Metric Conversion Factors

The Metrics International System of Units

The International System of Units (SI) is a modernized version of the metric system established by international agreement. The metric system of measurement was developed during the French Revolution and was first promoted in the U.S. by Thomas Jefferson. Its use was legalized in the U.S. in 1866. In 1902, proposed congressional legislation requiring the U.S. Government to use the metric system exclusively was defeated by a single vote.

SI provides a logical and interconnected framework for all measurements in science, industry, and commerce. The metric system is much simpler to use than the existing English system since all its units of measurement are divisible by 10.

Conversion Factors

The following list provides the conversion relationship between U.S. customary units and SI (International System) units. The proper conversion procedure is to multiply the specified value on the left (primarily U.S. customary values) by the conversion factor exactly as given below and then round to the appropriate number of significant digits desired. For example, to convert 11.4 ft to meters: 11.4 X 0.3048 = 3.47472, which rounds to 3.47 meters. Do not round either value before performing the multiplication, as accuracy would be reduced. A complete guide to the SI system and its use can be found in ASTM E 380, Metric Practice.

The 1959 definitions of inch and foot and their derived measurements, the ton to kilogram conversion factor differs from the conversion factor published on this page by 1 in the 7th digit, the Fahrenheit to Kelvin conversion factor differs by 0.017 degree Kelvin, the BTU/hour to watt conversion differs by 3 in the 4th digit, and the ft/sec^2 to m/sec^2 conversion differs by 1 in the 6th digit.

Conversion Symbols

The prefixes and symbols listed below are commonly used to form names and symbols of the decimal multiples and sub multiples of the SI units.

Multiplication Factor	Prefix	Symbol
$1,000,000,000 = 10^{9}$	giga	G
$1,000,000 = 10^{6}$	mega	M
$1,000 = 10^{3}$	kilo	k
$100 = 10^{2}$	hecto	h
$1 = 1$		
$0.01 = 10^{-2}$	centi	c
$0.001 = 10^{-3}$	milli	m
$0.000001 = 10^{-6}$	micro	µ
$0.000000001 = 10^{-9}$	nano	n

INTERIM UNITS OF MEASURE
As suggested by Federal Standard 376B
January 27, 1993

AS USED IN THE STANDARD ITEM TABLE	**METRIC EQUIVALENT**
ACRE	hectare (ha)
CUBIC FOOT	cubic meter (m3)
CUBIC YARD	cubic meter (m3)
GALLON/MGALLON	liter (L), cubic meter (m3)
HUNDRED	Hundred for traffic buttons
HUNDRED WEIGHT	kilogram (kg)
LINEAR FOOT	meter (m)
MBOARD FEET	cubic meter (m3)
MILE	kilometer (km)
NAUTICAL MILE	Nautical Mile
POUND	kilogram (kg) for mass newton (N) for force
SQUARE FOOT	square meter (m2)
SQUARE YARD	square meter (m2)
TON	tonne (t)

UNITS OF MEASUREMENT USED IN SPECIAL PROVISIONS AND GENERAL SPECIAL PROVISIONS		METRIC EQUIVALENT
GAGE; GAUGE	METAL THICKNESS	gage (mm)
FAHRENHEIT	TEMPERATURE	kelvin (K) or degree Celsius (C)
FATHOM	WATER DEPTH	meter (m)
FOOT/LBS	TORQUE	newton-meter (N-m)
LBS/SQ. IN	PRESSURES	kilopascal (kPa) megapascal (MPa) (if very large number)
LBS/SQ. FT		kilopascal (kPa)
LBS/SQ YD		kilopascal (kPa)
INCH	LINEAR	millimeter (mm)
KIPS; KSI	TENSION	kilopascal (kPa) or megapascal (MPa)
LBS/ACRE	EROSION CONTROL	kilograms/hectare
LBS/CU. FT.	DENSITY	kilogram per cubic meter (kg/m3)
MIL	THICKNESS	micrometer (um)
FT. LBS./SEC.	HORSE POWER	watt (W)

UNITS OF MEASUREMENTS USED ON CONTRACT PLANS	METRIC EQUIVALENT
DEGREES/BEARINGS	No change for surveying.
STATIONING	1,000 meters = 1 station
MILEPOSTS	This one is still under review as mileposts are part of the signing issue. Use mileposts for now, but also state kilometerposts.
ELEVATIONS	meter (m)

