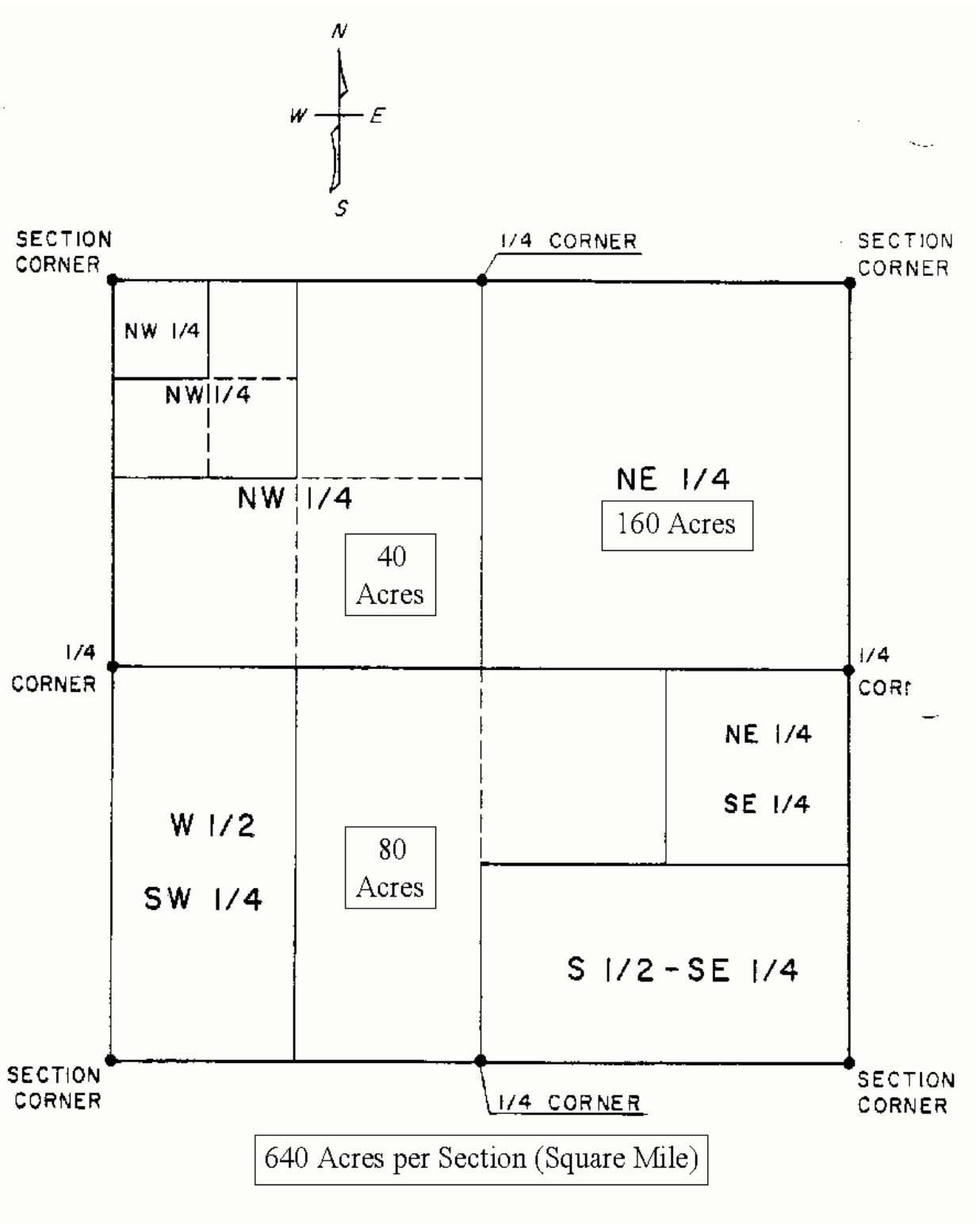
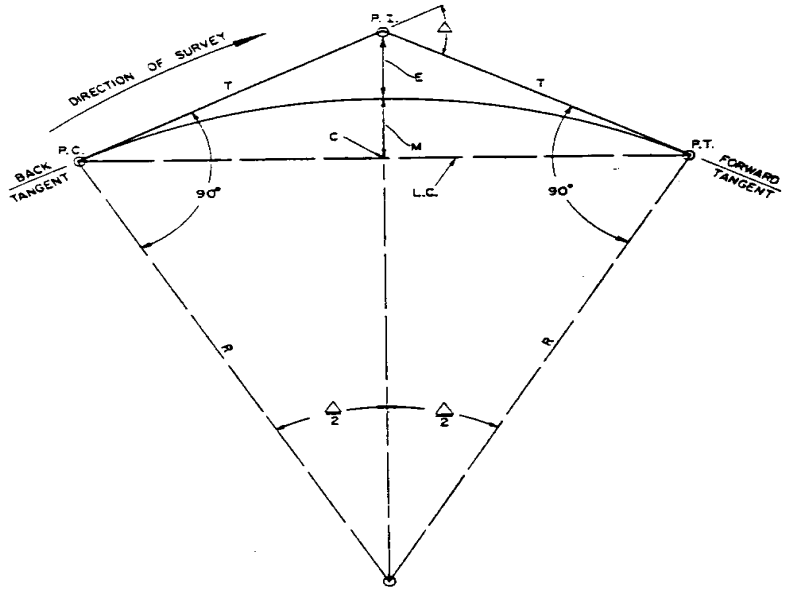
1301 TOWNSHIP SUBDIVISION



1302 SECTION SUBDIVISION



1303 CURVE COMPUTATION BY ARC DEFINITION



P.I. = POINT OF INTERSECTION

P.C. = POINT OF CURVATURE

P.T. = POINT OF TANGENCY

Δ = DEFLECTION ANGLE
BETWEEN THE TANGENTS

T = TANGENT DISTANCE

E = EXTERNAL DISTANCE

R = RADIUS OF THE CIRCULAR ARC

M = MIDDLE ORDINATE

L.C. = LONG CHORD
(DISTANCE BETWEEN P.C. AND P.T.)

C = MIDPOINT OF LONG CHORD

D = DEGREE OF CURVATURE

GENERAL FORMULAS FOR ARC DEFINITION

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

$D = 5729.578 / R$

$L.C. = 2 R \sin(\Delta / 2)$

$E = T \tan(\Delta / 4)$

WHEN ‘R’ IS KNOWN, $E = R \sec(\Delta / 2) - R = R \operatorname{exsec}(\Delta / 2)$

$M = E \cos(\Delta / 2)$

WHEN ‘R’ IS KNOWN, $M = R (1 - \cos(\Delta / 2)) = R \operatorname{vers}(\Delta / 2)$

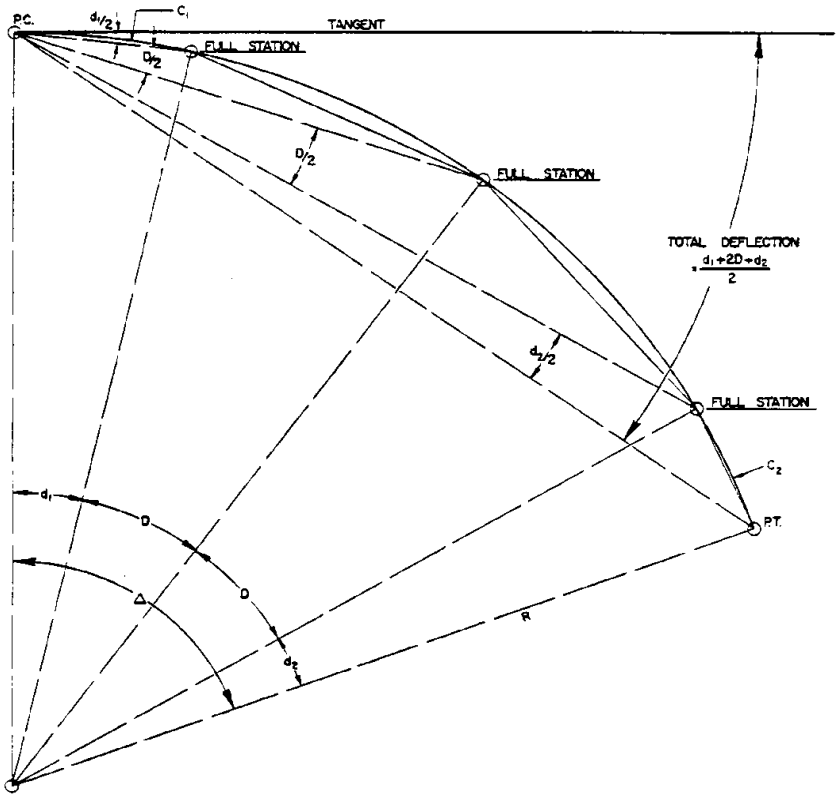
LENGTH OF CURVE, $L = (100 \Delta) / D$ WHEN Δ AND ‘D’ ARE IN MINUTES

LOCATING THE P.C. AND P.T.

STA. P.C. = STA. P. I. - T

STA. P.T. = STA. P.C. + L

1304 CURVE COMPUTATION BY DEFLECTION ANGLE



D = CENTRAL ANGLE FOR A FULL STATION OF ARC LENGTH

C_1 = LENGTH OF ARC FROM P.C. TO THE FIRST FULL STATION

C_2 = LENGTH OF ARC FROM THE LAST FULL STATION TO P.T.

1. FROM THE GENERAL FORMULAS IN FIGURE 12-100.1, COMPUTE 'D' AND STATIONS P.C. AND P.T.
2. SOLVING FOR THE DEFLECTION ANGLES, IN MINUTES, HAVING LENGTHS OF THE ARC LESS THAN A FULL STATION,

   $d_1 / 2 = 0.30\ C_1\ D$

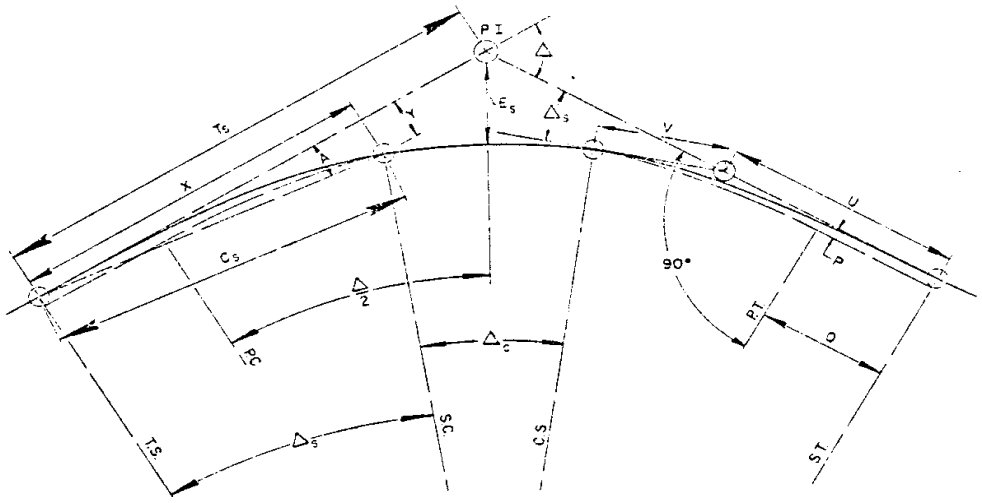
   $d_2 / 2 = 0.30\ C_2\ D$
3. THE DEFLECTION ANGLE IN DEGREES, FOR A FULL STATION ARC

   LENGTH EQUALS D / 2.
4. THE DEFLECTION ANGLE, IN MINUTES, FOR ANY ARC LENGTH,

   DEFLECTION = (1718.873 / R) X ARC LENGTH
5. A RUNNING TOTAL OF STATION TO STATION DEFLECTIONS GIVES THE TOTAL DEFLECTION ANGLE FROM THE P.C.

   COMPUTE CHECK: THE TOTAL DEFLECTION ANGLE TO THE P.T. MUST EQUAL Δ / 2

1305 SPIRAL CURVE TRANSITIONS



L_S = LENGTH OF SPIRAL

D = DEGREE OF CURVATURE OF THE CIRCULAR CURVE

T_S = TANGENT DISTANCE

Δ = DEFLECTION ANGLE BETWEEN THE TANGENTS

Δ_S = SPIRAL ANGLE

Δ_C = CENTRAL ANGLE BETWEEN THE S.C. AND C.S.

E_S = EXTERNAL DISTANCE

C_S = LONG CHORD

U = LONG TANGENT

V = SHORT TANGENT

X = SPIRAL COORDINATE (ABSCISSA)

Y = SPIRAL COORDINATE (ORDINATE)

Q = SIMPLE CURVE COORDINATE (ABSCISSA)

P = SIMPLE CURVE COORDINATE (ORDINATE)

A = DEFLECTION ANGLE OF SPIRAL CURVE

K = CONSTANT OF INCREASING CURVATURE

T.S. = TANGENT TO SPIRAL

S.C. = SPIRAL TO CURVE

C.S. = CURVE TO SPIRAL

S.T. = SPIRAL TO TANGENT

SPIRAL CURVE FORMULAS:

$\Delta_S = (D\ L_S)/200$ $D = K\ L_S$ $\Delta_S = (K\ (L_S)^2)/200$

TO CALCULATE T_S AND E_S OF A SIMPLE CURVE WITH EQUAL SPIRALS:

$T_S = (R+P)\ TAN\ (\Delta / 2) + Q$ $E_S = (R+P)\ EXSEC\ (\Delta / 2) + P$

$T_S = T + Q + P\ \ TAN\ (\Delta / 2)$ $E_S = E + P/\ COS\ (\Delta / 2)$

TO CALCULATE THE TANGENT DISTANCES OF A SIMPLE CURVE WITH UNEQUAL SPIRALS:

$T_{S1} = ((R+P)_2 / SIN\Delta) - (R+P\ )_1\ COT\Delta + Q_1$ $T_{S2} = ((R+P)_1 / SIN\Delta) - (R+P\ )_2\ COT\Delta + Q_2$

FOR DEFLECTION ANGLES TO INTERMEDIATE POINTS ON A SPIRAL:

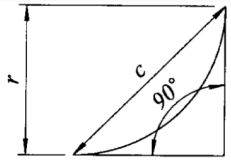
Δ (IN MINUTES) = 10K S^2, WHERE S = DISTANCE IN STATIONS TO POINT. THIS VALUE MAY HAVE TO BE ADJUSTED DOWNWARD. NOTE THAT THE ONE-TENTH MINUTES OF THE TABULATED DEFLECTION ANGLES FORM A WAVE LIKE PATTERN (EQUIVALENT TO THE ABOVE FORMULA) UNTIL THEY FALL OFF NEAR THE BOTTOM OF THE TABLE. ADJUSTMENTS FOR INTERMEDIATE POINTS MAY BE INTERPOLATED.

TO SET STAKES WITH THE INSTRUMENT SET UP AT A POINT ON THE SPIRAL, WE TAKE ADVANTAGE OF THE FACT THAT THE SPIRAL IS LAID OUT ON A SYSTEM OF COORDINATES. WE FIRST SET THE INSTRUMENT PLATE ZERO PARALLEL TO THE TANGENT TO THE SPIRAL. THIS IS DONE BY SIGHTING BACK ON THE T.S. WITH 'A' FOR THE INSTRUMENT SET-UP POINT ON THE PLATES; OR BY BRINGING THE INSTRUMENT TANGENT TO THE CURVE WITH Δ_S FOR THE INSTRUMENT SETUP POINTS ON THE PLATES. THEN THE DIFFERENCE BETWEEN COORDINATES OF POINTS TO BE SET AND THE INSTRUMENT GIVES US DEFLECTION ANGLES:

$$\text{DEFL. ANGLE} = \text{TAN}^{-1} (Y_1-Y_0)/(X_1-X_0)$$

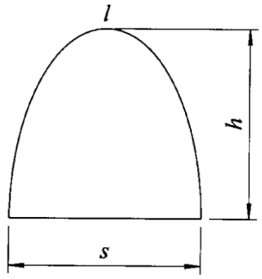
1306 GEOMETRIC SOLUTIONS

1306-1 Areas of Plane Figures



Spandrel

Area = $0.2146 r^2 = 0.1073 c^2$
Example $r = 3$
Area = $0.2146 \times 3^2 = 1.0314$ Ans.



