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Track

To find the weight of rail in long tons (2240 lbs) required to lay 1 mile of single track multiply the weight of the rail in pounds per yard, by 1.5714

To find the weight of rail in long tons (2240 lbs.) required to lay 1000 ft. of single track multiply the weight of the rail in pounds per yard, by .29761

Thus, the weight of 60 lb. steel for 1 mile and for 1000 feet of single track will be respectively

60 x 1.5714 =

94.28 long tons

and 60 x .29761 =

17.857 long tons

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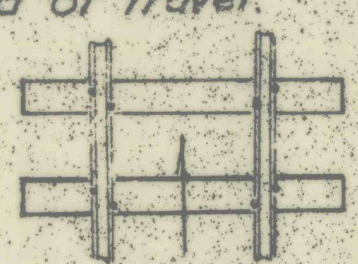
Track

Ties are normally spaced on centers between 18 and 30 inches. Each tie will use four spikes with the outside spike on each rail ahead of the inside spike in the direction of heaviest load of travel.



Heaviest load of travel

Rails above 50 lbs. per yard come in 33 foot lengths – those below 50 lbs. come in 30 foot lengths

Standard railroad gage is 56½ inches

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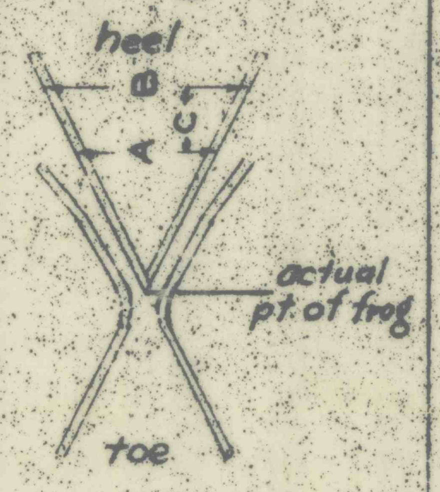
Track

To determine the number of a frog measure across the frog at point A where the gage line will have an even number of inches, then measure across at point B where the gage line will be one inch longer, and the distance C in inches between the two lines will give the frog number.



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Track

Curves

Room Curves usually have radii from 25 to 35 feet while haulage curves range from 60 to 100 feet in radius; if high speed haulage is desired, radii of 200 feet or more are used. The minimum radius allowable depends on the wheel base and wheel diameter of the largest piece of equipment that will use the curve, a good rule is to divide the wheel base in inches by 2 to get the minimum radius in feet.

Elev. outer rail at curves

Radius curve in ft.	Speed M.P.H (44" gage) 4	6	8	10
	Elev. outer rail inches			
25	1.88	4.18	7.49	11.72
30	1.59	3.47	6.23	9.78
35	1.34	2.97	5.35	8.38
60	.787	1.74	3.13	4.89
80	.585	1.30	2.36	3.67
100	.470	1.04	1.87	2.93
200		.522	.935	1.48

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Track

Selecting proper frogs for various curves.

Find number of frog that should be used for a curve of 44 ft. radius and a track gage of 44 inches.

$$N = \sqrt{\frac{6R}{G}} =$$

$$N = \sqrt{\frac{6 \times 44}{44}} = 2.5 \text{ app.}$$

Find proper radius curve for a No. 3 frog if the track gage is 44"

$$R = \frac{GN^2}{6} =$$

$$R = \frac{44 \times 3^2}{6} = 66 \text{ ft.}$$

N = Frog No.
R = Radius of curve (feet)
G = Track gage (inches)

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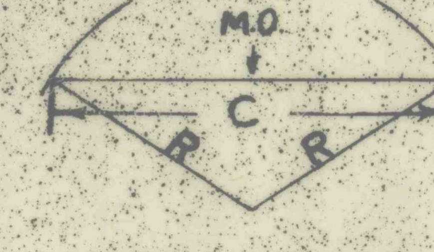
Track

Determining Radii by means of chords and ordinates



R = Radius of curve in ft.
C = Length of chord in ft.
M.O. = Middle ordinate in ins.

Radius R in feet	Length of chord (C) in ft. 5	10	20
	Height of M.O. in inches		
25	1½	6⅛	25⅛
30	1¼	5	20⅝
40		3¾	15¼
60		2½	10⅛
80			7½
100			6
120			5

37

Timbering posts

Posts should have a diameter in inches equal to its length in feet, or the diameter should be ½ of the length in order to present equal resistance to crushing and bending.