UNITS OF MEASUREMENTS USED IN COMMERCIAL STANDARDS	METRIC EQUIVALENT
GALS/HR or MIN (PUMPS)	liters per second (L/s)
500 GALLON TANKS	cubic meter (m3) but it could also possibly be in liter (L)
55 GALLON DRUMS	cubic meter (m3) or liter (L) for liquid
94 LBS/SACK (CEMENT)	kilogram (kg)
DIAMETER OF REINFORCING STEEL	millimeter (mm)
LBS/FT OF REINFORCING STEEL	kilogram per meter (kg/m)
BUSHEL	cubic meter (m3)

Length Conversion Factors

Length		
To convert from	**to**	**multiply by**
mile (US Statute)	kilometer (km)	1.609347
inch (in)	millimeter (mm)	25.4 *
inch (in)	centimeter (cm)	2.54 *
inch (in)	meter (m)	0.0254 *
foot (ft)	meter (m)	0.3048 *
yard (yd)	meter (m)	0.9144 *

Area Conversion Factors

Area		
To convert from	**to**	**multiply by**
square foot (sq ft)	square meter (sq m)	0.09290304 E
square inch (sq in)	square meter (sq m)	0.00064516 E
square yard (sq yd)	square meter (sq m)	0.83612736 E
acre (ac)	hectare (ha)	0.4047

Volume Conversion Factors

Volume		
To convert from	**to**	**multiply by**
cubic inch (cu in)	cubic meter (cu m)	0.00001639
cubic foot (cu ft)	cubic meter (cu m)	0.02831685
cubic yard (cu yd)	cubic meter (cu m)	0.7645549
U.S. liquid**		
gallon (gal)	cubic meter (cu m)	0.00378541
gallon (gal)	liter	3.785
fluid ounce (fl oz)	milliliters (ml)	29.57353
fluid ounce (fl oz)	cubic meter (cu m)	0.00002957

Force Conversion Factors

Force		
To convert from	**to**	**multiply by**
kip (1000 lb)	kilogram (kg)	453.6
kip (1000 lb)	newton (N)	4,448.222
pound (lb) avoirdupois	kilogram (kg)	0.4535924
pound (lb)	newton (N)	4.448222

Pressure or Stress Conversion Factors

Pressure or stress		
kip per square inch (ksi)	megapascal (MPa)	6.894757
pound per square foot (psf)	kilogram per square meter (kg/sq m)	4.8824
pound per square foot (psf)	pascal (Pa)	47.88
pound per square inch (psi)	pascal (Pa)	6,894.757
pound per square inch (psi)	megapascal (MPa)	0.00689476

Mass Conversion Factors

Mass (weight)		
pound (lb) avoirdupois	kilogram (kg)	0.4535924
ton, 2000 lb	kilogram (kg)	907.1848
grain	kilogram (kg)	0.0000648

Mass (weight) per length		
kip per linear foot (klf)	kilogram per meter (kg/m)	0.001488
pound per linear foot (plf)	kilogram per meter (kg/m)	1.488

Mass per volume (density)		
pound per cubic foot (pcf)	kilogram per cubic meter (kg/cu m)	16.01846
pound per cubic yard (lb/cu yd)	kilogram per cubic meter (kg/cu m)	0.5933

Temperature Conversion Factors

Temperature		
degree Fahrenheit (F)	degree Celsius (C)	tc=(tF-32)/1.8
degree Fahrenheit (F)	kelvin (K)	tk = (tF+459.7)/1.8
kelvin (K)	degree Celsius (C)	tc=tk-273.15
Energy and heat		
British thermal unit(Btu)	joule (J)	1055.056
calorie (cal)	joule (J)	4.1868E
Btu/degree	F x hr x ft2 W/m2 - degree K	5.678263
kilowatt-hour (kwh)	joule (J)	3,600,000E
British thermal unit per pound (Btu/lb)	calories per gram (cal/g)	0.55556
British thermal unit per hour (Btu/hr)	watt (W)	0.2930711

Power Conversion Factors

Power		
horsepower (hp) (550 ft-lb/sec)	watt (W)	745.6999 E
Velocity		
mile per hour (mph)	kilometer per hour(km/hr)	1.60934
mile per hour (mph)	meter per second (m/s)	0.44704
Permeability		
darcy	centimeter per second (cm/sec)	0.000968
feet per day (ft/day)	centimeter per second (cm/sec)	0.000352

*indicates that the factor given is exact.
**One U.S. gallon equals 0.8327 Canadian gallon.
t--A pascal equals 1.000 newton per square meter.