Parabola

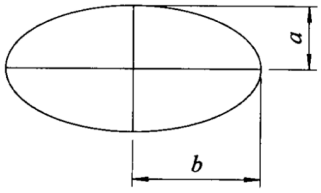
l = length of curvedline = periphery - s

$$l = \frac{s^2}{8h}\left[\sqrt{c(1+c)} + 2.0326 \times \log\left(\sqrt{c} + \sqrt{1+c}\right)\right] \text{ in which } c = \left(\frac{4h}{s}\right)^2$$

$$\text{Area} = \frac{l}{3} sh$$

Example $s = 3$; $h = 4$;

$$\text{Area} = \frac{l}{3} \times 3 \times 4 = 8 \text{ Ans.}$$



Ellipse

Area = π ab = 3.1416 ab

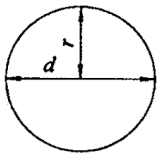
$$\textbf{Circum} = 2\pi \sqrt{\frac{a^2 + b^2}{2}}$$

(close approximation)

Example a = 3; b =4
Area = 3.1416 x 3 x 4 = 37.6992 Ans.

$$\textbf{Circum} = 2 \times 3.1416 \times \sqrt{\frac{3^2 + 4^2}{2}} = 6.2832 \times \sqrt{12.5} = 6.2832 \times 3.5355 = 22.21 \text{ Ans.}$$

Circle



$\pi = 3.1416$; $A =$ area; $d =$ diameter; $p =$ circumference or periphery; $r =$ radius;

$p = \pi d = 3.1416\,d.$ $\quad p = 2\sqrt{\pi A} = 3.54\sqrt{A}$

$p = 2\,\pi r = 6.2832\,r.$ $\quad p = \frac{2A}{r} = \frac{4A}{d}$

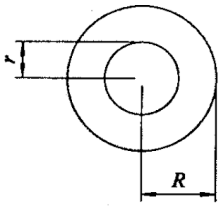
$d = \frac{p}{\pi} = \frac{p}{3.1416}$ $\quad d = 2\sqrt{\frac{A}{\pi}} = 1.128\sqrt{A}$

$r = \frac{p}{2\pi} = \frac{p}{6.2832}$ $\quad r = \sqrt{\frac{A}{\pi}} = 0.564\sqrt{A}$

$A = \frac{\pi d^2}{4} = 0.7854\,d^2$ $\quad A = \frac{p^2}{4\pi} = \frac{p^2}{12.57}$

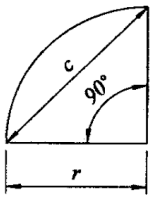
$A = \pi r^2 = 3.1416\,r^2$ $\quad A = \frac{pr}{2} = \frac{pd}{4}$

Circular Ring



Area $= \pi\,(R^2 - r^2) = 3.1416\,(R^2 - r^2)$
Area $= 0.7854\,(D^2 - d^2) = 0.7854\,(D-d)(D+d)$
Area = difference in areas between the inner and outer circles.
Example. $R = 4$; $r = 2$
Area $= 3.1416(4^2 - 2^2) = 37.6992$ Ans.

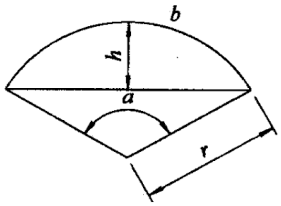
Quadrant



Area $= \frac{\pi r^2}{4} = 0.7854\,r^2 = 0.3927\,c^2$

Example. $r = 3$; $c =$ chord
Area $= .7854 \times 3^2 = 7.0686$ Ans.

Segment



$b =$ length of arc, $a =$ angle in degrees
$c =$ chord $= \sqrt{4\,(2hr - h^2)}$
Area $= 1/2\,[br - c(r-h)]$

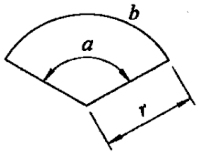
or $\quad = \pi r^2 \frac{a}{360} - \frac{c(r-h)}{2}$

When o is greater than 180° than $\frac{c}{2}$ x difference between r and h is added to the fraction $\frac{\pi r^2}{360}$

Example. $r = 3$; $a = 120°$; $h = 1.5$

Area $= 3.1416 \times 3^2 \times \frac{120}{360} - \frac{5.196(3-1.5)}{2} = 5.5278$ Ans.

Sector

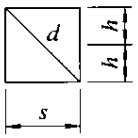


Area $= \frac{br^2}{2}$ or $\pi r^2 \frac{a}{360°}$

$a =$ angle in degrees; $b =$ length of arc

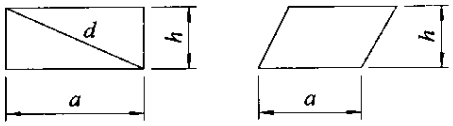
Example. $r = 3$; $a = 120°$

Area $= 3.1416 \times 3^2 \times \frac{120}{360} = 9.4248$ Ans.



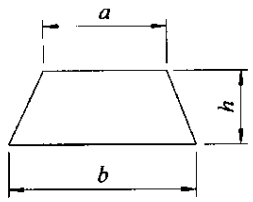
Square

Diagonal = $d = s\sqrt{2}$
Area = $s^2 = 4b^2 = 0.5d^2$
Example. $s = 6$: $b = 3$. Area = $(6)^2 = 36$ Ans.
$d = 6 \times 1.414 = 8.484$ Ans



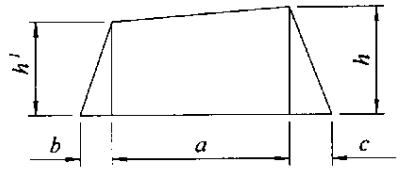
Rectangle and Parallelogram

Area = ab or $b\sqrt{d^2 - b^2}$
Example $a = 6$: $b = 3$.
Area = $3x6 = 18$ Ans.



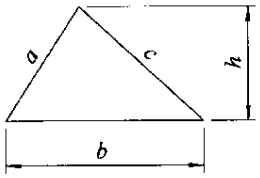
Trapezoid

Area = $1/2\ h(a + b)$
Example. $a = 2$; $b = 4$; $h = 3$.
Area = $1/2 \times 3(2+4) = 9$ Ans.



Trapesium

Area = $1/2[a(h+h') + bh' + ch]$
Example. $a = 4$; $b = 2$; $c = 2$; $h = 3$; $h' = 2$.
Area = $1/2[4(3+2)+(2x2)+(2x3)] = 15$ Ans



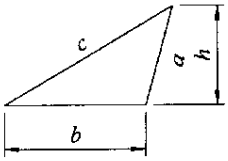
Triangles

Both formulas apply to both figures

Area = $1/2bh$
Example. $h = 3$; $b = 5$
Area = $1/2(3x5) = 7\ 1/2$ Ans.
Area = $\sqrt{S(S-a)(S-b)(S-c)}$ when $S = \frac{a+b+c}{2}$
Example. $a = 2$; $b = 3$; $c = 4$

$$S = \frac{2+3+4}{2} = 4.5$$

Area = $4.5(4.5-2)(4.5-3)(4.3-4) = 2.0$ Ans

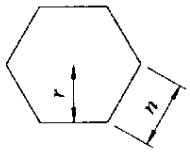


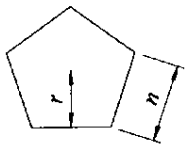
Regular Polygons

Area
5 sides = 1.720477 S^2 = 3.63271 r^2
6 sides = 2.598150 S^2 = 3.46410 r^2
7 sides = 3.633875 S^2 = 3.37101 r^2
8 sides = 4.828427 S^2 = 3.31368 r^2
9 sides = 6.181875 S^2 = 3.27573 r^2
10 sides = 7.894250 S^2 = 3.24920 r^2
11 sides = 9.365675 S^2 = 3.22993 r^2
12 sides = 11.196300 S^2 = 3.21539 r^2

n = number of sides r = short radius
S = length of side R = long radius

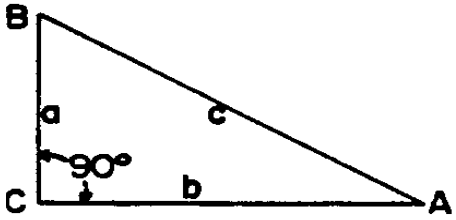
Area = $\frac{n}{4} S^2 \cot \frac{180^\circ}{n} = \frac{n}{2} R^2 \sin \frac{360^\circ}{n} = nr^2 \tan \frac{180^\circ}{n}$





1306-2 Triangles

RIGHT TRIANGLE



(1) sin A = a / c = cos B

(2) cos A = b / c = sin B

(3) tan A = a / b = cot B

(4) cot A = b / a = tan B

(5) sec A = c / b = csc B

(6) csc A = c / a = sec B

(7) vers A = 1 - cos A = 1 - b /c

(8) exsec A = sec A - 1 = c/b -1

(9) a = $\sqrt{(c + b)(c - b)}$

(10) b = $\sqrt{(c + a)(c - a)}$

(11) c = $\sqrt{(a)^2 + (b)^2}$

(12) Area = (1/2) a b

(13) Area = (1/2) b2 tan A

Trigonometric Functions of any Angle

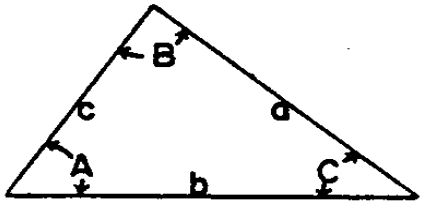
sin (900 + θ) = cos θ

cos (900 + θ) = - sin θ

tan (900 + θ) = - cot θ

cot (900 + θ) = - tan θ

OBLIQUE TRIANGLE



(1) Law of Sines

(When two angles and included sides are known)

(sin A) /a = (sin B) / b = (sin C)/c

(2) Law of Tangents

(When two sides and the included angle are known)

(a +b) / (a -b) =

(tan (1/2) (A + B)) / (tan (1/2) (A-B))

(3) Law of Cosines

(When two sides and the included angle are known

or when all three sides are known)

$a^2 = b^2 + c^2 - 2bc \cos A$

$b^2 = a^2 + c^2 - 2ac \cos B$

c2 = a2 + b2 - 2ab cos A

(4) Half-angle formula

(when all three sides are known)

* s = (1 / 2) (a + b + c)

sin (1 / 2)A = $\sqrt{\frac{(s-b)(s-c)}{bc}}$

(5) Area = (1/2)ab sin C

Area = (1/2)bc sin A

Area = (1/2)ac sin B

1307 FRACTIONS OF INCH IN DECIMALS

Inches and Fractions of an Inch in Decimals of a Foot:

1/16 Inch = 0.005208333 Foot

Inch	0"	1"	2"	3"	4"	5"	6"	7"	8"	9"	10"	11"
0	**0.0000**	**0.0833**	**0.1667**	**0.2500**	**0.3333**	**0.4167**	**0.5000**	**0.5833**	**0.6667**	**0.7500**	**0.8333**	**0.9167**
1/32	0.0026	0.0859	0.1693	0.2526	0.3359	0.4193	0.5026	0.5859	0.6693	0.7526	0.8359	0.9193
1/16	0.0052	0.0885	0.1719	0.2552	0.3385	0.4219	0.5052	0.5885	0.6719	0.7552	0.8385	0.9219
3/32	0.0078	0.0911	0.1745	0.2578	0.3411	0.4245	0.5078	0.5911	0.6745	0.7578	0.8411	0.9245
1/8	**0.0104**	**0.0938**	**0.1771**	**0.2604**	**0.3438**	**0.4271**	**0.5104**	**0.5938**	**0.6771**	**0.7604**	**0.8438**	**0.9271**
5/32	0.0130	0.0964	0.1797	0.2630	0.3464	0.4297	0.5130	0.5964	0.6797	0.7630	0.8464	0.9297
3/16	0.0156	0.0990	0.1823	0.2656	0.3490	0.4323	0.5156	0.5990	0.6823	0.7656	0.8490	0.9323
7/32	0.0182	0.1016	0.1849	0.2682	0.3516	0.4349	0.5182	0.6016	0.6849	0.7682	0.8516	0.9349
1/4	**0.0208**	**0.1042**	**0.1875**	**0.2708**	**0.3542**	**0.4375**	**0.5208**	**0.6042**	**0.6875**	**0.7708**	**0.8542**	**0.9375**
9/32	0.0234	0.1068	0.1901	0.2734	0.3568	0.4401	0.5234	0.6068	0.6901	0.7734	0.8568	0.9401
5/16	0.0260	0.1094	0.1927	0.2760	0.3594	0.4427	0.5260	0.6094	0.6927	0.7760	0.8594	0.9427
11/32	0.0286	0.1120	0.1953	0.2786	0.3620	0.4453	0.5286	0.6120	0.6953	0.7786	0.8620	0.9453
3/8	**0.0313**	**0.1146**	**0.1979**	**0.2812**	**0.3646**	**0.4479**	**0.5313**	**0.6146**	**0.6979**	**0.7813**	**0.8646**	**0.9479**
13/32	0.0339	0.1172	0.2005	0.2839	0.3672	0.4505	0.5339	0.6172	0.7005	0.7839	0.8672	0.9505
7/16	0.0365	0.1198	0.2031	0.2865	0.3698	0.4531	0.5365	0.6198	0.7031	0.7865	0.8698	0.9531
15/32	0.0391	0.1224	0.2057	0.2891	0.3724	0.4557	0.5391	0.6224	0.7057	0.7891	0.8724	0.9557
1/2	**0.0417**	**0.1250**	**0.2083**	**0.2917**	**0.3750**	**0.4583**	**0.5417**	**0.6250**	**0.7083**	**0.7917**	**0.8750**	**0.9583**
17/32	0.0443	0.1276	0.2109	0.2943	0.3776	0.4609	0.5443	0.6276	0.7109	0.7943	0.8776	0.9609
9/16	0.0469	0.1302	0.2135	0.2969	0.3802	0.4635	0.5469	0.6302	0.7135	0.7969	0.8802	0.9635
19/32	0.0495	0.1328	0.2161	0.2995	0.3828	0.4661	0.5495	0.6328	0.7161	0.7995	0.8828	0.9661
5/8	**0.0521**	**0.1354**	**0.2188**	**0.3021**	**0.3854**	**0.4688**	**0.5521**	**0.6354**	**0.7188**	**0.8021**	**0.8854**	**0.9688**
21/32	0.0547	0.1380	0.2214	0.3047	0.3880	0.4714	0.5547	0.6380	0.7214	0.8047	0.8880	0.9714
11/16	0.0573	0.1406	0.2240	0.3073	0.3906	0.4740	0.5573	0.6406	0.7240	0.8073	0.8906	0.9740
23/32	0.0599	0.1432	0.2266	0.3099	0.3932	0.4766	0.5599	0.6432	0.7266	0.8099	0.8932	0.9766
3/4	**0.0625**	**0.1458**	**0.2292**	**0.3125**	**0.3958**	**0.4792**	**0.5625**	**0.6458**	**0.7292**	**0.8125**	**0.8958**	**0.9792**
25/32	0.0651	0.1484	0.2318	0.3151	0.3984	0.4818	0.5651	0.6484	0.7318	0.8151	0.8984	0.9818
13/16	0.0677	0.1510	0.2344	0.3177	0.4010	0.4844	0.5677	0.6510	0.7344	0.8177	0.9010	0.9844
27/32	0.0703	0.1536	0.2370	0.3203	0.4036	0.4870	0.5703	0.6536	0.7370	0.8203	0.9036	0.9870
7/8	**0.0729**	**0.1563**	**0.2396**	**0.3229**	**0.4063**	**0.4896**	**0.5729**	**0.6563**	**0.7396**	**0.8229**	**0.9063**	**0.9896**
29/32	0.0755	0.1589	0.2422	0.3255	0.4089	0.4922	0.5755	0.6589	0.7422	0.8255	0.9089	0.9922
15/16	0.0781	0.1615	0.2448	0.3281	0.4115	0.4948	0.5781	0.6615	0.7448	0.8281	0.9115	0.9948
31/32	0.0807	0.1641	0.2474	0.3307	0.4141	0.4974	0.5807	0.6641	0.7474	0.8307	0.9141	0.9974

