SI Units for Structural Steel Design

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Although there are seven metric base units in the SI system, only four are currently used by AISC in structural steel design. These base units are listed in the following table.

Quantity	Unit	Symbol
length	meter	m
mass	kilogram	kg
time	second	s
temperature	celcius	°C

Similarly, of the numerous decimal prefixes included in the SI system, only three are used in steel design.

Prefix	Symbol	Order of Magnitude	Expression
mega	M	10^6	1,000,000 (one million)
kilo	k	10^3	1,000 (one thousand)
milli	m	10^{-3}	0.001 (one thousandth)

In addition, three derived units are applicable to the present conversion.

Quantity	Name	Symbol	Expression
force	newton	N	$N = kg \times m / s^2$
stress	pascal	Pa	$Pa = N / m^2$
energy	joule	J	$J = N \times m$

Although specified in SI, the pascal is not universally accepted as the unit of stress. Because section properties are expressed in millimeters, it is more convenient to express stress in newtons per square millimeter ($1N / mm^2 = 1$ MPa). This is the practice followed in recent international structural design standards, including the International Standards Organization (ISO), Draft International Standard for Steel Design,[1] as well as the April 1990 draft of Eurocode 3, Design of Steel Structures, Part 1—General Rules and Rules for Buildings. It should be noted that the joule, as the unit of energy, is used to express energy absorption requirements for impact tests. Moments are expressed in terms of $N \times m$.

The following conversion factors relate traditional U.S. units of measurement to the corresponding SI units:

Multiply	by:	to obtain:
inch (in.)	25.4	millimeters (mm)
foot (ft)	305	millimeters (mm)
pound-mass (lb)	0.454	kilogram (kg)
pound-force (lbf)	4.448	newton (N)
ksi	6.895	N / mm^2
ft-lbf	1.356	joule (J)

Note that fractions resulting from metric conversion should be rounded to whole millimeters. Following are common fractions of inches and their metric equivalent.

Fraction, in.	Exact conversion, mm	Rounded to: (mm)
1/16	1.5875	2
1/8	3.175	3
3/16	4.7625	5
1/4	6.35	6
5/16	7.9375	8
3/8	9.525	10
7/16	11.1125	11
1/2	12.7	13
5/8	15.875	16
3/4	19.05	19
7/8	22.225	22
1	25.4	25

Bolt diameters are taken directly from the ASTM Specification A325M and A490M rather than converting the diameters of bolts dimensioned in inches. The metric bolt designations are as follows:

Designation	Diameter, mm	Diameter, in.
M16	16	0.63
M20	20	0.79
M22	22	0.87
M24	24	0.94
M27	27	1.06
M30	30	1.18
M36	36	1.42

The yield strengths of structural steels covered in the metric LRFD Specification are taken from the metric ASTM Specifications. It should be noted that the yield points are slightly different from the traditional values.

ASTM Designation	Yield stress, N / mm^2	Yield stress, ksi
A36M	250	36.26
A572M Gr. 345 A588M	345	50.04
A852M	485	70.34
A514M	690	100.07

On the basis of the above selection of units and conversion factors, the 1986 LRFD Specification has been translated into the SI system. When necessary, formulas were revised to make all coefficients nondimensional. In most instances, this could be achieved by explicitly showing the modulus of elasticity, E, in the formulation.

The converted LRFD Specification is offered to the federal agencies and consultants as an interim document to facilitate design of metric demonstration projects. It will also serve as an introduction of the SI units of measurement to the general design profession and fabricating industry. More complete information is available in the Metric Guide for Federal Construction, First Edition, prepared by the Construction Subcommittee of the Metrication Operating Committee. The guide is available from the National Institute of Building Sciences in Washington D.C.*

REFERENCES

1. *Steel Structures—Materials and Design,* Committee Draft TC167 / SCI CD10721, ISO, 1991.

* Call (202) 289-7800 for ordering information.