Find safe working load on a seasoned black oak mine prop 7" dia. 7' long.

$$\frac{\text{end area} \times \text{crushing strength}}{2000 \text{ lbs.}}$$

$$\frac{7^2 \times .7854 \times 7000}{2000} =$$

134.7 tons = load prod. crushing

The safe working load will depend on the quality of the prop, its condition and how it has been set. assuming a safety factor of 3 the safe working load will be

$$\frac{134.7}{3} = 44.9 \text{ tons}$$

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Timb. posts

Properties and strengths of well seasoned mine timbers (Used as posts)

Wood	Crushing load lbs/sq. in.	Strength as Post
Ash	6800	moderately strong
Beech	7000	moderately strong
Birch	8000	strong
Hickory	8000	strong
Black Yellow Locust	9800	very strong
Sugar Black Maple	8000	Strong
White red Maple	6800	moderately strong
White, red, black Oak	7000	moderately Strong
chestnut, live Oak	7500	moderately strong
Poplar	5000	moderately weak
Black Spruce	5700	moderately weak

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Timb. beams

The quiescent (gradual) breaking load of a round beam loaded at its midpoint between supports, is found by cubing the diameter in inches dividing by the distance between the supports in feet, and multiplying by the constant for that particular timber (pg 42)

Find the breaking and safe working loads of a seasoned round white oak beam 12 in. in diameter and 15 ft. between supports uniformly loaded

$$\text{breaking load} = \frac{12^3}{15} \times 353 \times 2 =$$

80,664 lbs.

$$\text{safe working load} = \frac{80{,}664}{3} =$$

26,888 lbs.

Where the load is uniformly distributed along the entire beam (round or square) the values obtained should be multiplied by 2.

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Timb. beams

To find the quiescent (gradual) breaking load of a horizontal beam with a square or rectangular cross section loaded at midpoint between supports multiply the width in inches by the depth squared also in inches, divide by the distance between supports in feet and multiply by the constant (Pg 42) for that particular timber.

Find the breaking and safe working loads of a seasoned white ash beam 10 inches square and 10 ft. between the legs.

$$\text{breaking load} = \frac{w \times d^2}{l} \times \text{constant} =$$

$$\frac{10 \times 10^2}{10} \times 650 = 65{,}000 \text{ lbs.}$$

Using a safety factor of 3 the safe working load would be 21,667 lbs. For green timber the breaking and safe loads would be one half of these values.

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Timb. beams

A square beam need only have a side which is ⅚ ths of the diameter of a round beam to give the same support providing the beam lengths and material are the same.

Find the breaking loads of 2 seasoned white oak beams 10 ft between supports and loaded in the middle of one is square in section and 10 inches on a side while the other is round and 12 inches in diameter.

$$\text{Square beam} = \frac{10 \times 10^2}{10} \times 600 =$$

60,000 lbs

$$\text{Round beam} = \frac{12^3}{10} \times 353 =$$

60,998.4 lbs.

For green timber the breaking and safe loads would be one-half of these values.

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Timb. beams

Constants for seasoned timber (used as beams)

Wood	Constant: Square or rectangular	Round
White Ash	650	383
Red Beech	550	324
Rock Elm	600	353
Hickory	650	383
Ironwood	600	353
Locust	600	353
Maple	550	324
Red Black Oak	550	324
White oak	600	353
Poplar	550	324

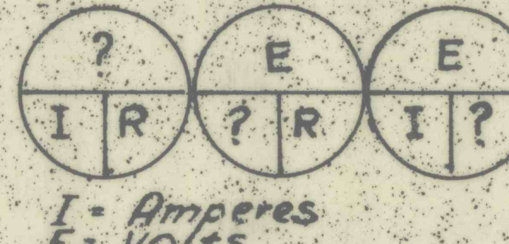
43

Electricity

Direct Current

Required	Formulae
Amperes when H.P. is Known	$\frac{H.P. \times 746}{E \times EFF.}$
Amperes when Kilowatts are Known	$\frac{KW \times 1000}{E}$
Kilowatts	$\frac{I \times E}{1000}$
Horsepower output	$\frac{I \times E \times EFF}{746}$

Ohm's Law



I = Amperes
E = Volts
EFF = Effeciency
H.P. = Horsepower
K.W. = Kilowatts
R = Resistance (ohms)

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Elect.