1308 CONVERSION FACTORS

1308-1 Linear Conversions

Units	Inches	Feet	Yards	Rods	Miles	Meters
1 Inch	1	0.08333	0.027778	0.005051	0.0000157828	0.0254
1 Foot	12	1	0.3333	0.060606	0.00018939	0.304801
1 Yard	36	3	1	0.181818	0.000568182	0.914402
1 Rod (Surveyor's Measure)	198	16.5	5.5	1	0.003125	5.029216
1 Mile (U.S. Statute)	63360	5280	1760	320	1	1609.347
1 Meter	39.37	3.280833	1.093611	0.198838	0.00062137	1
1 Link	7.92	0.66	0.22	0.04	0.000125	0.201168
1 Chain (Surveyor's Measure)	792	66	22	4	0.0125	20.117
1 Station	1200	100	33.33	6.060606	0.0189394	30.4801
1 Furlong	7920	660	220	40	0.125	201.168
1 Mile (Int. Nautical)	72913	6076.103	2025.366	368.248	1.15078	1852
1 Millimeter	0.03937	0.003281	0.001094	0.000199	~~~~~~~	0.001
1 Centimeter	0.3937	0.032808	0.010936	0.001988	~~~~~~~	0.01
1 Kilometer	~~~~~~~	3280.833	1093.611	198.836	0.62137	1000

1308-2 Area Conversions

Units	Square Inches	Square Feet	Square Yards	Square Rods	Acres	Square Miles	Square Meters
1 Square Inch	1	0.006944	0.0007716	~~~~~~~	~~~~~~~	~~~~~~~	0.00064516
1 Square Foot	144	1	0.11111	0.0036731	~~~~~~~	~~~~~~~	0.09290341
1 Square Yard	1,296	9	1	0.033058	0.0002066	~~~~~~~	0.8361307
1 Square Rod	39,204	272.25	30.25	1	0.00625	~~~~~~~	25.29295
1 Acre	~~~~~~~	43560	4840	160	1	0.0015625	4,046.873
1 Square Mile	~~~~~~~	~~~~~~~	3,097,600	102,400	640	1	2589998
1 Square Meter	1,550.00	10.76387	1.195985	0.0395367	0.0002471	~~~~~~~	1
1 Square Link	62.7264	0.4356	0.0484	0.0016	0.00001	~~~~~~~	0.040468
1 Square Chain	627264	4356	484	16	0.1	~~~~~~~	404.689
1 Square	14400	100	11.1111	0.367309	0.0022956	~~~~~~~	9.29034
1 Section	~~~~~~~	~~~~~~~	3097600	102400	640	1	2589998
1 Square Centimeter	0.1549997	0.0010764	0.0001196	~~~~~~~	~~~~~~~	~~~~~~~	0.0001
1 Hectare	~~~~~~~	107638.7	11959.85	395.367	2.471044	0.003861	10000
1 Square Kilometer	~~~~~~~	~~~~~~~	1195985	39536.7	247.1044	0.3861006	1000000

1309 WEIGHTS AND MEASUREMENTS

1309-1 General Weights And Measurements

Avoirdupois Weight:

27-11/32 grains		= 1 dram
16 drams	= 437.5 grains	= 1 ounce
16 ounces	= 7,000 grains	= 1 pound
28 pounds		= 1 quarter
4 quarters	= 112 pounds	= 1 hundred wt. (cwt.)
20 cwt.	= 2240 pounds	= 1 long ton

Surveyors Measure:

7.92 inches	= 1 link
25 links	= 1 rod
4 rods	= 1 chain
10 chains	= 1 furlong
8 furlongs	= 1 mile
10 square chains	= 1 acre

Metric Conversion:

2.540 centimeters	= 1 inch
39.37 inches	= 1 meter
0.6214 miles	= 1 kilometer
1.057 quarts	= 1 liter
453.59 grams	= 1 pound (av.)
2.205 pounds (av.)	= 1 kilogram

Dry Measure:		**Liquid Measure:**	
2 pints	= 1 quart	4 gills	= 1 pint
8 quarts	= 1 peck	2 pints	= 1 quart
4 pecks	= 1 bushel	4 quarts	= 1 gallon

Metric Measure:

Micro-	= 0.000001 units	Deca-	= 10 units
Milli-	= 0.001 units	Hecto-	= 100 units
Centi-	= 0.01 units	Kilo-	= 1,000 units
Deci-	= 0.1 units	Mega-	= 1,000,000 units

*** Examples:**

1 centimeter (cm) = 0.01 meters (m)

1 kilogram (kg) = 1000 grams (g)

1309-2 Weight and Measurement Equivalents

A. Volume Equivalents

Cubic Inches	Cubic Feet	Cubic Yards	Liters	U.S. Gallons	British Imperial Gallons
1	0.0005787	0.00002143	0.01639	0.004329	0.003605
1,728.0	1	0.03704	28.32	7.481	6.229
46,656.0	27.0	1	764.6	202..0	168.2
61.02	0.03531	0.001308	1	0.2642	0.2200
231	0.1337	0.004951	3.785	1	0.8327
277.4	0.1605	0.005946	4.546	1.201	1

B. Weight Equivalents

Ounces (Avoirdupois)	Pounds (Avoirdupois)	Short Tons	Long Tons	Metric Tons	Kilograms
1	0.0625	0.00003125	0.00002790	0.00002835	0.02835
16.0	1	0.0005000	0.0004464	0.0004536	0.4536
32,000.0	2,000.0	1	0.8929	0.9072	907.2
35,840.0	2,240.0	1.12	1	1.016	1,016
35,274.	2,205	1.102	0.9842	1	1,000.0
35.27	2.205	0.001102	0.0009842	0.001	1

C. Linear Measure Equivalents

Inches	Feet	Yards	Meters	Rods	Kilometers	Miles
1	0.08333	0.02778	0.02540	0.005051	0.00002540	0.00001578
12.0	1	0.3333	0.3048	0.06061	0.0003048	0.0001894
36.0	3.0	1	0.9144	0.1818	0.0009144	0.0005682
39.37	3.281	1.094	1	0.1988	0.001000	0.0006214
198	16.5	5.5	5.029	1	0.005029	0.003125
39,370.	3,281.	1,094.	1,000.00	198.8	1	0.6214
63,360.0	5,280.0	1,760.0	1,609.00	320.0	1.609	1

D. Square Measure Equivalents

Square Inches	Square Feet	Square Yards	Square Meters	Square Rods	Acres	Square Miles
1	0.006944	0.0007716	0.0006452	0.00002551	~~~~~~~	~~~~~~~
144.0	1	0.1111	0.09290	0.003673	0.00002296	~~~~~~~
1,296.0	9.0	1	0.8361	0.03306	0.0002066	~~~~~~~
1,550	10.76	1.196	1	0.03954	0.0002471	~~~~~~~
39,204	272.25	30.25	25.29	1	0.006250	~~~~~~~
6,272,640.	43,560.	4,840	4,047.	160.0	1	0.001562
~~	~~~~~~~	3,097,600.	2,589,998.	102,400.00	640.0	1

1310 VOLUME CORRECTIONS FOR ASPHALT

The average number of gallons per ton and the average pounds per gallons for various types and grades of asphalt are shown in Table IX.

TABLE IX

AVERAGE WEIGHTS AND VOLUMES OF ASPHALTS

GRADE	GALLONS PER TON @ 60° F.	POUNDS PER GALLON @ 60° F.
LIQUID ASPHALTS:		
MC-70	253	7.91
MC-250	249	8.03
MC-800	245	8.16
MC-3000	241	8.30
PAVING ASPHALTS:		
PG 76-XX	232	8.62
PG 70-XX	233	8.58
PG 64-XX	235	8.51
PG 58-XX	236	8.47
PG 52-XX	238	8.40
EMULSIFIED ASPHALTS:		
All Grades	240	8.33

While actual weights may vary slightly, weights of asphalts used on the Pacific Coast may be considered uniform for all ordinary purposes.

TEMPERATURE - VOLUME CORRECTIONS FOR ASPHALT

Asphalt changes in volume with change in temperature. Change in unit volume, per degree change in temperature, is termed “Coefficient of Expansion”, a factor which varies with the specific gravity of asphalt. A temperature of 60 degrees F., is customarily used as the standard basis for volume determinations of asphalt and other petroleum products. Therefore, if the volume is actually measured at any temperature other than 60 degrees F., a correction factor must be applied to convert the measured volume to volume at 60 degrees F.

The American Society for Testing and Materials prepared and published extensive tables on temperature - volume corrections of petroleum products. These tables appear in a book entitled “ASTM - IP Petroleum Measurement Tables”, published in January 1953 (ASTM Designation D 1250). Temperature-Volume correction tables contained herein have been extracted from this ASTM publication.

Temperature - Volume correction factors are given in the following tabulations for asphalt having a specific gravity at 60 degrees F. above 0.966 (designated by ASTM as Group O materials) and for asphalt having a specific gravity at 60 degrees F. of 0.850 to 0.966 inclusive (designated by ASTM as Group 1 materials), and for emulsified asphalts.

Paving asphalts and liquid asphalts of grades RC, MC and SC 250, 800, and 3000 fall into the Group O classifications. Use Table X for volume corrections. Liquid asphalts of grades RC, MC, SC 70 fall into Group 1. Use Table XI for volume corrections. Use Table XII for temperature-volume corrections factors for emulsified asphalts.

EXAMPLE OF USE: Assume an MC 250 grade of liquid asphalt. Assume also that a volume of this material is measured to be 9,000 gallons at a temperature of 180 degrees F. The volume of this material at the standard temperature of 60 degrees F. is 8,628 gallons (9,000 gallons x 0.9587)

TABLE X
TEMPERATURE - VOLUME CORRECTIONS FOR ASPHALTIC MATERIALS
GROUP 0 - SPECIFIC GRAVITY AT 60° F ABOVE 0.966

LEGEND:

t = observed temperature in degrees Fahrenheit
M = multiplier for correcting oil volumes to the basis of 60° F

t	M	t	M	t	M	t	M	t	M	t	M	t	M	t	M	t	M	t	M
0	1.0211	50	1.0035	100	0.9861	150	0.9689	200	0.952	250	0.9352	300	0.9187	350	0.9024	400	0.8864	450	0.8705
1	1.0208	51	1.0031	101	0.9857	151	0.9686	201	0.9516	251	0.9349	301	0.9184	351	0.9021	401	0.8861	451	0.8702
2	1.0204	52	1.0028	102	0.9854	152	0.9682	202	0.9513	252	0.9346	302	0.9181	352	0.9018	402	0.8857	452	0.8699
3	1.0201	53	1.0024	103	0.9851	153	0.9679	203	0.9509	253	0.9342	303	0.9177	353	0.9015	403	0.8854	453	0.8696
4	1.0197	54	1.0021	104	0.9847	154	0.9675	204	0.9506	254	0.9339	304	0.9174	354	0.9011	404	0.8851	454	0.8693
5	1.0194	55	1.0017	105	0.9844	155	0.9672	205	0.9503	255	0.9336	305	0.9171	355	0.9008	405	0.8848	455	0.869
6	1.019	56	1.0014	106	0.984	156	0.9669	206	0.9499	256	0.9332	306	0.9167	356	0.9005	406	0.8845	456	0.8687
7	1.0186	57	1.001	107	0.9837	157	0.9665	207	0.9496	257	0.9329	307	0.9164	357	0.9002	407	0.8841	457	0.8683
8	1.0183	58	1.0007	108	0.9833	158	0.9662	208	0.9493	258	0.9326	308	0.9161	358	0.8998	408	0.8838	458	0.868
9	1.0179	59	1.0003	109	0.983	159	0.9658	209	0.9489	259	0.9322	309	0.9158	359	0.8995	409	0.8835	459	0.8677
10	1.0176	60	1	110	0.9826	160	0.9655	210	0.9486	260	0.9319	310	0.9154	360	0.8992	410	0.8832	460	0.8674
11	1.0172	61	0.9997	111	0.9823	161	0.9652	211	0.9483	261	0.9316	311	0.9151	361	0.8989	411	0.8829	461	0.8671
12	1.0169	62	0.9993	112	0.9819	162	0.9648	212	0.9479	262	0.9312	312	0.9148	362	0.8986	412	0.8826	462	0.8668
13	1.0165	63	0.999	113	0.9816	163	0.9645	123	0.9476	263	0.9309	313	0.9145	363	0.8982	413	0.8822	463	0.8665
14	1.0162	64	0.9986	114	0.9813	164	0.9641	214	0.9472	264	0.9306	314	0.9141	364	0.8979	414	0.8819	464	0.8661
15	1.0158	65	0.9983	115	0.9809	165	0.9638	215	0.9469	265	0.9302	315	0.9138	365	0.8976	415	0.8816	465	0.8658
16	1.0155	66	0.9979	116	0.9806	166	0.9635	216	0.9466	266	0.9299	316	0.9135	366	0.8973	416	0.8813	466	0.8655
17	1.0151	67	0.9976	117	0.9802	167	0.9631	217	0.9462	267	0.9296	317	0.9132	367	0.8969	417	0.881	467	0.8652
18	1.0148	68	0.9972	118	0.9799	168	0.9628	218	0.9459	268	0.9293	318	0.9128	368	0.8966	418	0.8806	468	0.8649
19	1.0144	69	0.9969	119	0.9795	169	0.9624	219	0.9456	269	0.9289	319	0.9125	369	0.8963	419	0.8803	469	0.8646
20	1.0141	70	0.9965	120	0.9792	170	0.9621	220	0.9452	270	0.9286	320	0.9	370	0.896	420	0.88	470	0.8643
21	1.0137	71	0.9962	121	0.9788	171	0.9618	221	0.9449	271	0.9283	321	0.9118	371	0.8957	421	0.8797	471	0.864
22	1.0133	72	0.9958	122	0.9785	172	0.9614	222	0.9446	272	0.9279	322	0.9115	372	0.8953	422	0.8794	472	0.8636
23	1.0131	73	0.9955	123	0.9782	173	0.9611	223	0.9442	273	0.9276	323	0.9112	373	0.895	423	0.8791	473	0.8633
24	1.0126	74	0.9951	124	0.9778	174	0.9607	224	0.9439	274	0.9273	324	0.9109	374	0.8947	424	0.8787	474	0.863
25	0.0435	75	0.9948	125	0.9775	175	0.9604	225	0.9436	275	0.9269	325	0.9105	375	0.8944	425	0.8784	475	0.8627
26	1.0119	76	0.9944	126	0.9771	176	0.9601	226	0.9432	276	0.9266	326	0.9102	376	0.8941	426	0.8781	476	0.8624
27	1.0116	77	0.9941	127	0.9768	177	0.9597	227	0.9429	277	0.9263	327	0.9099	377	0.8937	427	0.8778	477	0.8621

28	1.0112	78	0.9937	128	0.9764	178	0.9594	228	0.9426
29	1.0109	79	0.9934	129	0.9761	179	0.959	229	0.9422
30	1.0105	80	0.993	130	0.9758	180	0.9587	230	0.9419
31	1.0102	81	0.9993	131	0.9754	181	0.9584	231	0.9416
32	1.0098	82	0.9923	132	0.9751	182	0.958	232	0.9412
33	1.0095	83	0.992	133	0.9747	183	0.9577	233	0.9409
34	1.0091	84	0.9916	134	0.9744	184	0.9574	234	0.9405
35	1.008	85	0.9913	135	0.974	185	0.957	235	0.9402
36	1.0084	86	0.9909	136	0.9737	186	0.9567	236	0.9399
37	1.0081	87	0.9906	137	0.9734	187	0.9563	237	0.9395
38	1.007	88	0.9902	138	0.973	188	0.956	238	0.9392
39	1.0074	89	0.9899	139	0.9727	189	0.9557	239	0.9389
40	1.007	90	0.9896	140	0.9723	190	0.9553	240	0.9385
41	1.0067	91	0.9892	141	0.972	191	0.955	241	0.9382
42	1.0063	92	0.9889	142	0.9716	192	0.9547	242	0.9379
43	1.006	93	0.9885	143	0.9713	193	0.9543	243	0.9375
44	1.0056	94	0.9882	144	0.971	194	0.954	244	0.9372
45	1.0053	95	0.9878	145	0.9706	195	0.9536	245	0.9369
46	1.0049	96	0.9875	146	0.9703	196	0.9533	246	0.9365
47	1.0046	97	0.9871	147	0.9699	197	0.953	247	0.9362
48	1.0042	98	0.9868	148	0.9696	198	0.9526	248	0.9359
49	1.0038	99	0.9864	149	0.9693	199	0.9523	249	0.9356