Note:
One U.S. gallon of water weighs 8.34 pounds (U.S.) at 60 degrees F.
One cubic foot of water weighs 62.4 pounds (U.S.).
One milliliter of water has a mass of 1 gram and has a volume of one cubic centimeter.
One U.S. bag of cement weighs 94 lbs.

More Useful Conversion Factors

Quantity	From English Units	To Metric Units	Multiply by*
Length			
	mile	km	1.609347
	yard	m	0.9144**
	foot	m	0.3048**
	inch	mm	25.40**
Area			
	square mile	km 2	2.590
	acre	m 2	4047
	acre	hectare	0.4047
	square yard	m 2	0.8361
	square foot	m 2	0.092 90
	square inch	mm 2	645.2
Volume			
	acre foot	m 3	1 233
	cubic yard	m 3	0.7646
	cubic foot	m 3	0.028 32
	cubic foot	L (1000 cm 3)	28.32
	100 board feet	m 3	0.2360
	gallon	L (1000 cm 3)	3.785
Mass			
	lb	kg	0.4536
	kip (1000 lb)	metric ton (1000kg)	0.4536
Mass/unit length			
	plf	kg/m	1.488
Mass/unit area			
	psf	kg/m 2	4.882

Mass density			
	pcf	kg/m 3	16.02
Force			
	lb	N	4.448
	kip	kN	4.448
Force/unit length			
	plf	N/m	14.59
	klf	kN/m	14.59
Pressure, stress, modules of elasticity			
	psf	Pa	47.88
	ksf	kPa	47.88
	psi	kPa	6.895
	ksi	MPa	6.895
Bending moment, torque, moment of force			
	ft-lb	N . m	1.356
	ft-kip	kN . m	1.356

* 4 significant digits
**denotes exact conversion

Quantity	From English Units	To Metric Units	Multiply by*
Moment of mass			
	lb . ft	kg . m	0.1383
Moment of inertia			
	lb . ft2	kg . m 2	0.042 14
Second moment of area			
	in4	mm4	416 200

Section modulus			
	in3	mm3	16 390
Power			
	ton (refrig)	kW	3.517
	Btu/s	kW	1.054
	hp (electric)	W	745.7
	Btu/h	W	0.2931
Volume rate of flow			
	ft 3/s	m 3/s	0.028 32
	cfm	m 3/s	0.000 471 9
	cfm	L/s	0.4719
	mgd	m 3/s	0.0438
Velocity, speed			
	ft/s	m/s	**0.3048
Acceleration			
	f/s 2	m/s 2	0.3048
Momentum			
	lb . ft/sec	kg . m/s	0.1383
Angular momentum			
	lb . ft 2/s	kg . m 2/s	0.042 14
Plane Angle			
	degree	rad	0.017 45
		mrad	17.45

* 4 significant digits
**denotes exact conversion

Pavement Conversion Factors

METRIC CONVERSION – PAVEMENTS

Roadway	Dimensions		Bridge Ht.		PCCP Thickness'		Resilient Modulus	
	ft	m	ft	m	(inches)	(mm)	psi	MPa
Lane								
	12	3.6	14.5	4.4	9	225	3,000	21
Shoulder								
	4	1.2	16.0	4.9	10	250	4,000	28
	10	3.0			11	275	5,000	34
					12	300	10,000	69
							12,000	83
							15,000	103
							20,000	138

Typical Density Values			Axle Loads		Tire Loads (per tire width)	
	pcf	kg/m 2	lbs	kN	lbs/inch	kg/mm
PCCP	150	2403	18,000	80	500	9
ACP	137/0.10' depth	2439				

TYPICAL QUANTITIES

Asphalt Concrete Paving Quantities (metric tons/kilometer)

Depth of Pavement														
(ft)	0.10	0.15	0.20	0.25	0.30	0.35	0.40	0.45	0.50	0.55	0.60	0.65	0.70	0.75
(mm)	30	45	60	75	90	105	120	135	150	165	180	195	210	225