Ampere – is a unit of electric current.
Volt is a unit of electric pressure or electromotive force (EMF)
Watt – is a unit of power.
Kilowatt called KW, is 1,000 watts
KW ÷ 0.746 = H.P.
Electrical input to a motor is always measured in KW.

Horsepower is a unit of mechanical energy, or work and is equal to – 33,000 ft. lbs. per min
550 ft. lbs. per sec.
42.4 B.T.U. per min.

Foot-Pound is a unit of mechanical energy or work and is the work required to lift one lb through a vertical distance of 1 foot.

$$\text{Amps} = \frac{\text{watts}}{\text{volts}} \quad \text{volts} = \frac{\text{watts}}{\text{Amps}}$$

Watts = Amps x Volts

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Elect

Horsepower hour = unit of mechanical energy

Kilowatt hour = unit of electrical energy

The relation between these units is as follows

1 Hp. hr. = 0.746 Kwh
1 Kwh = 1.34 Hp. hr

Find energy supplied by a 300 KW generator running 75 per cent full load in 12 hours

0.75 x 300 = 225 Kw
12 x 225 = 2700 Kwh

Find Kwh a 50 hp. motor will deliver in 8 hours at full load

8 x 50 = 400 hp hr.

0.746 x 400 hp hr =

298.4 Kwh

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Elect.

Find energy a pump motor consumes in a 7 hr day in (a) Kwh (b) hp. hr. consuming 19.9 amperes at 250 volts.

Volts x amps = watts

250 x 19.9 = 4975

7 hrs x 4975 = 34825

34825 ÷ 1000 = 34.82 Kwh

34.82 x 1.34 = 46.66 hp-hr.

If the cost of D.C. energy is 2¢ per Kwh, what is the charge on a motor operating at 40 amperes on 250 volts for 100 hours?

$$\frac{40 \times 250 \times 100}{1{,}000} = 1{,}000 \text{ Kwh.}$$

1000 x .02 = $20.00

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Tables

Length

Inches	x	.0833	=	feet
Inches	x	.0278	=	yards
inches	x	.00001578	=	miles
Feet	x	.3333	=	yards
Feet	x	.0001894	=	miles
Yards	x	36.00	=	inches
Yards	x	3.00	=	feet
Yards	x	.0005681	=	miles
Miles	x	63360.00	=	inches
Miles	x	5280.00	=	feet
Miles	x	1760.00	=	yards
Circ. of circle	x	.31831	=	diameter
Dia. of circle	x	3.1416	=	Circ.

Area

Sq. inches	x	.00694	=	Sq. feet
Sq. inches	x	.0007716	=	Sq. yards
Sq. feet	x	144.00	=	Sq. inches
Sq. feet	x	.1111	=	Sq. yards
Sq. yards	x	1296.00	=	Sq. inches
Sq. yards	x	9.00	=	Sq. feet
Dia. of circle sqd.	x	.7854	=	area
Dia. of sphere sqd.	x	3.1416	=	surface

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Tables

Volume

cu. inches	x	.0005787	=	cu. feet
cu. inches	x	.00002143	=	cu. yards
cu. inches	x	.004329	=	U.S. gals.
Cu. feet	x	1728.00	=	cu. inches
Cu. feet	x	.03704	=	cu. yards
Cu. feet	x	7.4805	=	U.S. gals
cu. yards	x	46656.00	=	cu. inches
cu. yards	x	27.00	=	cu. feet
Dia. Sphere cubed	x	.5236	=	volume

Energy

Horsepower x 33000 = ft. lbs. per min
B.t.u. x 777.52 = ft. lbs

Power

Horsepower x 746.00 = watts
Watts x .00134 = horsepower
Horsepower x 42.4 = B.T.U. per. min.

Speed

Miles per hr.	x	1.467	=	ft per sec.
Miles per hr.	x	88.02	=	ft per min
Miles per hr.	x	29.34	=	yds per min.
ft. per sec.	x	0.682	=	miles per hr.
ft. per min.	x	0.01136	=	miles per hr.