278	0.9259	328	0.9096	378	0.8934	428	0.8775	478	0.8618
279	0.9256	329	0.9092	379	0.8931	429	0.8772	479	0.8615
280	0.9253	330	0.9089	380	0.8928	430	0.8768	480	0.8611
281	0.925	331	0.9086	381	0.8924	431	0.8765	481	0.8608
282	0.9246	332	0.9083	382	0.8921	432	0.8762	482	0.8603
283	0.9243	333	0.9079	383	0.8918	433	0.8759	483	0.8602
284	0.924	334	0.9076	384	0.8915	434	0.8756	484	0.8599
285	0.9236	335	0.9073	385	0.8912	435	0.8753	485	0.8596
286	0.9233	336	0.907	386	0.8908	436	0.8749	486	0.8593
287	0.923	337	0.9066	387	0.8905	437	0.8746	487	0.859
288	0.9277	338	0.9063	388	0.8902	438	0.8743	488	0.8587
289	0.9223	339	0.906	389	0.8899	439	0.874	489	0.8583
290	0.922	340	0.9057	390	0.8896	440	0.8737	490	0.858
291	0.9217	341	0.9053	391	0.8892	441	0.8734	491	0.8577
292	0.9213	342	0.905	392	0.8889	442	0.8731	492	0.8574
293	0.921	343	0.9047	393	0.8886	443	0.8727	493	0.8571
294	0.9207	344	0.9044	394	0.8883	444	0.8724	494	0.8568
295	0.9204	345	0.904	395	0.888	445	0.8721	495	0.8565
296	0.92	346	0.9037	396	0.8876	446	0.8718	496	0.8562
297	0.9197	347	0.9034	397	0.8873	447	0.8715	497	0.8559
298	0.9194	348	0.9031	398	0.887	448	0.8712	498	0.8556
299	0.919	349	0.9028	399	0.8867	449	0.8709	499	0.8552

TABLE XI
TEMPERATURE - VOLUME CORRECTIONS FOR ASPHALTIC MATERIALS
GROUP 1 - SPECIFIC GRAVITY AT 60° F FROM 0.850 TO 0.966

LEGEND

t = observed temperature in degrees Fahrenheit
M = multiplier for correcting oïl volumes to the basis of 60° F

t	M	t	M	t	M	t	M	t	M	t	M	t	M	t	M	t	M	t	M
0	1.0241	50	1.004	100	0.9842	150	0.9647	200	0.9456	250	0.9268	300	0.9083	350	0.8902	400	0.8724	450	0.855
1	1.0237	51	1.0036	101	0.9838	151	0.9643	201	0.9452	251	0.9264	301	0.908	351	0.8899	401	0.8721	451	0.8547
2	1.0233	52	1.0032	102	0.9834	152	0.9639	202	0.9448	252	0.926	302	0.9076	352	0.8895	402	0.8717	452	0.8543
3	1.0229	53	1.0028	103	0.983	153	0.9635	203	0.9444	253	0.9257	303	0.9072	353	0.8891	403	0.8714	453	0.854
4	1.0225	54	1.0024	104	0.9826	154	0.9632	204	0.9441	254	0.9253	304	0.9069	354	0.8888	404	0.871	454	0.8536
5	1.0221	55	1.002	105	0.9822	155	0.9628	205	0.9437	255	0.9249	305	0.9065	355	0.8884	405	0.8707	455	0.8533
6	1.0217	56	1.0016	106	0.9818	156	0.9624	206	0.9433	256	0.9245	306	0.9061	356	0.8881	406	0.8703	456	0.8529
7	1.0213	57	1.0012	107	0.9814	157	0.962	207	0.9429	257	0.9242	307	0.9058	357	0.8877	407	0.87	457	0.8526
8	1.0209	58	1.0008	108	0.981	158	0.9616	208	0.9425	258	0.9238	308	0.9054	358	0.8873	408	0.8696	458	0.8522
9	1.0205	59	1.0004	109	0.9806	159	0.9612	209	0.9422	259	0.9234	309	0.905	359	0.887	409	0.8693	459	0.8519
10	1.0201	60	1	110	0.9803	160	0.9609	210	0.9418	260	0.9231	310	0.9047	360	0.8866	410	0.8689	460	0.8516
11	1.0197	61	0.9996	111	0.9799	161	0.9605	211	0.9414	261	0.9227	311	0.9043	361	0.8863	411	0.8686	461	0.8512
12	1.0193	62	0.9992	112	0.9795	162	0.9601	212	0.941	262	0.9223	312	0.9039	362	0.8859	412	0.8682	462	0.8509
13	1.0189	63	0.9988	113	0.9791	163	0.9597	123	0.9407	263	0.9219	313	0.9036	363	0.8956	413	0.8679	463	0.8505
14	1.0185	64	0.9984	114	0.9787	164	0.9591	214	0.9403	264	0.9216	314	0.9032	364	0.8952	414	0.8675	464	0.8502
15	1.0181	65	0.998	115	0.9783	165	0.9589	215	0.9399	265	0.9212	315	0.9029	365	0.8848	415	0.8672	465	0.8498
16	1.0177	66	0.9976	116	0.9779	166	0.9585	216	0.9395	266	0.9208	316	0.9025	366	0.8845	416	0.8668	466	0.8495
17	1.0173	67	0.9972	117	0.9775	167	0.9582	217	0.9391	267	0.9205	317	0.9021	367	0.8841	417	0.8665	467	0.8492
18	1.0168	68	0.9968	118	0.9771	168	0.9578	218	0.9388	268	0.9201	318	0.9018	368	0.8838	418	0.8661	468	0.8488
19	1.0164	69	0.9964	119	0.9767	169	0.9574	219	0.9384	269	0.9197	319	0.9014	369	0.8834	419	0.8658	469	0.8485
20	1.016	70	0.996	120	0.9763	170	0.957	220	0.938	270	0.9194	320	0.901	370	0.8831	420	0.8654	470	0.8481
21	1.0156	71	0.9956	121	0.976	171	0.9566	221	0.9376	271	0.919	321	0.9007	371	0.8827	421	0.8651	471	0.8478
22	1.0152	72	0.9952	122	0.9756	172	0.9562	222	0.9373	272	0.9186	322	0.9003	372	0.8823	422	0.8647	472	0.8474
23	1.0148	73	0.9948	123	0.9752	173	0.9559	223	0.9369	273	0.9182	323	0.9	373	0.882	423	0.8644	473	0.8471
24	1.0144	74	0.9944	124	0.9748	174	0.9555	224	0.9365	274	0.9179	324	0.8996	374	0.8816	424	0.864	474	0.8468
25	0.014	75	0.994	125	0.9744	175	0.9551	225	0.9361	275	0.9175	325	0.8992	375	0.8813	425	0.8637	475	0.8464
26	1.0136	76	0.9936	126	0.974	176	0.9547	226	0.9358	276	0.9171	326	0.8989	376	0.8809	426	0.8633	476	0.8461
27	1.0132	77	0.9932	127	0.9736	177	0.9543	227	0.9354	277	0.9168	327	0.8985	377	0.8806	427	0.863	477	0.8457
28	1.0128	78	0.9929	128	0.9732	178	0.9539	228	0.935	278	0.9164	328	0.8981	378	0.8802	428	0.8626	478	0.8454
29	1.0124	79	0.9925	129	0.9728	179	0.9536	229	0.9346	279	0.916	329	0.8978	379	0.8799	429	0.8623	479	0.8451
30	1.012	80	0.9921	130	0.9725	180	0.9532	230	0.9343	280	0.9157	330	0.8974	380	0.8795	430	0.8619	480	0.8447

31	1.0116	81	0.9917	131	0.9721	181	0.9528	231	0.9339
32	1.0112	82	0.9913	132	0.9717	182	0.9524	232	0.9335
33	1.0108	83	0.9909	133	0.9713	183	0.952	233	0.9331
34	1.0104	84	0.9905	134	0.9707	184	0.9517	234	0.9328
35	1.01	85	0.9901	135	0.9705	185	0.9513	235	0.9324
36	1.0096	86	0.9897	136	0.9701	186	0.9509	236	0.932
37	1.0092	87	0.9893	137	0.9697	187	0.9505	237	0.9316
38	1.0088	88	0.9889	138	0.9693	188	0.9501	238	0.9313
39	1.0084	89	0.9885	139	0.969	189	0.9498	239	0.9309
40	1.008	90	0.9881	140	0.9686	190	0.9494	240	0.9305
41	1.0076	91	0.9877	141	0.9682	191	0.949	241	0.9301
42	1.0072	92	0.9873	142	0.9678	192	0.9486	242	0.9298
43	1.0068	93	0.9869	143	0.9674	193	0.9482	243	0.9294
44	1.0064	94	0.9865	144	0.967	194	0.9478	244	0.929
45	1.006	95	0.9861	145	0.9666	195	0.9475	245	0.9286
46	1.0056	96	0.9857	146	0.9662	196	0.9471	246	0.9283
47	1.0052	97	0.9854	147	0.9659	197	0.9467	247	0.9279
48	1.0048	98	0.985	148	0.9655	198	0.9463	248	0.9275
49	1.0044	99	0.9846	149	0.9651	199	0.946	249	0.9272

281	0.9153	331	0.8971	381	0.8792	431	0.8616	481	0.8444
282	0.9149	332	0.8967	382	0.8788	432	0.8612	482	0.844
283	0.9146	333	0.8963	383	0.8784	433	0.8609	483	0.8437
284	0.9142	334	0.896	384	0.8781	434	0.8605	484	0.8433
285	0.9138	335	0.8956	385	0.8777	435	0.8602	485	0.843
286	0.9135	336	0.8952	386	0.8774	436	0.8599	486	0.8427
287	0.9131	337	0.8949	387	0.877	437	0.8595	487	0.8423
288	0.9127	338	0.8945	388	0.8767	438	0.8592	488	0.842
289	0.9124	339	0.8942	389	0.8763	439	0.8588	489	0.8416
290	0.912	340	0.8938	390	0.876	440	0.8585	490	0.8413
291	0.9116	341	0.8934	391	0.8756	441	0.8581	491	0.841
292	0.9113	342	0.8931	392	0.8753	442	0.8578	492	0.8406
293	0.9109	343	0.8927	393	0.8749	443	0.8574	493	0.8403
294	0.9105	344	0.8924	394	0.8746	444	0.8571	494	0.8399
295	0.9102	345	0.892	395	0.8742	445	0.8567	495	0.8396
296	0.9098	346	0.8916	396	0.8738	446	0.8564	496	0.8393
297	0.9094	347	0.8913	397	0.8735	447	0.856	497	0.8389
298	0.9091	348	0.8909	398	0.8731	448	0.8557	498	0.8386
299	0.9087	349	0.8906	399	0.8728	449	0.8554	499	0.8383

TABLE XII

TEMPERATURE-VOLUME CORRECTIONS FOR EMULSIFIED ASPHALTS

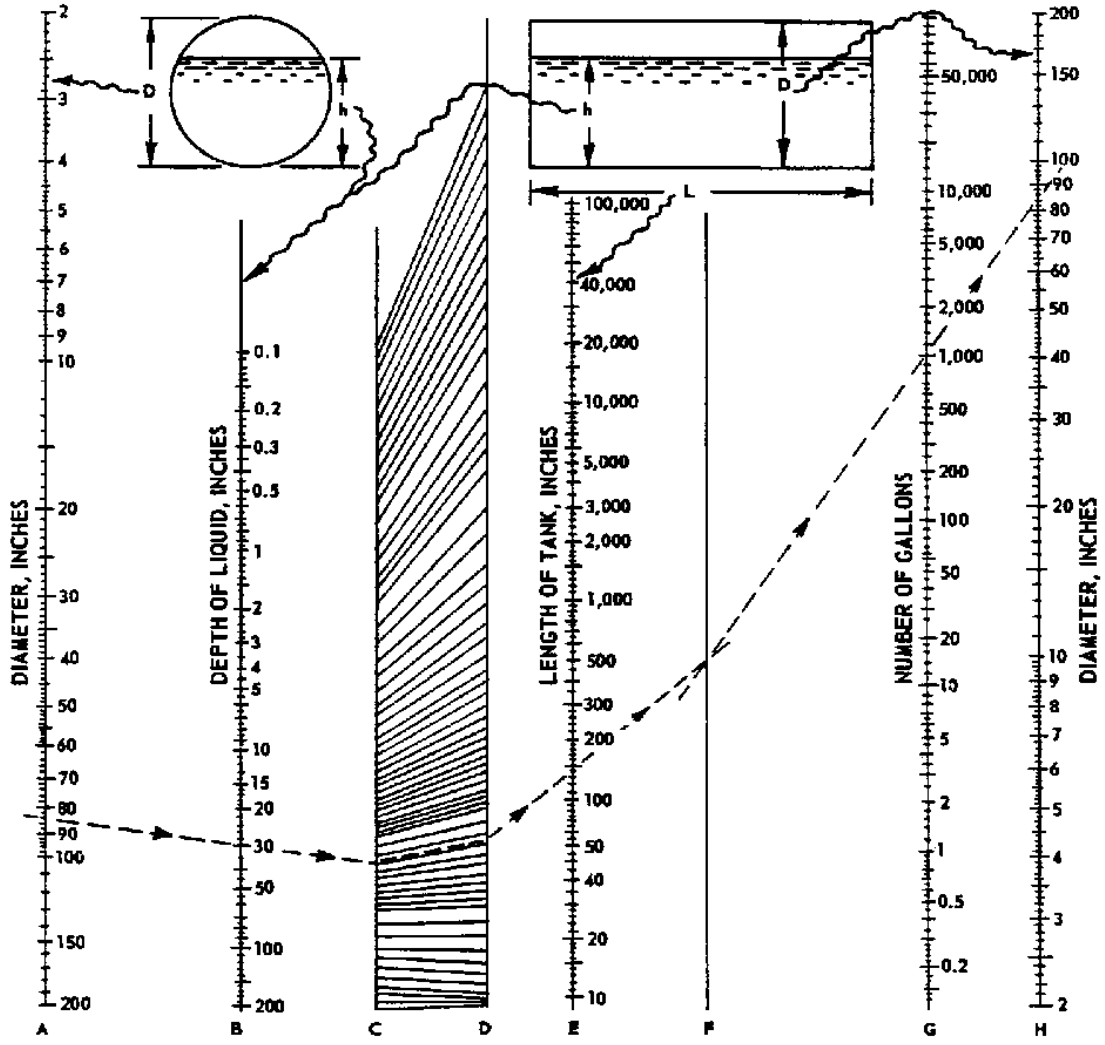
LEGEND:

t = observed temperature in degrees Fahrenheit
M = multiplier for correcting volumes to the basis of 60 degrees Fahrenheit

t	M	t	M	t	M
50	1.0025	95	0.99125	140	0.98
51	1.00225	96	0.991	141	0.97975
52	1.002	97	0.99075	142	0.9795
53	1.00175	98	0.9905	143	0.97925
54	1.0015	99	0.99025	144	0.979
55	1.00125	100	0.99	145	0.97875
56	1.001	101	0.98975	146	0.9785
57	1.00075	102	0.9895	147	0.97825
58	1.0005	103	0.98925	148	0.978
59	1.00025	104	0.989	149	0.97775
60	1	105	0.98875	150	0.9775
61	0.99975	106	0.9885	151	0.97725
62	0.9995	107	0.98825	152	0.977
63	0.99925	108	0.988	153	0.97675
64	0.999	109	0.98775	154	0.9765
65	0.99875	110	0.9875	155	0.97625
66	0.9985	111	0.98725	156	0.976
67	0.99825	112	0.987	157	0.97575
68	0.998	113	0.98675	158	0.9755
69	0.99775	114	0.9865	159	0.97525
70	0.9975	115	0.98625	160	0.975
71	0.99725	116	0.986	161	0.97475
72	0.997	117	0.98575	162	0.9745
73	0.99675	118	0.9855	163	0.97425
74	0.9965	119	0.98525	164	0.974
75	0.99625	120	0.985	165	0.97375
76	0.996	121	0.98475	166	0.9735
77	0.99575	122	0.9845	167	0.97325
78	0.9955	123	0.98425	168	0.973

79	0.99525	124	0.984	169	0.97275
80	0.995	125	0.98375	170	0.9725
81	0.99475	126	0.9835	171	0.97225
82	0.9945	127	0.98325	172	0.972
83	0.99425	128	0.983	173	0.97175
84	0.994	129	0.98275	174	0.9715
85	0.99375	130	0.9825	175	0.97125
86	0.9935	131	0.98225	176	0.971
87	0.99325	132	0.982	177	0.97075
88	0.993	133	0.98175	178	0.9705
89	0.99275	134	0.9815	179	0.97025
90	0.9925	135	0.98125	180	0.97
91	0.99225	136	0.981	181	0.96975
92	0.992	137	0.98075	182	0.9695
93	0.99175	138	0.9805	183	0.96925
94	0.9915	139	0.98025	184	0.969
				185	0.96875

1311 CAPACITY CHART FOR CYLINDRICAL TANKS



Example: How many gallons are in a tank 84 in. in diameter, the depth of the liquid being 30 in. and the length of the tank being 142 in.?