Width of Pavement															
(ft)	(M)	Metric tons per kilometer													
4	1.2	88	132	176	219	263	307	351	395	439	483	527	571	614	658
6	1.8	132	198	263	329	395	461	527	593	658	724	790	856	922	988
8	2.4	176	263	351	439	527	614	702	790	878	966	1,053	1,141	1,229	1,317
10	3.0	219	329	439	549	658	768	878	988	1,097	1,207	1,317	1,427	1,536	1,646
11	3.3	241	362	483	604	724	845	966	1,086	1,207	1,328	1,448	1,569	1,690	1,811
12	3.6	263	395	527	658	790	922	1,053	1,185	1,317	1,448	1,580	1,712	1,843	1,975
22	6.6	483	724	966	1,207	1,448	1,690	1,931	2,173	2,414	2,655	2,897	3,138	3,380	3,621
24	7.2	527	790	1,053	1,317	1,580	1,843	2,107	2,370	2,634	2,897	3,160	3,424	3,687	3,950

Based on 2439 kg/m 3 ; 30 mm compacted depth = 73.17 kg/m 2

Pavement Marking Conversion Chart

Wet Material Thickness		Edge Line Coverage			Area Coverage		
English mils (0.001")	Metric mm (0.001M)	English Ft/gal	Met./Eng. M/gal	Metric M/Liter	English SF/gal	Met./Eng. SM/gal	Metric SM/Liter
1.0	0.025	4832	1473	393.7	1611	150	39.37
10.0	0.254	483	147	39.4	161	15	3.94
15.0	0.381	322	98.2	26.2	107	10	2.62
19.7	0.500	245	74.8	20.0	82	7.6	2.00
20.0	0.508	242	73.6	19.7	81	7.5	1.97
25.0	0.635	193	58.9	15.7	64	6.0	1.57
30.0	0.762	161	49.1	13.1	54	5.0	1.31
35.0	0.889	138	42.1	11.2	46	4.3	1.12
39.4	1.000	123	37.4	10.0	41	3.8	1.00
40.0	1.016	121	36.8	9.8	40	3.7	0.98
45.0	1.143	107	32.7	8.7	36	3.3	0.87
49.2	1.250	98	29.9	8.0	33	3.0	0.80
50.0	1.270	97	29.5	7.9	32	3.0	0.79
59.1	1.500	82	24.9	6.7	27	2.5	0.67
60.0	1.524	81	24.5	6.6	27	2.5	0.66
78.7	2.000	61	18.7	5.0	20	1.9	0.50

88.6	2.250	55	16.6	4.4	18	1.7	0.44
90.0	2.286	54	16.4	4.4	18	1.7	0.44
98.4	2.500	49	15.0	4.0	16	1.5	0.40
100.0	2.540	48	14.7	3.9	16	1.5	0.39
118.1	3.000	41	12.5	3.3	14	1.3	0.33
120.0	3.048	40	12.3	3.3	13	1.2	0.33
236.2	6.000	20	6.2	1.7	7	0.6	0.17
250.0	6.350	19	5.9	1.6	6	0.6	0.16
255.9	6.500	19	5.8	1.5	6	0.6	0.15
260.0	6.604	19	5.7	1.5	6	0.6	0.15

WDB 4.22.97

Sheet Metal Conversion Factors

SHEET METAL Most specification references use gage number followed by the decimal inch thickness. Example: 22 gage (0.034 inch) Metric specifications use the absolute mm thickness. It is not the intent of this guidance to change the thickness of currently used sheeting. The following chart may be used to specify sheet metal. The thickness under "Specify" is thinner than the actual gage thickness, since specifications give minimum thickness.

Gage	Inch	Exact (mm)	Specify (mm)	Percent Thinner Than "Exact" Value
32	0.0134	0.3404	0.34	0.1
30	0.0157	0.3988	0.39	2.2
28	0.0187	0.4750	0.47	1.1
26	0.0217	0.5512	0.55	0.2
24	0.0276	0.7010	0.70	0.1
22	0.0336	0.8534	0.85	0.4
20	0.0396	1.0058	1.0	0.6
18	0.0516	1.3106	1.3	0.8
16	0.0635	1.6129	1.6	0.8
14	0.0785	1.9939	1.9	4.7
12	0.1084	2.7534	2.7	1.9
10	0.1382	3.5103	3.5	0.3
8	0.1681	4.2697	4.2	1.6

This schedule was developed since no existing material was found to clearly identify existing sheeting in metric units. Until a more efficient method is developed to address this issue, specifiers may wish to retain the gage number in specifications, and couple this with a rounded mm size in parenthesis.