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Tables

Water Factors (39.2°F) of water

Miners inch	x	8.976	=	U.S. G.P.M.
cu. inches	x	.036124	=	pounds
cu. inches	x	.004329	=	U.S. gals.
cu. feet	x	62.425	=	pounds
cu. feet	x	.03121	=	tons
cu. feet	x	7.4805	=	U.S. gals
cu. ft. of ice	x	57.2	=	pounds
pounds	x	27.68	=	cu. inches
pounds	x	.01602	=	cu. feet
pounds	x	.1198	=	U.S. gals
tons	x	32.04	=	cu. feet
tons	x	239.6	=	U.S. gals.
U.S. gals.	x	231.00	=	cu. inches
U.S. gals.	x	.13368	=	cu. feet
U.S. gals.	x	8.345	=	pounds

A column of water 1 inch sq. by 1 ft. high weighs 0.4335 lbs.
A column of water 1 inch sq. by 2.307 ft high weighs 1 lb.
Water is at its greatest density at 39.2°F.
Sea water is 2 to 3% heavier than fresh water.
One cubic inch of water makes approximately 1 cu. foot of steam at atmo. press.

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Tables

Miscellaneous

Cu. contents of cylinder in bbls. (measurement in ft.) = Diameter² x H x 0.14

Cu contents of cylinder in gals. (measurement in ft.) = Diameter² x H x 5.8752

5.61 cu. ft. = 1 bbl. = 42 gals.

Doubling the diameter or circumference of a pipe or cylinder increases its capacity four times

Volume per inch of depth in bbls = circ. in ft² x 0.0011811
in cu. ft. = Circ. in ft² x 0.0066314

The slurry produced by 1 sack of cement is commonly assumed to have a volume of 1.1 cu. ft. when set.

Tons of coal in 1 acre tract Specific gravity 1.3 – height 6'

$$\frac{6 \times 43560 \times 1.3 \times 62.4}{2000} =$$

= 10,590 Tons.

1 cu. ft. Coal in place 80 lbs.
1 cu. ft. coal lumped 50 lbs.
1 cu. ft. Coal Slacked 54 lbs.

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Tables

Corresponding mercury and air columns and pressure per sq. foot for each inch of water column. at (60°F) (B 30")

Water gauge inches	Mercury column inches	Air column feet T 60° B 30"	Pressure pounds per sq. foot
1	.0735	68	5.2
2	.1471	136	10.4
3	.2206	204	15.6
4	.2941	272	20.8
5	.3676	340	26.0
6	.4412	407	31.2
7	.5147	475	36.4
8	.5882	543	41.6
9	.6618	611	46.8
10	.7353	679	52.0

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Tables

Measurement of Atmospheric pressure

The pressure of the atmosphere may be measured by the height of a column of air of uniform density, or that of a column of water (water gauge) or of mercury (Barometer) necessary to produce such pressure

Equivalent heights of columns of Air, Water, and Mercury (32°F)

Pressure pounds per sq. inch	Height of column to Produce Pressure: Air Feet	Water Feet	Mercury inches
14.697	26,220	33.942	29.921
.491	876	1.134	1
.433	772	1	.882
.036	64	1/12 or 1 in.	.074

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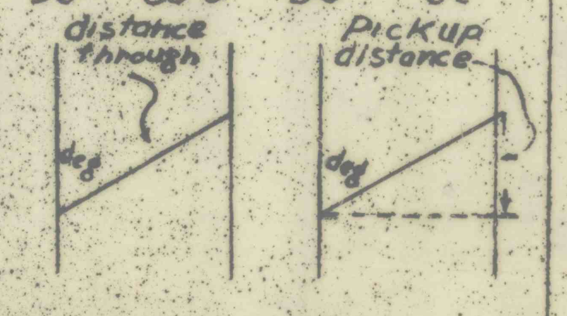
Tables

30' Centers

distance through deg		pick up distance deg	
5°	917' 10¾"	5°	914' 4¾"
10°	460' 8⅜"	10°	453' 8⅞"
15°	309' 1¼"	15°	298' 6⅞"
20°	233' 10¾"	20°	219' 9⅝"
25°	189' 3⅝"	25°	171' 6¾"
30°	160' 0"	30°	138' 6⅞"
35°	139' 5¾"	35°	114' 3"
40°	124' 5½"	40°	95' 4⅛"
45°	113' 1⅝"	45°	80' 0"
50°	104' 5⅛"	50°	67' 1¼"
55°	97' 7⅛"	55°	56' 1¼"
60°	92' 4½"	60°	46' 2¼"
65°	88' 3¼"	65°	37' 3⅝"
70°	85' 1½"	70°	29' 1½"
75°	82' 9⅞"	75°	21' 5¼"
80°	81' 2¾"	80°	14' 1⅜"
85°	80' 3¾"	85°	7' 0"
90°	80' 0"	90°	0' 0"



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Tables