Run a straight line through the 84, column A, and the 30 in column B and locate the intersection with column C. By eye follow the radiating guide lines to column D, locating a second point of intersection. From this last intersection run through the 142, column E, and locate the point of intersection in column F. Then from this point run over to the 84, column H, and the intersection in column G will be found to be close to 1,050 gallons.

1312 TEMPERATURE CONVERSIONS

0C.		0F.	0C.		0F.	0C.		0F.	0C.		0F.	0C.		0F.	0C.		0F.
-78.9	-110	-166.0	-0.6	31	87.8	32.8	91	195.8	66.1	151	303.8	99.4	211	411.8	132.8	271	519.8
-73.3	-100	-148.0	0.0	32	89.6	33.3	92	197.6	66.7	152	305.6	100.0	212	413.6	133.3	272	521.6
-67.8	-90	-130.0	0.6	33	91.4	33.9	93	199.4	67.2	153	307.4	100.6	213	415.4	133.9	273	523.4
-62.2	-80	-112.0	1.1	34	93.2	34.4	94	201.2	67.8	154	309.2	101.1	214	417.2	134.4	274	525.2
-56.7	-70	-94.0	1.7	35	95.0	35.0	95	203.0	68.3	155	311.0	101.7	215	419.0	135.0	275	527.0
-51.1	-60	-76.0	2.2	36	96.8	35.6	96	204.8	68.9	156	312.8	102.2	216	420.8	135.6	276	528.8
-45.6	-50	-58.0	2.8	37	98.6	36.1	97	206.6	69.4	157	314.6	102.8	217	422.6	136.1	277	530.6
-40.0	-40	-40.0	3.3	38	100.4	36.7	98	208.4	70.0	158	316.4	103.3	218	424.4	136.7	278	532.4
-34.4	-30	-22.0	3.9	39	102.2	37.2	99	210.2	70.6	159	318.2	103.9	219	426.2	137.2	279	534.2
-28.9	-20	-4.0	4.4	40	104.0	37.8	100	212.0	71.1	160	320.0	104.4	220	428.0	137.8	280	536.0
-28.3	-19	-2.2	5.0	41	105.8	38.3	101	213.8	71.7	161	321.8	105.0	221	429.8	138.3	281	537.8
-27.8	-18	-0.4	5.6	42	107.6	38.9	102	215.6	72.2	162	323.6	105.6	222	431.6	138.9	282	539.6
-27.2	-17	1.4	6.1	43	109.4	39.4	103	217.4	72.8	163	325.4	106.1	223	433.4	139.4	283	541.4
-26.7	-16	3.2	6.7	44	111.2	40.0	104	219.2	73.3	164	327.2	106.7	224	435.2	140.0	284	543.2
-26.1	-15	5.0	7.2	45	113.0	40.6	105	221.0	73.9	165	329.0	107.2	225	437.0	140.6	285	545.0
-25.6	-14	6.8	7.8	46	114.8	41.1	106	222.8	74.4	166	330.8	107.8	226	438.8	141.1	286	546.8
-25.0	-13	8.6	8.3	47	116.6	41.7	107	224.6	75.0	167	332.6	108.3	227	440.6	141.7	287	548.6
-24.4	-12	10.4	8.9	48	118.4	42.2	108	226.4	75.6	168	334.4	108.9	228	442.4	142.2	288	550.4
-23.9	-11	12.2	9.4	49	120.2	42.8	109	228.2	76.1	169	336.2	109.4	229	444.2	142.8	289	552.2
-23.3	-10	14.0	10.0	50	122.0	43.3	110	230.0	76.7	170	338.0	110.0	230	446.0	143.3	290	554.0
-22.8	-9	15.8	10.6	51	123.8	43.9	111	231.8	77.2	171	339.8	110.6	231	447.8	143.9	291	555.8
-22.2	-8	17.6	11.1	52	125.6	44.4	112	233.6	77.8	172	341.6	111.1	232	449.6	144.4	292	557.6
-21.7	-7	19.4	11.7	53	127.4	45.0	113	235.4	78.3	173	343.4	111.7	233	451.4	145.0	293	559.4
-21.1	-6	21.2	12.2	54	129.2	45.6	114	237.2	78.9	174	345.2	112.2	234	453.2	145.6	294	561.2
-20.6	-5	23.0	12.8	55	131.0	46.1	115	239.0	79.4	175	347.0	112.8	235	455.0	146.1	295	563.0
-20.0	-4	24.8	13.3	56	132.8	46.7	116	240.8	80.0	176	348.8	113.3	236	456.8	146.7	296	564.8
-19.4	-3	26.6	13.9	57	134.6	47.2	117	242.6	80.6	177	350.6	113.9	237	458.6	147.2	297	566.6
-18.9	-2	28.4	14.4	58	136.4	47.8	118	244.4	81.1	178	352.4	114.4	238	460.4	147.8	298	568.4
-18.3	-1	30.2	15.0	59	138.2	48.3	119	246.2	81.7	179	354.2	115.0	239	462.2	148.3	299	570.2
-17.8	0	32.0	15.6	60	140.0	48.9	120	248.0	82.2	180	356.0	115.6	240	464.0	148.9	300	572.0

-17.2	1	33.8	16.1	61	141.8	49.4	121	249.8	82.8	181	357.8	116.1	241	465.8	151.7	305	581.0
-16.7	2	35.6	16.7	62	143.6	50.0	122	251.6	83.3	182	359.6	116.7	242	467.6	154.4	310	590.0
-16.1	3	37.4	17.2	63	145.4	50.6	123	253.4	83.9	183	361.4	117.2	243	469.4	157.2	315	599.0
-15.6	4	39.2	17.8	64	147.2	51.1	124	255.2	84.4	184	363.2	117.8	244	471.2	160.0	320	608.0
-15.0	5	41.0	18.3	65	149.0	51.7	125	257.0	85.0	185	365.0	118.3	245	473.0	162.8	325	617.0
-14.4	6	42.8	18.9	66	150.8	52.2	126	258.8	85.6	186	366.8	118.9	246	474.8	165.6	330	626.0
-13.9	7	44.6	19.4	67	152.6	52.8	127	260.6	86.1	187	368.6	119.4	247	476.6	168.3	335	635.0
-13.3	8	46.4	20.0	68	154.4	53.3	128	262.4	86.7	188	370.4	120.0	248	478.4	171.1	340	644.0
-12.8	9	48.2	20.6	69	156.2	53.9	129	264.2	87.2	189	372.2	120.6	249	480.2	173.9	345	653.0
-12.2	10	50.0	21.1	70	158.0	54.4	130	266.0	87.8	190	374.0	121.1	250	482.0	176.7	350	662.0
-11.7	11	51.8	21.7	71	159.8	55.0	131	267.8	88.3	191	375.8	121.7	251	483.8	179.4	355	671.0
-11.1	12	53.6	22.2	72	161.6	55.6	132	269.6	88.9	192	377.6	122.2	252	485.6	182.2	360	680.0
-10.6	13	55.4	22.8	73	163.4	56.1	133	271.4	89.4	193	379.4	122.8	253	487.4	185.0	365	689.0
-10.0	14	57.2	23.3	74	165.2	56.7	134	273.2	90.0	194	381.2	123.3	254	489.2	187.8	370	698.0
-9.4	15	59.0	23.9	75	167.0	57.2	135	275.0	90.6	195	383.0	123.9	255	491.0	190.6	375	707.0
-8.9	16	60.8	24.4	76	168.8	57.8	136	276.8	91.1	196	384.8	124.4	256	492.8	193.3	380	716.0
-8.3	17	62.6	25.0	77	170.6	58.3	137	278.6	91.7	197	386.6	125.0	257	494.6	196.1	385	725.0
-7.8	18	64.4	25.6	78	172.4	58.9	138	280.4	92.2	198	388.4	125.6	258	496.4	198.9	390	734.0
-7.2	19	66.2	26.1	79	174.2	59.4	139	282.2	92.8	199	390.2	126.1	259	498.2	201.7	395	743.0
-6.7	20	68.0	26.7	80	176.0	60.0	140	284.0	93.3	200	392.0	126.7	260	500.0	204.4	400	752.0
-6.1	21	69.8	27.2	81	177.8	60.6	141	285.8	93.9	201	393.8	127.2	261	501.8	207.2	405	761.0
-5.6	22	71.6	27.8	82	179.6	61.1	142	287.6	94.4	202	395.6	127.8	262	503.6	210.0	410	770.0
-5.0	23	73.4	28.3	83	181.4	61.7	143	289.4	95.0	203	397.4	128.3	263	505.4	212.8	415	779.0
-4.4	24	75.2	28.9	84	183.2	62.2	144	291.2	95.6	204	399.2	128.9	264	507.2	215.6	420	788.0
-3.9	25	77.0	29.4	85	185.0	62.8	145	293.0	96.1	205	401.0	129.4	265	509.0	218.3	425	797.0
-3.3	26	78.8	30.0	86	186.8	63.3	146	294.8	96.7	206	402.8	130.0	266	510.8	221.1	430	806.0
-2.8	27	80.6	30.6	87	188.6	63.9	147	296.6	97.2	207	404.6	130.6	267	512.6	223.9	435	815.0
-2.2	28	82.4	31.1	88	190.4	64.4	148	298.4	97.8	208	406.4	131.1	268	514.4	226.7	440	824.0
-1.7	29	84.2	31.7	89	192.2	65.0	149	300.2	98.3	209	408.2	131.7	269	516.2	229.4	445	833.0
-1.1	30	86.0	32.2	90	194.0	65.6	150	302.0	98.9	210	410.0	132.2	270	518.0	232.2	450	842.0

Note: The numbers in white face type refer to the temperature, either in degrees Centigrade or Fahrenheit, which it is desired to convert. If converting from ^{0}F. to ^{0}C., the equivalent temperature will be found in the left column. If converting from ^{0}C. to ^{0}F., the answer will be found in the right column: ^{0}F. = (1.8 ^{0}C.) + 32 and ^{0}C. = (^{0}F. - 32) / 1.8.

1313 MISCELLANEOUS INFORMATION

Freezing point of water = 32° F. = 0 ° C.

Boiling point of water at atmospheric pressure = 212° F. = 100° C.

Absolute zero = -459.7° F. = -273.2 ° C.

°C. = 5/9(°F. - 32 °)

°F. = (9/5 °C.) + 32 °

1 hp = 550 ft. lbs./sec. = 33,000 ft. lbs./min.

1 hp = 2544 BTUs/hr.

1 hp = 745.5 watts.

1 BTU = 778.26 ft. lbs.

1 cu. ft. of water at 39.2° F. and atmospheric pressure = 62.428 lbs.

1 cu. ft. of water at 60° F. and atmospheric pressure = 62.30 lbs.

1 cu. ft. of water at 212° F. and atmospheric pressure = 59.83 lbs.

Approximate heat capacity of superheated steam at atmospheric pressure = 0.47 BTU/lb/°F.

Total heat of saturated steam at atmospheric pressure = 1150.4 BTU's.

π = 3.1416 = ratio of circumference of circle to diameter. (C/d)

= ratio of area of circle to square of radius. (A/r^2)

Circumference of circle = diameter x π. ($C = \pi d$)

Diameter of circle = circumference x 0.31831. ($d = 0.31831\ C = C / \pi$)

Area of circle = square of diameter x 0.7854. ($A = 0.7854d^2 = \pi / 4\ (d^2) = \pi\ (r^2)$).

Double diameter of the circle increases its area four times. ($4\ A = 0.7854\ (2d)^2$)

Area of rectangle = length x width. (A = l w)

Area of triangle = base x 1/2 perpendicular height. (A = (1/2) b h)

Volume of cone = area of base x 1/3 perpendicular height. (V = (1/3) b h)

Doubling the diameter of a pipe increases its capacity four times.

A gallon of water (U.S. standard) weighs 8.33 pounds and contains 231 cubic inches.

A cubic foot of water contains 7.5 gallons or 1728 cubic inches, and weighs 62.5 pounds.

To find the approximate pressure in pounds per square inch of a column of water, multiply the height of the column in feet by 0.434.

Steam rising from water as its boiling point (212° F.) has a pressure equal to the atmosphere (14.7 lbs. per square inch).

Approximate heat capacity of superheated steam at atmospheric pressure equals 0.47 BTU's per lb. per ° F.

Total heat of saturated steam at atmospheric pressure equals 1150.4 BTUs.

To find the capacity in U.S. gallons of cylindrical tanks knowing the dimensions in inches, square the diameter, multiply by the length, and multiply by 0.0034.

CONVERSION TABLE:

MULTIPLY	BY	TO OBTAIN
Acres	43,560	Square Feet
Barrels of cement	376	Pounds of cement
Bags of cement	94	Pounds of cement
Cubic feet	7.48052	U.S. Gallons
Cubic feet	1.728	Cubic inches
Cubic feet	0.03704	Cubic yards
Cubic inches	0.0005787	Cubic feet
Cubic inches	0.004329	U.S. Gallons
Cubic yards	27	Cubic feet
Cubic yards	46.656	Cubic inches
Cubic yards	202.0	U.S. Gallons
Fathoms	6	Feet
Feet	0.3048	Meters
Meters	3.281	Feet
Meters	39.37	Inches
Meters	1.094	Yards
Miles	5,280	Feet
Pounds of water	0.01602	Cubic feet
Pounds of water	27.68	Cubic inches
Pounds of water	0.1198	U.S. Gallons
Square feet	144	Square inches
Square miles	640	Acres
Square yards	9	Square feet
Square yards	0.0002066	Acres
Tons (short)	2,000	Pounds
Tons (long)	2,240	Pound

1314 MEASUREMENT OF GRADES

Under the commonly accepted system of measuring gradients, grade is defined as the change in elevation divided by the horizontal distance traveled, and is expressed as a percentage.

A grade of 100 percent corresponds to an angle of 45 degrees. A 1 in 3 grade is the same as 33 1/3 percent grade, and a 1 in 2 grade the same as a 50 percent grade.