Reinforcing Steel Conversion Factors

REINFORCING STEEL

WSDOT Metric projects will continue to use U.S. Customary units on PS&E's.

The following table shows the current U.S. customary rebar sizes in relationship to the respective diameters and cross-sectional areas.

	Customary English System		Metric Equivalent	
U. S. Customary Designation	**Diameter (in.)**	**Area (in 2)**	**Diameter (mm)**	**Area (mm 2)**
#3	0.375	0.11	9.5	71
#4	0.500	0.20	12.7	127
#5	0.625	0.31	15.9	198
#6	0.750	0.44	19.1	285
#7	0.875	0.60	22.2	388
#8	1.000	0.79	25.4	507
#9	1.125	1.00	28.6	641
#10	1.270	1.27	32.3	817
#11	1.410	1.56	35.8	1007
#14	1.693	2.25	43.0	1452
#18	2.257	4.00	57.3	2581

Wire Conversion Factors

SEVEN-WIRE, UNCOATED STRAND FOR PRESTRESSED CONCRETE STRUCTURES The prestressing industry again uses the soft conversion for all dimensional units of prestressing wire. This soft conversion is utilized worldwide and a copy of the equivalent physical properties for Grade 270 low-relaxation strand, as provided by Florida Wire and Cable Company, is provided below:

270 GRADE LOW-RELAXATION ASTM A-416

Nominal Strand Diameter		Minimum Strength		Area	
(mm)	(in.)	(kN)	(lb.)	(mm 2)	(in 2)
10	(3/8)	102.3	(23,000)	54.8	(0.085)
11	(7/16)	137.9	(31,000)	74.2	(0.115)
12	(15/32)	160.1	(36,000)	85.8	(0.133)
13	(1/2)	183.7	(41,300)	98.7	(0.153)
14	(9/16)	230.0	(51,700)	123.9	(0.192)
15	(0.600)	260.6	(58,600)	140.0	(0.217)

Sieve Conversion Factors

SIEVES

Sieve Designation (W)						
Standard	Alternative	Nominal Sieve Opening (in.)	Permissible Variation of Average Opening from the Standard Sieve Designation (y) + or	Intermediate Tollerance (x)	Maximum Individual Opening (x)	Nominal Wire Diameter (mm)
125 mm	5 in.	5	3.70 mm	130.0 mm	130.9 mm	8.00
106 mm	4.24 in.	4.24	3.20 mm	110.2 mm	111.1 mm	6.40
100 mm	4 in.	4	3.00 mm	104.0 mm	104.8 mm	6.30
90 mm	3 1/2 in.	3.5	2.70 mm	93.6 mm	94.4 mm	6.08
75 mm	3 in.	3	2.20 mm	78.1 mm	78.7 mm	5.80