Table of Gradients

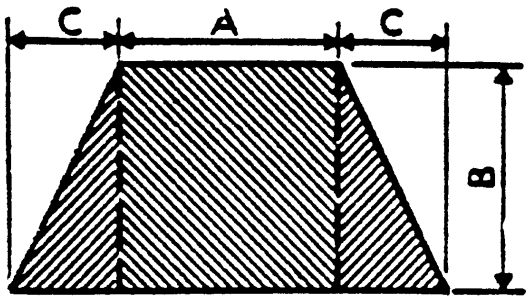
SLOPE	PERCENT GRADE	CORRES- PONDING ANGLE (degrees)	RISE or FALL IN ONE MILE (feet)	RISE or FALL IN ONE KILOMETER (meters)
1 in 1	100.00	45.00	5280	1000.0
1 in 2	50.00	26.57	2640	500.0
1 in 3	33.33	18.43	1760	333.3
1 in 4	25.00	14.03	1320	250.0
1 in 5	20.00	11.32	1056	200.0
1 in 6	16.67	9.47	880	166.7
1 in 7	14.29	8.13	754	142.9
1 in 8	12.50	7.12	660	125.0
1 in 9	11.11	6.33	587	111.1
1 in 10	10.00	5.72	528	100.0
1 in 11	9.09	5.20	480	90.9
1 in 12	8.33	4.77	440	83.3
1 in 13	7.69	4.40	406	76.9
1 in 14	7.14	4.08	377	71.4
1 in 15	6.67	3.82	352	66.7
1 in 16	6.25	3.58	330	62.5
1 in 17	5.88	3.37	311	58.8
1 in 18	5.56	3.18	293	55.6
1 in 19	5.26	3.02	278	52.6
1 in 20	5.00	2.87	264	50.0
1 in 25	4.00	2.28	211	40.0
1 in 30	3.33	1.90	176	33.3
1 in 35	2.86	1.63	151	28.6
1 in 40	2.50	1.43	132	25.0

1315 WEIGHTS OF MATERIALS

MATERIAL	Approximate Kilograms per Cubic Meter	Approximate pounds per Cubic Foot	
Aluminum	2659.1	166	
Ashes	688.8	43	
Asphalt	1297.5	81	
Brass	8393.7	524	
Brick (Common)	1922.2	120	(About 3 tons per thousand)
Brick (Fire)	2322.7	145	
Bronze	8553.9	534	
Cement	1505.7	94	(= one sack)
Concrete	2402.8	150	(4050 lbs. per cubic yard)
Copper	8601.9	537	
Crushed Rock	1521.8	95	(2565 lbs. per cubic yard)
Dry Earth Loose	1217.4	76	(2052 lbs. per cubic yard)
Granite	2867.3	179	
Lead	11341.1	708	
Lumber -- Fir,Spruce	512.6	32	(2666 lbs. per thousand feet)
Lumber -- Oak	993.1	62	(5166 lbs. per thousand feet)
Mortar	1601.8	100	
Portland Cement	1505.7	94	(376 lbs. per barrel)
River Sand	1922.2	120	(3240 lbs. per cubic yard)
Steel	7849.0	490	
Water	1001.2	62.5	
Zinc	7000.1	437	

1316 WINDROW CONTENTS

To calculate the quantity of aggregate in cubic feet, p
lineal foot of windrow:
Take measurements "A", "B", and "C"." Then,
("A" x "B" x 1 ft.) + ("C" x "B" x 1 ft) = cubic feet
windrowed aggregate per lineal foot.



Example:
"A" = 2' - 0", "B" = 2' - 0", and "C" = 1' - 0"
Then, (2' - 0" x 2' - 0" x 1') + (1' - 0" x 2' - 0" x 1')
= 4.0 ft.^{3} + 2.0 ft.^{3} = 6.0 cubic feet of
windrowed aggregate per lineal foot.

* Note: If measurement "C" is not the same on bo
sides of windrow, use the average measurement.

EQUIVALENT WEIGHTS OF AGGREGATES

Pounds per Cubic Foot	Pounds per Cubic Yard	Tons per Cubic Yard	Cubic Yards per Ton	Kilograms per Cubic Meter
60	1620	0.81	1.23	961
65	1755	0.88	1.14	1041
70	1890	0.95	1.06	1121
75	2025	1.01	0.99	1201
80	2160	1.08	0.93	1281
85	2295	1.15	0.87	1362
90	2430	1.22	0.82	1442
95	2565	1.28	0.78	1522
100	2700	1.35	0.74	1602
105	2835	1.42	0.71	1682
110	2970	1.49	0.67	1762
115	3105	1.55	0.64	1842
120	3240	1.62	0.62	1922
125	3375	1.69	0.59	2002
130	3510	1.76	0.57	2082
135	3645	1.82	0.55	2162
140	3780	1.89	0.53	2243

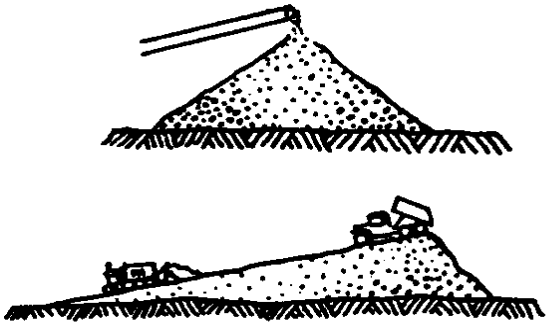
EQUIVALENT WEIGHTS OF AGGREGATE

Pounds per Cubic Yard	Pounds Per Cubic Foot	Tons per Cubic Yard	Cubic Yards per Ton	Kilograms per Cubic Meter
1800	66.7	0.90	1.11	1068
1850	68.5	0.93	1.08	1098
1900	70.4	0.95	1.05	1127
1950	72.2	0.97	1.03	1157
2000	74.1	1.00	1.00	1187
2050	75.9	1.03	0.98	1216
2100	77.8	1.05	0.95	1246
2150	79.6	1.08	0.93	1276
2200	81.5	1.10	0.91	1305
2250	83.3	1.13	0.89	1335
2300	85.2	1.15	0.87	1365
2350	87.0	1.18	0.85	1394
2400	88.9	1.20	0.83	1424
2450	90.7	1.23	0.82	1454
2500	92.6	1.25	0.80	1483
2550	94.4	1.28	0.78	1513
2600	96.3	1.30	0.77	1543
2650	98.1	1.33	0.75	1572
2700	100.0	1.35	0.74	1602
2750	101.9	1.38	0.73	1632
2800	103.7	1.40	0.71	1661
2850	105.6	1.43	0.70	1691
2900	107.4	1.45	0.69	1721
2950	109.3	1.48	0.68	1750
3000	111.1	1.50	0.67	1780
3050	113.0	1.53	0.66	1809
3100	114.8	1.55	0.65	1839
3150	116.7	1.58	0.63	1869
3200	118.5	1.60	0.63	1898
3250	120.4	1.63	0.62	1928
3300	122.2	1.65	0.61	1958
3350	124.1	1.68	0.60	1987
3400	125.9	1.70	0.59	2017
3450	127.8	1.73	0.58	2047
3500	129.6	1.75	0.57	2076
3550	131.5	1.78	0.56	2106
3600	133.3	1.80	0.56	2136
3650	135.2	1.83	0.55	2165
3700	137.0	1.85	0.54	2195
3750	138.9	1.88	0.53	2225
3800	140.7	1.90	0.52	2254

1317 STOCKPILING AGGREGATE

CORRECT

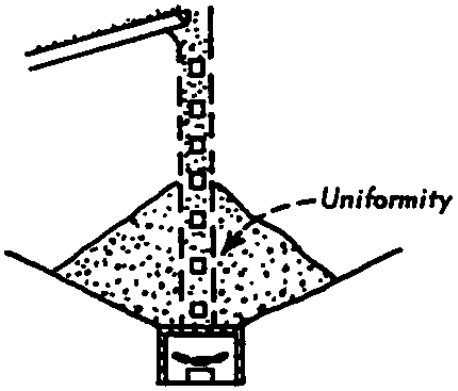
METHODS WHICH PLACE MATERIAL IN THE PILE IN INDIVIDUAL UNITS NOT LARGER THAN A TRUCK LOAD AND WHICH DO NOT PERMIT THE AGGREGATE TO RUN DOWN THE SLOPES AT THE EDGE OF THE PILE.



INCORRECT

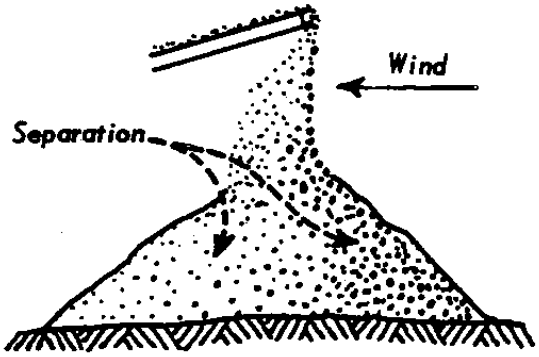
METHODS WHICH PERMIT THE AGGREGATE TO ROLL DOWN THE SLOPE AS IT IS ADDED TO THE PILE. THE USE OF BULLDOZERS IS ALSO INCORRECT.

UNFINISHED AGGREGATE STORAGE



CORRECT

CHIMNEY SURROUNDING MATERIAL FALLING FROM END OF CONVEYOR BELT TO PREVENT WIND FROM SEPARATING FINE AND COARSE MATERIAL. OPENINGS PROVIDED AS REQUIRED TO DISCHARGE MATERIAL AT VARIOUS ELEVATIONS OF THE PILE.

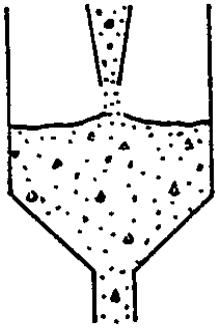


INCORRECT

FREE FALL OF MATERIAL FROM HIGH END OF CONVEYOR BELT PERMITTING WIND TO SEPARATE FINE FROM COARSE MATERIAL.

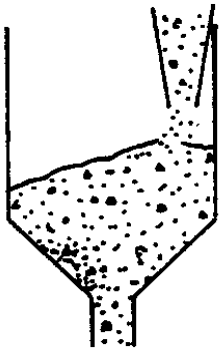
1318 LOADING HOPPERS

LOADING HOPPERS



CORRECT

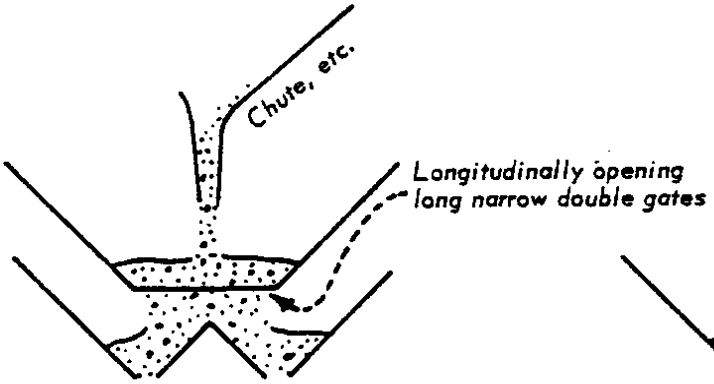
Dropping of concrete directly over gate opening.



INCORRECT

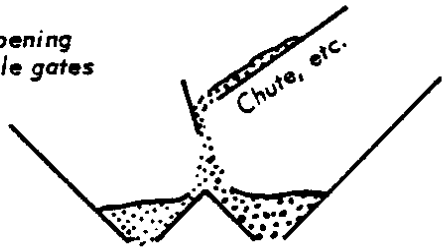
Dropping of concrete on the sloping side of the hopper.

DIVIDED HOPPERS



CORRECT

The above arrangement shows the only acceptable method if a divided hopper must be used. (Single discharge hoppers are to be used whenever possible.)

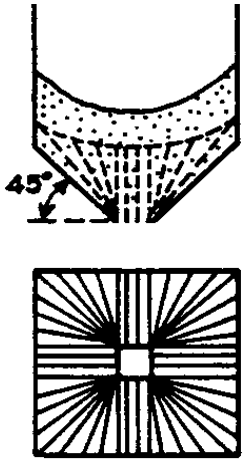


INCORRECT

Filling of divided hopper by flow of concrete. Separation and lack of uniformity in concrete delivered from either gate is inevitable.

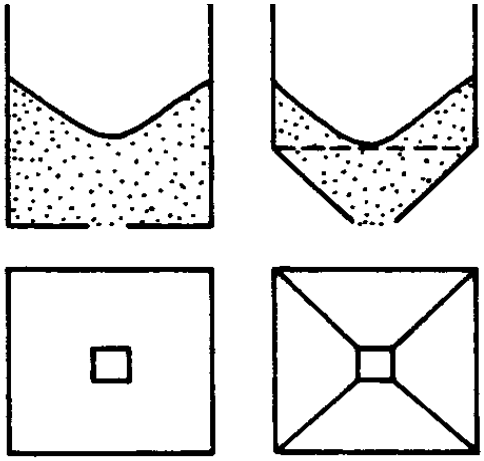
1319 FILLING AGGREGATE BINS

SHAPE OF AGGREGATE BIN BOTTOMS



CORRECT

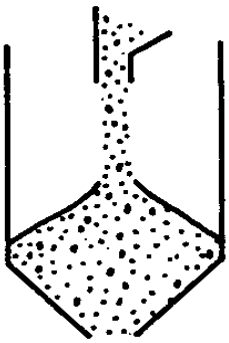
Bottom to slope up from outlet in all directions at not less than 450 from the horizontal. Corners to be filled and rounded to maintain required slope at all points.



INCORRECT

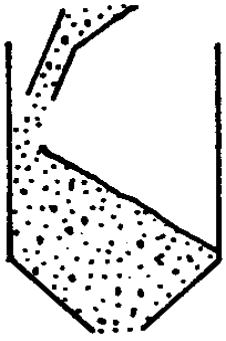
Flat bottom bins or those with any arrangement of slopes having corners or areas such that all material in the bin will not flow quickly through the outlet without shoveling.

AGGREGATE BIN FILLING



CORRECT

Dropping of material vertically and over discharge.

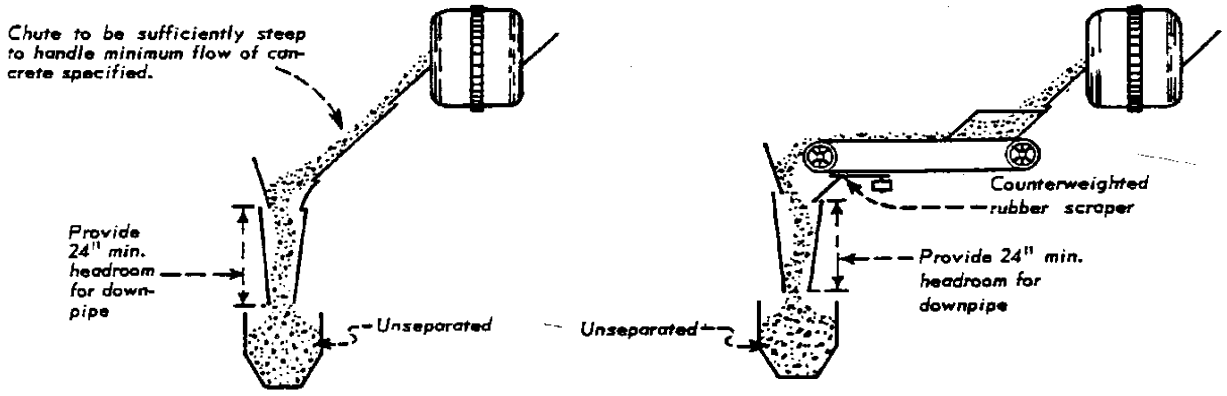


INCORRECT

Chuting material into bin on an angle so material falls other than directly over discharge.

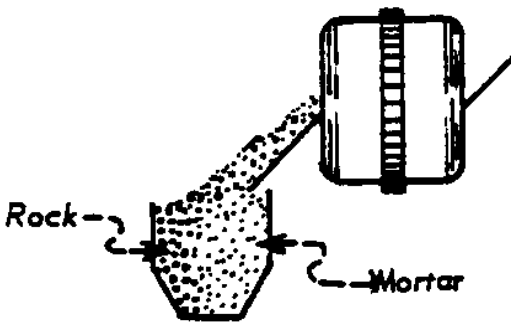
1320 DISCHARGING CONCRETE

CONTROL OF SEPARATION
AS CONCRETE IS DISCHARGED FROM MIXERS



CORRECT **CORRECT**

When discharging concrete into buckets, cars or hoppers, regardless of length of chute or conveyor, either of these arrangements are acceptable for preventing separation.

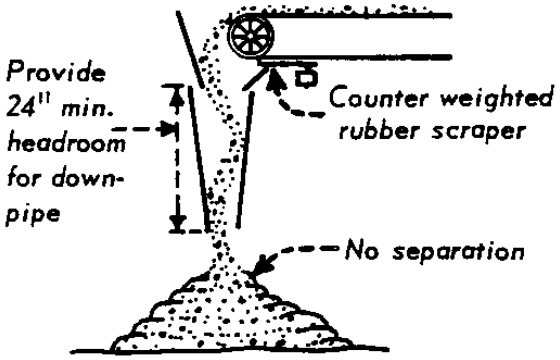


INCORRECT

When discharging concrete directly from any type of mixer into buckets, cars or hoppers.

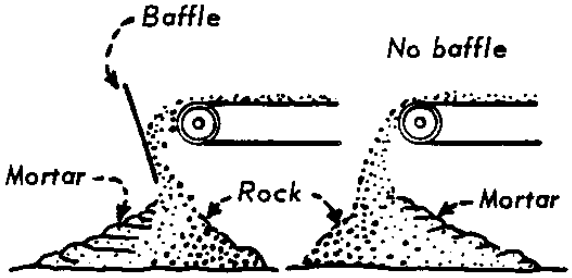
1321 STOCKPILING FROM CONVEYOR BELTS

CONTROL OF SEPARATION OF CONCRETE AT THE END OF CONVEYOR BELTS



CORRECT

THE ABOVE ARRANGEMENT FOR PREVENTION OF SEPARATION WHETHER DISCHARGING CONCRETE INTO HOPPERS, BUCKETS, CARS, FORMS OR ETC.

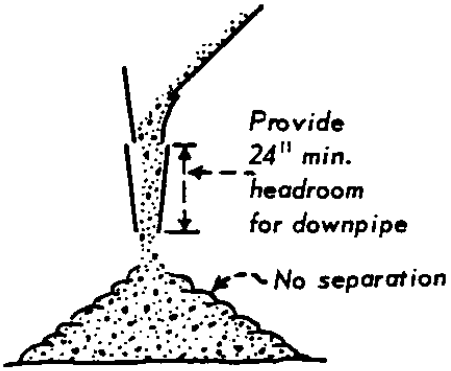


INCORRECT

IMPROPER OR COMPLETE LACK OF CONTROL AT THE END OF THE BELT. BAFFLES OR SHALLOW HOPPERS USUALLY MERELY CHANGE THE DIRECTION OF SEPARATION.

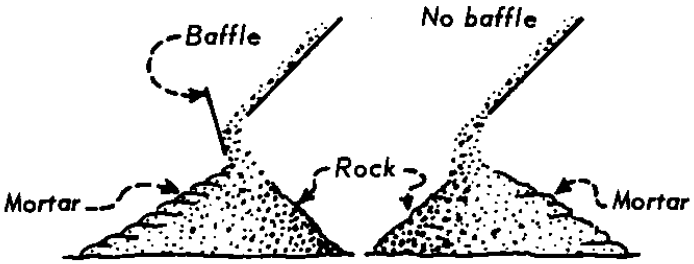
CONTROL OF SEPARATION AT THE END OF CONCRETE CHUTES

This applies to sloping discharges from mixers, transit mixers, etc., as well as to longer chutes but does not apply when concrete is discharged into another chute or on to a conveyor belt.



CORRECT

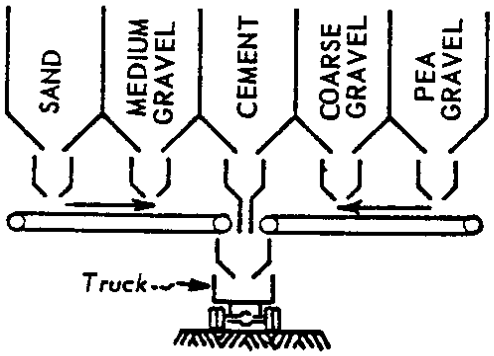
THE ABOVE ARRANGEMENT FOR PREVENTING SEPARATION REGARDLESS OF LENGTH OF CHUTE, WHETHER DISCHARGING CONCRETE INTO HOPPERS, BUCKET CARS, FORMS OR ETC.



INCORRECT

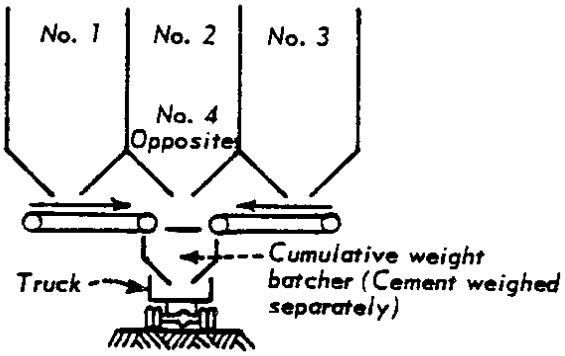
IMPROPER OR LACK OF CONTROL AT THE END OF ANY CONCRETE CHUTE REGARDLESS OF LENGTH. BAFFLES USUALLY MERELY CHANGE THE DIRECTION OF SEPARATION.

1322 BATCHING EQUIPMENT



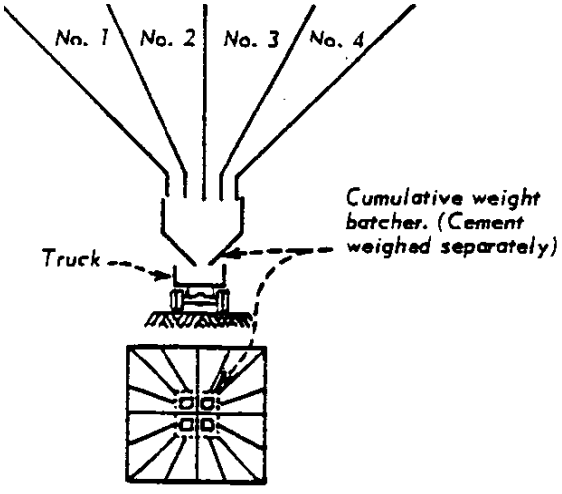
CORRECT

INDIVIDUAL AUTOMATIC WEIGHING OF INGREDIENTS ASSEMBLED INTO TRUCK OR MIXER LOADING HOPPER BY CONVEYOR BELTS. DISCHARGE OF CEMENT BATCHES TO BE CONTROLLED SO THAT CEMENT IS FLOWING FULL TIME AGGREGATE IS BEING DELIVERED BY CONVEYOR BELTS.



CORRECT

CUMULATIVE AUTOMATIC WEIGHING OF AGGREGATES USING CONVEYOR BELTS AUTOMATICALLY STARTED AND STOPPED BY THE WEIGHING EQUIPMENT AND HAVING NO GATES TO STICK. ACCESS FOR REPRESENTATIVE SAMPLING IS AFFORDED.

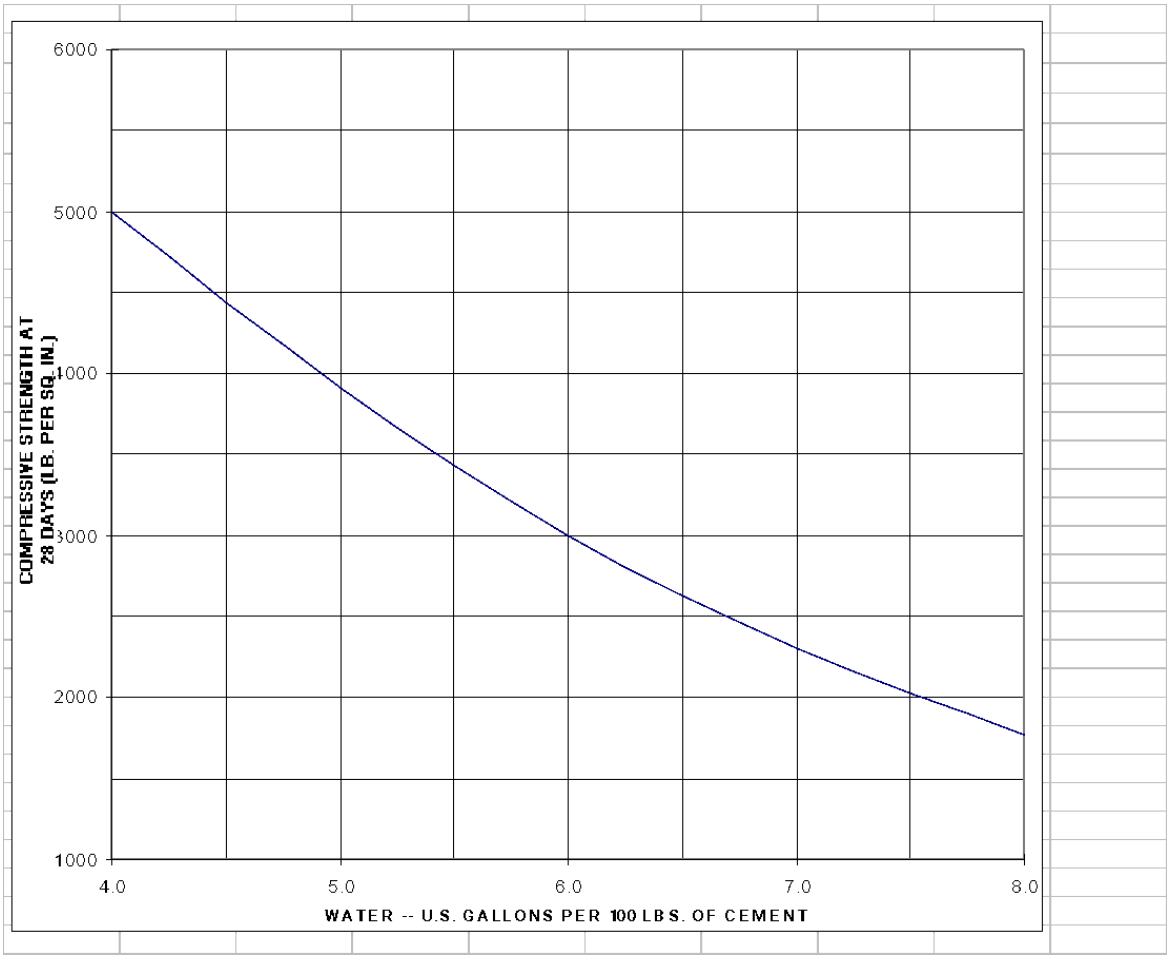


INCORRECT

CLOSE GROUPINGS OF BIN DISCHARGES WHICH CAUSE LONG SLOPES OF MATERIAL IN BINS WITH RESULTING SEPARATION AS MATERIAL IS LOWERED.

1323 WATER CEMENT RATIO AND PROBABLE STRENGTH

For workable mixes using clean sound aggregates, the strength and other desirable features of concrete are governed by the net quantity of mixing water used per unit of cement. The effect of the water-cement ratio is seen in the curve below.



1324 APPROXIMATE CYLINDER STRENGTH

Strength of Concrete Cylinders -- Specification requirements are normally based upon the strength of the concrete at 28 days but it is usually advisable, especially at the start of a project, to submit cylinders for 7 and 14 day tests so that the 28 day strength may be forecast, and to see that the concrete shows normal progressive hardening. For concrete without fly ash, the following formula will give a close approximation of the 28 day strength which may be expected from a known 7 day strength.

$$\text{English: } S_{28} = S_7 + (30\sqrt{S_7})$$

$$\text{Metric: } S_{28} = S_7 + (78.8\sqrt{S_7})$$

In which S_{28} = approximate 28 day strength and S_7 = known 7 day strength.

For approximating strengths at other ages from known strengths at various ages the following table may be used.

Probable Compressive Strength For Concrete Without Fly Ash

AGE	psi	kPa	psi	kPa	Psi	kPa	psi	kPa	psi	kPa	psi	kPa	psi	kPa	psi	kPa	psi	kPa
100	1550	10690	2250	15510	2900	19990	3490	24060	4150	28610	4720	32540	5400	37230	5970	41160	6560	45230
90	1500	10340	2180	15030	2830	19510	3440	23720	4050	27920	4620	31850	5240	36130	5840	40270	6430	44330
80	1460	10070	2110	14550	2740	18890	3350	23100	3950	27230	4510	31100	5150	35510	5710	39370	6290	43370
70	1390	9580	2030	14000	2640	18200	3250	22410	3830	26410	4380	30200	5000	34470	5550	38270	6110	42130
60	1330	9170	1940	13380	2540	17510	3120	21510	3690	25440	4220	29100	4840	33370	5370	37020	5930	40890
55	1290	8890	1890	13030	2470	17030	3050	21030	3610	24890	4140	28540	4750	32750	5270	36340	5820	40130
50	1250	8620	1840	12690	2410	16620	2970	20480	3520	24270	4050	27920	4640	31990	5170	35650	5700	39300
45	1200	8270	1780	12270	2330	16060	2890	19930	3420	23580	3950	27230	4520	31160	5040	34750	5570	38400
40	1150	7930	1700	11720	2250	15510	2790	19240	3310	22820	3830	26410	4400	30340	4910	33850	5430	37440
38	1130	7790	1670	11510	2220	15310	2760	19030	3280	22610	3790	26130	4350	29990	4860	33510	5380	37090
36	1110	7650	1640	11310	2190	15100	2720	18750	3230	22270	3740	25790	4300	29650	4800	33090	5310	36610
34	1080	7450	1610	11100	2140	14750	2670	18410	3180	21930	3680	25370	4220	29100	4720	32540	5240	36130
32	1050	7240	1580	10890	2100	14480	2620	18060	3120	21510	3620	24960	4160	28680	4650	32060	5170	35650
30	1030	7100	1540	10620	2050	14130	2560	17650	3060	21100	3560	24550	4090	28200	4570	31510	5090	35090
28	1000	6900	1500	10310	2000	13840	2500	17190	3000	20730	3500	24150	4000	27590	4500	31050	5000	34460
26	960	6620	1450	10000	1950	13440	2450	16890	2930	20200	3410	23510	3930	27100	4400	30340	4900	33780
24	920	6340	1400	9650	1890	13030	2380	16410	2850	19650	3340	23030	3840	26480	4300	29650	4800	33090
22	890	6140	1350	9310	1830	12620	2310	15930	2780	19170	3250	22410	3750	25860	4200	28960	4700	32410
20	850	5860	1300	8960	1770	12200	2240	15440	2700	18620	3160	21790	3640	25100	4100	28270	4590	31650
19	830	5720	1270	8760	1730	11930	2200	15170	2650	18270	3110	21440	3590	24750	4040	27850	4510	31100
18	800	5520	1240	8550	1690	11650	2150	14820	2600	17930	3050	21030	3520	24270	3980	27440	4450	30680
17	780	5380	1200	8270	1650	11380	2100	14480	2550	17580	3000	20680	3460	23860	3910	26960	4380	30200
16	750	5170	1170	8070	1600	11030	2050	14130	2490	17170	2940	20270	3400	23440	3830	26410	4300	29650
15	720	4960	1130	7790	1550	10690	2000	13790	2430	16750	2870	19790	3310	22820	3770	25990	4210	29030
14	690	4760	1090	7520	1500	10340	1950	13440	2360	16270	2800	19310	3250	22410	3690	25440	4130	28480
13	660	4550	1050	7240	1450	10000	1890	13030	2300	15860	2740	18890	3180	21930	3600	24820	4050	27920
12	630	4340	1000	6890	1400	9650	1820	12550	2230	15380	2660	18340	3090	21300	3500	24130	3960	27300
11	590	4070	950	6550	1350	9310	1750	12070	2150	14820	2570	17720	3000	20680	3400	23440	3850	26540
10	550	3790	900	6210	1280	8830	1680	11580	2070	14270	2490	17170	2900	19990	3300	22750	3730	25720
9	510	3520	840	5790	1200	8270	1590	10960	1980	13650	2380	16410	2780	19170	3170	21860	3600	24820
8	460	3170	780	5380	1130	7790	1500	10340	1880	12960	2280	15720	2650	18270	3050	21030	3460	23860
7	400	2760	700	4830	1040	7170	1380	9510	1750	12070	2120	14620	2500	17240	2890	19930	3280	22610
6	340	2340	600	4140	920	6340	1260	8690	1610	11100	1980	13650	2340	16130	2700	18620	3100	21370