63 mm	2 1/2 in.	2.5	1.90 mm	65.6 mm	66.2 mm	5.50
53 mm	2.12 in.	2.12	1.60 mm	55.2 mm	55.7 mm	5.15
50 mm	2 in.	2	1.50 mm	52.1 mm	52.6 mm	5.05
45 mm	1 3/4 in.	1.75	1.40 mm	46.9 mm	47.4 mm	4.85
37.5 mm	1 1/2 in.	1.5	1.10 mm	39.1 mm	39.5 mm	4.59
31.5 mm	1 1/4 in.	1.25	1.00 mm	32.9 mm	33.2 mm	4.23
26.5 mm	1.06 in.	1.06	0.80 mm	27.7 mm	28.0 mm	3.90
25.0 mm	1 in.	1	0.80 mm	26.1 mm	26.4 mm	3.80
22.4 mm		0.875	0.70 mm	23.4 mm	23.7 mm	3.50
19.0 mm	3/4 in.	0.750	0.60 mm	19.9 mm	20.1 mm	3.30
16.0 mm		0.625	0.50 mm	16.7 mm	17.0 mm	3.00
13.2 mm	0.530 in.	0.530	0.41 mm	13.83 mm	14.05 mm	2.75
12.5 mm	1/2 in.	0.500	0.39 mm	13.10 mm	13.31 mm	2.67
11.2 mm	7/16 in.	0.438	0.35 mm	11.75 mm	11.94 mm	2.45
9.50 mm		0.375	0.30 mm	9.97 mm	10.16 mm	2.27
8.00 mm	5/16 in.	0.312	0.25 mm	8.41 mm	8.58 mm	2.07
6.70 mm	0.265 in.	0.265	0.21 mm	7.05 mm	7.20 mm	1.87
6.30 mm	1/4 in.	0.250	0.20 mm	6.64 mm	6.78 mm	1.82
5.60 mm	No. 3 1/2	0.223	0.18 mm	5.90 mm	6.04 mm	1.68
4.75 mm	No. 4	0.187	0.15 mm	5.02 mm	5.14 mm	1.54
4.00 mm	No. 5	0.157	0.13 mm	4.23 mm	4 35 mm	1.37
3.35 mm	No. 6	0.132	0.11 mm	3.55 mm	3.66 mm	1.23
2.80 mm	No. 7	0.11	0.095 mm	2.975 mm	3.070 mm	1.10
2.36 mm	No. 8	0.0937	0.080 mm	2.515 mm	2.600 mm	1.00
2.00 mm	No. 10	0.0787	0.070 mm	2.135 mm	2.215 mm	0.900
1.70 mm	No. 12	0.0661	0.060 mm	1.820 mm	1.890 mm	0.810
1.40 mm	No. 14	0.0555	0.050 mm	1.505 mm	1.565 mm	0.725
1.18 mm	No. 16	0.0469	0.045 mm	1.270 mm	1.330 mm	0.650
1.00 mm	No. 18	0.0394	0.040 mm	1.080 mm	1.135 mm	0.580
0.850 mm	No. 20	0.0331	0.035 mm	0.925 mm	0.970 mm	0.510
0.710 mm	No. 25	0.0278	0.030 mm	0.775 mm	0.815 mm	0.450
0.600 mm	No. 30	0.0234	0.025 mm	0.660 mm	0.695 mm	0.390
0.500 mm	No. 35	0.0197	0.020 mm	0.550 mm	0.585 mm	0.340
0.425 mm	No. 40	0.0165	0.019 mm	0.471 mm	0.502 mm	0.290
0.355 mm	No. 45	0.0139	0.016 mm	0.396 mm	0.425 mm	0.247
0.300 mm	No. 50	0.0117	0.014 mm	0.337 mm	0.363 mm	0.215
0.250 mm	No. 60	0.0098	0.012 mm	0.283 mm	0.306 mm	0.180

0.212 mm	No. 70	0.0083	0.010 mm	0.242 mm	0.263 mm	0.152
0.180 mm	No. 80	0.0070	0.009 mm	0.207 mm	0.227 mm	0.131
0.150 mm	No. 100	0.0059	0.008 mm	0.174 mm	0.192 mm	0.110
0.125 mm	No. 120	0.0049	0.007 mm	0.147 mm	0.163 mm	0.091
0.106 mm	No. 140	0.0041	0.006 mm	0.126 mm	0.141 mm	0.076
0.090 mm	No. 170	0.0035	0.005 mm	0.108 mm	0.122 mm	0.064
0.075 mm	No. 200	0.0029	0.005 mm	0.091 mm	0.103 mm	0.053
0.063 mm	No. 230	0.0025	0.004 mm	0.077 mm	0.089 mm	0.044
0.053 mm	No. 270	0.0021	0.004 mm	0.066 mm	0.076 mm	0.037
0.045 mm	No. 325	0.0017	0.003 mm	0.057 mm	0.066 mm	0.030
0.038 mm	No. 400	0.0015	0.003 mm	0.048 mm	0.057 mm	0.025
0.032 mm	No. 450	0.0012	0.003 mm	0.042 mm	0.050 mm	0.028
0.025 mm	No. 500	0.0010	0.003 mm	0.034 mm	0.041 mm	0.025
0.020 mm	No. 635	0.0008	0.003 mm	0.029 mm	0.035 mm	0.020

Hard Conversions for Construction Materials

HARD CONVERSION FOR CONSTRUCTION MATERIALS

Structural Steel, M270

Grade	Min. Tensile Strength (MPa)	Min. Yield Strength (MPa)	Min. Yield Strength (ksi)
36	400	250	36
50	450	345	50
50W	485	345	50
70W	620	480	70

Reinforcing Bars, M31M

Grade		Tensile and Yield Strengths		
Metric	**English**	**Tensile Strength**	**Min. Yield Strength**	**Min. Yield Strength**
Value	**Value**	**(MPa)**	**(MPa)**	**(ksi)**
300	40	500	300	40
400	60	600	400	60

Common Concrete Strengths (f'c)							
Metric	**(MPa)**	20	28	35	43	48	55
English	**(psi)**	3000	4000	5000	6000	7000	8000

Coefficient of Thermal Expansion		
	Metric Value	**English Value**
Steel	0.0000117/oC	0.0000065/oF
Concrete	0.0000108/oC	0.000006/oF

Unit Weights		
	Metric Value	**English Value**
Steel	7848.3 kg/m3	490 pcf
Concrete	2402.5 kg/m3	150 pcf

The Construction Trades

THE CONSTRUCTION TRADES

Here are the metric units that will be used by the construction trades. The term "length" includes all linear measurements--length, width, height, thickness, diameter, and circumference.

	Quantity	**Unit**	**Symbol**
Surveying			
	length	kilometer, meter	km, m
	area	square kilometer	km2
		hectare (10,000 m2)	ha
		square meter	m2
	plane angle	degree (non metric)	^{o}
		minute (non metric)	'
		second (non metric)	"
Excavating			
	length	meter, millimeter	m, mm
	volume	cubic meter	m3

Trucking			
	distance	kilometer	km
	volume	cubic meter	m3
	mass	metric ton (1000 kg)	t
Paving			
	length	meter, millimeter	m, mm
	area	square meter	m2
Concrete			
	length	meter, millimeter	m, mm
	area	square meter	m2
	volume	cubic meter	m3
	temperature	degree Celsius	oC
	water capacity	liter (1000cm)	L
	mass (weight)	kilogram, gram	kg, g
	cross-sectional area	square millimeter	mm2

Pipe Conversion Factors

Pipe is one of the most ubiquitous products in construction. It is made of a wide variety of materials, including galvanized steel, black steel, copper, cast iron, concrete, and various plastics such as ABS, PVC, CPVC, polyethylene, and polybutylene, among others.

But like wood 2-by-4's which are not really 2 inches by 4 inches, pipe is identified by "nominal" or "trade" names that are related only loosely to actual dimensions. For instance, a 2-inch galvanized steel pipe has n inside diameter of about 2-1/8 inches and an outside diameter of about 2-5/8 inches. It is called "2-inch pipe" only for the sake of convenience.

Since few, if any, pipe products have actual dimensions that are in even, round inch-pound numbers, there is no need to convert them to even, round metric numbers. Instead, only their names will change--from inch-pound to metric. Pipe cross sections will not change. Fittings, flanges, couplings, valves, and other piping components will be renamed in like manner as will pipe threads. Here are the inch-pound names for pipe products (called NPS or "nominal pipe size") and their metric equivalents (called DN or "diameter nominal"). The metric names conform to International Standards Organization (ISO) usage and apply to all plumbing, natural gas, heating oil, drainage, and miscellaneous piping used in buildings and civil works projects.

NPS	DN	NPS	DN
1/8"	6 mm	8"	200 mm
3/16"	7 mm	10"	250 mm
1/4"	8 mm	12"	300 mm
3/8"	10 mm	14"	350 mm
1/2"	15 mm	16"	400 mm
5/8"	18 mm	18"	450 mm
3/4"	20 mm	20"	500 mm
1"	25 mm	24"	600 mm
1-1/4"	32 mm	28"	700 mm
1-1/2"	40 mm	30"	750 mm
2"	50 mm	32"	800 mm
2-1/2"	65 mm	36"	900 mm
3"	80 mm	40"	1000 mm
3-1/2"	90 mm	44"	1100 mm
4"	100 mm	48"	1200 mm
4-1/2"	115 mm	52"	1300 mm
5"	125 mm	56"	1400 mm
6"	150 mm	60"	1500 mm