1325 CULVERT PIPE THICKNESS

CORRUGATED GALVANIZED STEEL (Class 1, Zinc or Aluminum Coated)								
	THICKNESS		MINIMUM THICKNESS					
GAUGE			PIPE	PIPE	PIPE PLATE	PIPE PLATE	KILOGRAMS / m2	OUNCES / SQ. FT.
NO.	mm	in.	mm	in.	mm	in.	OF BASE MATERIAL	OF BASE MATERIAL
24	0.71	0.028	0.61	0.024				
22	0.86	0.034	0.76	0.030				
20	1.02	0.040	0.91	0.036			7.32	24
18	1.32	0.052	1.17	0.046			9.76	32
16	1.63	0.064	1.45	0.057			12.21	40
14	2.01	0.079	1.83	0.072			15.26	50
12	2.77	0.109	2.57	0.101	2.46	0.097	21.36	70
10	3.51	0.138	3.28	0.129	3.20	0.126	27.46	90
8	4.27	0.168	4.04	0.159	3.96	0.156	33.57	110
7	4.78	0.188			4.47	0.176	36.62	120
5	5.54	0.218			5.23	0.206	42.72	140
3	6.32	0.249			6.02	0.237	48.82	160
1	7.11	0.280			6.81	0.268	54.93	180

1326 CALIBRATION OF SLURRY SEAL MACHINE

Width of belt = 1.79'
Length of belt Travel per Revolution = 1.67'
Depth of Material (Gate Opening) 3-1/2 = 0.29'
Weight of Aggregate per Cubic Foot = 86.51 pounds

1.79 x 1.67 x 0.29 = 0.866897 Cubic Feet

0.866897 x 86.51 = 75.00 Weight of Material per Revolution

1 Revolution = 1.75 Gallons Emulsion
Weight of Emulsion = 8.33 Pounds

1.75 x 8.33 = 14.58 Pounds Emulsion per Revolution

75.00	Weight of Aggregate per Revolution
14.58	Weight of Emulsion
89.58	

14.58 / 89.58 = 16.3% Specification -- 14-18

75.00 / 89.58 = 83.7% Specification -- 82-86

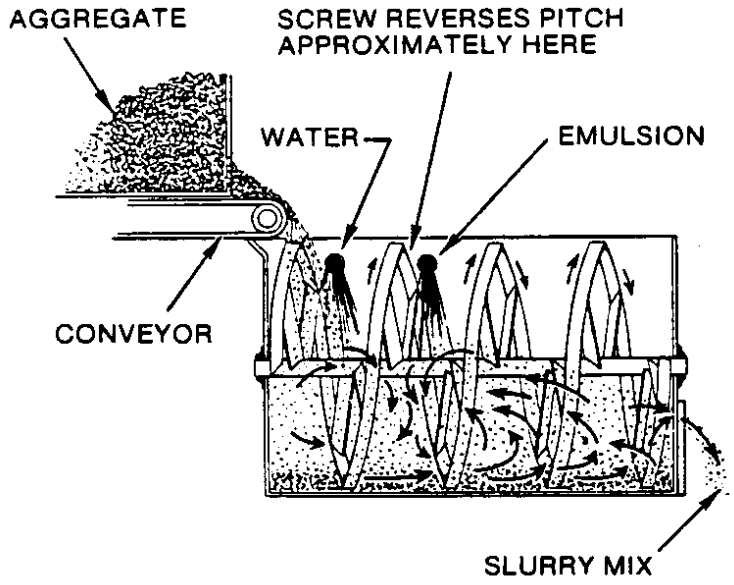
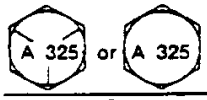


Figure A
Flow diagram of slurry mixer

The mixer contains a specially designed agitator built with a change of pitch in the blades at a point approximately one-third from the feet end. This causes the material in the mixer to be blended toward the middle from both ends of the unit. The product is a homogeneous slurry mix. It is forced by the outer spiral of the agitator to the rear of the mixer where it is allowed to flow out into the spreader. Figure "A" is a diagram of this mixing operation. Note that the emulsion is fed into the mixer at the point where opposing forces are motion met. This ensures that the emulsion does not contact dry material which is important to the success of the process.

1327 MARKINGS FOR STEEL BOLTS

ASTM AND SAE GRADE MARKINGS FOR STEEL BOLTS AND SCREWS

GRADE MARKING	SPECIFICATION	MATERIAL
 NO MARK	SAE-Grade 1	Low or Medium Carbon Steel
	ASTM-A 307	Low Carbon Steel
	SAE-Grade 2	Low or Medium Carbon Steel
	SAE-Grade 5	Medium Carbon Steel, Quenched and Tempered
	ASTM-A 449	
	SAE-Grade 5.2	Low Carbon Martensite Steel, Quenched and Tempered
	ASTM-A 325 Type 1 ASHTO-M 164	Medium Carbon Steel, Quenched and Tempered
	ASTM-A 325 Type 2 ASHTO-M 164	Low Carbon Martensite Steel, Quenched and Tempered
	ASTM-A 325 Type 3 ASHTO-M 164	Atmospheric Corrosion (Weathering) Steel, Quenched and Tempered
	ASTM-A354 Grade BB	Low Alloy Steel, Quenched and Tempered
	ASTM-A 354 Grade BC	Low Alloy Steel, Quenched and Tempered
	SAE-Grade 7	Medium Carbon Alloy Steel, Quenched and Tempered Roll Threaded After Heat Treatment
	SAE-Grade 8	Medium Carbon Alloy Steel, Quenched and Tempered
	ASTM-A-354 Grade BD	Alloy Steel, Quenched and Tempered
	ASTM-A 490 ASHTO-M 253	Alloy Steel, Quenched and Tempered

ASTM Standards:

A 307 - Low Carbon Steel Externally and Internally Threaded Standard Fasteners.
A 325 - High Strength Steel Bolts for Structural Steel Joints, including Suitable Nuts and Plain Hardened Washers.
A 449 - Quenched and Tempered Steel Bolts and Studs.
A 354 - Quenched and Tempered Alloy Steel Bolts and Studs with Suitable Nuts.
A 490 - Quenched and Tempered Alloy Steel Bolts for Structural Steel Joints.

SAE Standards:

J429 – Mechanical and Quality Requirements for Externally Threaded Fasteners.

1328 STEEL WIRE GAUGES

GAUGE	DECIMAL EQUIVALENT	DECIMAL EQUIVALENT	GAUGE	DECIMAL EQUIVALENT	DECIMAL EQUIVALENT
NO.	mm	in.	NO.	mm	in.
0/7	12.446	0.490	9	3.759	0.148
0/6	11.735	0.462	9 1/2	3.607	0.142
0/5	10.922	0.430	10	3.429	0.135
0/4	10.008	0.394	10 1/2	3.251	0.128
0/3	9.195	0.362	11	3.048	0.120
0/2	8.407	0.331	11 1/2	2.870	0.113
0/1	7.772	0.306	12	2.692	0.106
1	7.188	0.283	12 1/2	2.515	0.099
1 1/2	6.909	0.272	13	2.337	0.092
2	6.655	0.262	13 1/2	2.184	0.086
2 1/2	6.426	0.253	14	2.032	0.080
3	6.198	0.244	14 1/2	1.930	0.076
3 1/2	5.944	0.234	15	1.829	0.072
4	5.715	0.225	15 1/2	1.702	0.067
4 1/2	5.486	0.216	16	1.575	0.062
5	5.258	0.207	16 1/2	1.473	0.058
5 1/2	5.080	0.200	17	1.372	0.054
6	4.877	0.192	17 1/2	1.295	0.051
6 1/2	4.674	0.184	18	1.219	0.048
7	4.496	0.177	18 1/2	1.118	0.044
7 1/2	4.318	0.170	19	1.041	0.041
8	4.115	0.162	19 1/2	0.965	0.038
8 1/2	3.937	0.155	20	0.889	0.035

The steel wire gauge outlined in this table has been taken from the original Washburn and Moen Gauge Chart. In 20 gauge and coarser, sizes originally quoted to 4 decimal equivalent places have been rounded to 3 decimal places in accordance with rounding procedures of ASTM Standard Practice E29.

1329 CEMENT CONVERSION FACTORS

Change from bags to Pounds of Portland Cement and Gallons per bag to a Weight Ratio

Cement Content		Water - Cement Ratio	
Bag/C.Y.	**Lb./C.Y.**	**Gal./Bag**	**Weight Ratio**
4.0	376	4.0	0.36
4.5	423	4.5	0.40
5.0	470	5.0	0.44
5.5	517	5.5	0.49
6.0	564	6.0	0.53
6.5	611	6.5	0.58
7.0	658	7.0	0.62
7.5	705	7.5	0.66
8.0	752	8.0	0.71
8.5	799	8.5	0.75
9.0	846	9.0	0.80

1330 EQUIVALENT VELOCITIES

MIles Per Hour		Feet Per Minute		Feet Per Second		Kilometers Per Hour		Meters Per Minute		Meters Per Second
1	=	88	=	1.46	=	1.61	=	26.82	=	0.45
2	=	176	=	2.94	=	3.22	=	53.64	=	0.89
3	=	264	=	4.40	=	4.83	=	80.47	=	1.34
4	=	352	=	5.87	=	6.44	=	107.29	=	1.79
5	=	440	=	7.33	=	8.05	=	134.11	=	2.24
6	=	528	=	8.80	=	9.66	=	160.93	=	2.68
7	=	616	=	10.26	=	11.27	=	187.76	=	3.13
8	=	704	=	11.73	=	12.87	=	214.58	=	3.58
9	=	792	=	13.20	=	14.48	=	241.40	=	4.02
10	=	880	=	14.67	=	16.09	=	268.22	=	4.47
11	=	968	=	16.13	=	17.70	=	295.05	=	4.92
12	=	1056	=	17.60	=	19.31	=	321.87	=	5.36
13	=	1144	=	19.07	=	20.92	=	348.69	=	5.81
14	=	1232	=	20.52	=	22.53	=	375.51	=	6.26
15	=	1320	=	22.00	=	24.14	=	402.34	=	6.71
16	=	1408	=	23.47	=	25.75	=	429.16	=	7.15
17	=	1496	=	24.93	=	27.36	=	455.98	=	7.60
18	=	1584	=	26.40	=	28.97	=	482.80	=	8.05
19	=	1672	=	27.87	=	30.58	=	509.63	=	8.49
20	=	1760	=	29.33	=	32.19	=	536.45	=	8.94
21	=	1848	=	30.80	=	33.80	=	563.27	=	9.39
22	=	1936	=	32.26	=	35.41	=	590.09	=	9.83
23	=	2024	=	33.72	=	37.01	=	616.92	=	10.28
24	=	2112	=	35.20	=	38.62	=	643.74	=	10.73
25	=	2200	=	36.67	=	40.23	=	670.56	=	11.18
26	=	2288	=	38.14	=	41.84	=	697.38	=	11.62
27	=	2376	=	39.60	=	43.45	=	724.20	=	12.07
28	=	2464	=	41.04	=	45.06	=	751.03	=	12.52
29	=	2552	=	42.50	=	46.67	=	777.85	=	12.96
30	=	2640	=	44.00	=	48.28	=	804.67	=	13.41

1331 RANDOM NUMBER TABLE

0.489	0.190	0.093	0.625	0.045	0.033	0.925	0.366	0.138	0.706
0.352	0.851	0.078	0.627	0.566	0.667	0.099	0.615	0.056	0.994
0.230	0.388	0.759	0.266	0.921	0.814	0.910	0.757	0.939	0.349
0.367	0.710	0.575	0.545	0.705	0.206	0.682	0.053	0.839	0.401
0.589	0.011	0.481	0.292	0.413	0.233	0.188	0.682	0.800	0.109
0.309	0.487	0.633	0.607	0.585	0.041	0.733	0.300	0.705	0.564
0.081	0.811	0.585	0.443	0.605	0.594	0.662	0.484	0.047	0.444
0.973	0.788	0.954	0.660	0.312	0.418	0.318	0.245	0.236	0.493
0.894	0.070	0.209	0.893	0.740	0.395	0.661	0.199	0.991	0.659
0.243	0.058	0.414	0.944	0.060	0.601	0.769	0.016	0.170	0.084
0.507	0.358	0.115	0.410	0.838	0.092	0.778	0.678	0.699	0.198
0.350	0.428	0.651	0.944	0.667	0.728	0.245	0.920	0.730	0.762
0.878	0.596	0.661	0.079	0.670	0.799	0.887	0.152	0.412	0.024
0.844	0.418	0.082	0.981	0.961	0.429	0.000	0.278	0.221	0.301
0.116	0.662	0.077	0.095	0.494	0.710	0.999	0.295	0.499	0.383
0.441	0.036	0.731	0.344	0.502	0.245	0.240	0.458	0.066	0.345
0.037	0.363	0.703	0.675	0.452	0.529	0.113	0.290	0.356	0.719
0.386	0.299	0.787	0.234	0.871	0.384	0.004	0.877	0.929	0.673
0.506	0.015	0.349	0.604	0.046	0.673	0.716	0.960	0.168	0.038
0.502	0.711	0.303	0.305	0.173	0.827	0.950	0.249	0.079	0.719
0.979	0.447	0.425	0.463	0.585	0.545	0.091	0.467	0.917	0.484
0.584	0.725	0.929	0.080	0.914	0.333	0.472	0.879	0.658	0.405
0.155	0.683	0.010	0.061	0.024	0.658	0.086	0.628	0.567	0.419
0.273	0.723	0.098	0.026	0.898	0.368	0.039	0.256	0.003	0.795
0.126	0.104	0.502	0.096	0.088	0.871	0.505	0.371	0.817	0.792
0.091	0.546	0.560	0.571	0.308	0.489	0.171	0.758	0.681	0.612
0.948	0.350	0.016	0.590	0.098	0.550	0.770	0.368	0.335	0.060
0.780	0.103	0.680	0.838	0.623	0.209	0.956	0.714	0.394	0.147
0.044	0.772	0.182	0.126	0.396	0.910	0.021	0.368	0.871	0.473
0.603	0.095	0.399	0.383	0.535	0.891	0.519	0.647	0.412	0.598
0.315	0.681	0.499	0.405	0.784	0.322	0.295	0.273	0.166	0.966
0.763	0.372	0.272	0.712	0.507	0.674	0.333	0.938	0.680	0.354
0.407	0.204	0.902	0.173	0.877	0.889	0.962	0.475	0.060	0.474
0.601	0.977	0.478	0.873	0.146	0.997	0.800	0.721	0.273	0.273
0.004	0.015	0.696	0.036	0.777	0.035	0.045	0.496	0.698	0.928
0.724	0.385	0.220	0.882	0.036	0.725	0.998	0.272	0.337	0.475
0.574	0.718	0.522	0.203	0.978	0.424	0.611	0.458	0.246	0.730
0.717	0.979	0.413	0.279	0.187	0.413	0.990	0.694	0.183	0.682
0.473	0.181	0.497	0.677	0.906	0.967	0.869	0.410	0.034	0.968
0.606	0.304	0.071	0.601	0.765	0.754	0.626	0.150	0.691	0.644
0.797	0.578	0.193	0.941	0.995	0.210	0.134	0.055	0.500	0.176
0.716	0.102	0.297	0.030	0.248	0.730	0.215	0.455	0.669	0.669