****(For pipe over 60 inches, use 1 inch equals 25 mm)**

TABLE 1

PROPOSED METRIC CSP DIAMETER SIZES

Proposed Metric (mm)	Current Standard (inches)
150	6
200	8
250	10
300	12
375	15
450	18
525	21
600	24
675	27
750	30
825	33
900	36
1050	42
1200	48
1350	54
1500	60
1650	66
1800	72
1950	78
2100	84
2250	90
2400	96
2550	102
2700	108
2850	114
3000	120
3150	126
3300	132
3450	138
3600	144

TABLE 2

Current (inches)	Corrugation Sizes Proposed (millimeters)
2 2/3 x 1/2	68 x 13
3 x 1	76 x 25
5 x 1	125 x 25
3/4 x 3/4 x 7 1/2	19 x 19 x 191
3/4 x 1 x 11 1/2	19 x 25 x 292

TABLE 3

PIPE WALL THICKNESS

Current Gage	Nominal Thickness (inches)	Proposed Nominal Thickness (millimeters)
16	0.064	1.6
14	0.079	2.0
12	0.109	2.8
10	0.138	3.5
8	0.168	4.3

TABLE 4

PIPE ARCH SIZES

Corrugations		Corrugations	
Inches	**Millimeters**	**Inches**	**Millimeters**
2 2/3 x 1/2	68 x 13	3 x 1 & 5 x 1	76 x 25 & 125 x 25
Span x Rise	Span x Rise	Span x Rise	Span x Rise
17 x 13	425 x 325	53 x 41	1325 x 1025
21 x 15	525 x 375	60 x 46	1500 x 1150
24 x 18	600 x 450	66 x 51	1650 x 1275
28 x 20	700 x 500	73 x 55	1825 x 1375
35 x 24	875 x 600	81 x 59	2025 x 1475
42 x 29	1050 x 725	87 x 63	2175 x 1575
49 x 33	1225 x 825	95 x 67	2375 x 1675
57 x 38	1425 x 950	103 x 71	2575 x 1775
64 x 43	1600 x 1075	112 x 75	2800 x 1875
71 x 47	1775 x 1175	117 x 79	2925 x 1975
77 x 52	1925 x 1300	128 x 83	3200 x 2075
83 x 57	2075 x 1425	137 x 87	3425 x 2175
142 x 91	3550 x 2275		

Note: millimeters equal to inches x 25. Assumed pipe diameters will be x 25.

TABLE 4A

PIPE ARCH SIZES

Corrugations (inches) 3/4 x 3/4 x 7 1/2 Span x Rise	**Corrugations (millimeters)** 19 x 19 x 191 Span x Rise
20 x 16	500 x 400
23 x 19	575 x 475
27 x 21	675 x 525
33 x 26	825 x 650
40 x 31	1000 x 775
46 x 36	1150 x 900
53 x 41	1325 x 1025
60 x 46	1500 x 1150
66 x 51	1650 x 1275
73 x 55	1825 x 1375
81 x 59	2025 x 1475
87 x 63	2175 x 1575
95 x 67	2375 x 1675

Note: millimeters equal to inches x 25. Assumed pipe diameters will be x 25.

Structural Plate Conversion Factors

STRUCTURAL PLATE DIMENSIONS

6 X 2 Corrugation
31 Inch Corner Radius

Span	Rise	R	R
ft-in	ft-in	ft.	ft.
13-3	9-4	6.68	16.05
14-11	10-2	7.48	18.98
16-6	11-0	8.29	21.93
18-1	11-10	9.09	24.98
19-8	12-8	9.90	28.04

TABLE 5M

STRUCTURAL PLATE DIMENSIONS

152 x 51 Corrugation
787 mm Corner Radius
(millimeters)

Span	Rise	R	R
4039	2845	2036	4892
4547	3099	2280	5785
5029	3353	2527	6684
5512	3607	2771	7614
5994	3861	3018	8547

TABLE 6

STRUCTURAL PLATE THICKNESS

Current Specification		Proposed
Gage	**Inches**	**Millimeters**
12	.111	2.5
10	.140	3.5
8	.170	4.5
7	.188	-
5	.218	5.5
3	.249	6.5
1	.280	7.0

5/16	.318	8.0
3/8	.377	9.5