STRUCTURAL SYSTEMS REFERENCE INDEX

The following is a list of formulas and references that will be available to all candidates during their Structural System Exam, with the permission of the *American Institute of Steel Construction*, the *Canadian Institute of Steel Construction*, the *International Code Council*, and the *National Research Council Canada*. NCARB does not have copyright permission to reproduce these references *except* in testing centers. In order to help candidates properly prepare for the test, sources for each reference are listed.

Reference	
International System of Units in Structural Engineering	*See Attached*
Bean Diagrams and Formula - Nomenclature	**A:** *pg.* 2-293 & 2-294
Simple Beam Formulas - Conditions 1-3	**A:** *pg.* 2-296 or **E:** *pg.* 3-211
Simple Beam Formulas - Conditions 4-6	**A:** *pg.* 2-297 or **E:** *pg.* 3-212
Simple Beam Formulas - Conditions 7-9	**A:** *pg.* 2-298 or **E:** *pg.* 3-213
Beam Fixed at Both Ends Formulas - Conditions 15-17	**A:** *pg.* 2-301 or **E:** *pg.* 3-216
Beam Overhanging One Support Formulas - Conditions 24-28	**A:** *pg.* 2-304 & 2-305 or **E:** *pg.* 3-219 & 3-220
Dimensions and Properties of US Members	
W 44 thru 27 - Dimensions and Properties	**A:** *pg.* 1-10 thru 1-16 or **E:** *pg.* 1-10 thru 1-15
W 24 thru W14x145 - Dimensions and Properties	**A:** *pg.* 1-18 thru 1-25 or **E:** *pg.* 1-16 thru 1-21
W 14x132 thru W4 - Dimensions and Properties	**A:** *pg.* 1-26 thru 1-32 or **E:** *pg.* 1-22 thru 1-27
C - Dimensions and Properties	**A:** *pg.* 1-40 thru 1-41 or **E:** *pg.* 1-34 thru 1-35
Angles Properties	**A:** *pg.* 1-46 thru 1-52 or **E:** *pg.* 1-40 thru 1-47
Rectangular HSS Dimensions and Properties	**A:** *pg.* 1-97 thru 1-103 or **E:** *pg.* 1-72 thru 1-89
Square HSS Dimensions and Properties	**A:** *pg.* 1-94 thru 1-96 or **E:** *pg.* 1-90 thru 1-93
Round HSS Dimensions and Properties	**E:** *pg.* 1-94 thru 1-98
Bolts Threaded Parts, and Rivets Loads in Tension and Shear	**A:** *pg.* 4-3 & 4-5
Dimensions and Properties of Canadian Members	
W1100 thru W610 - Properties, Dimensions and Surface Areas	**B:** *pg.* 6-40 thru 6-45
W530 thru W360x216 - Properties, Dimensions and Surface Areas	**B:** *pg.* 6-46 thru 6-49
W360x196 thru W100 - Properties, Dimensions and Surface Areas	**B:** *pg.* 6-50 thru 6-55
C - Shapes	**B:** *pg.* 6-66 thru 6-67
MC - Shapes	**B:** *pg.* 6-68 thru 6-71
Angles Properties About Geometric Axis, Dimension & Properties About Principal Axis	**B:** *pg.* 6-72 thru 6-81
Rectangular Hollow Structural Sections Properties and Dimensions	**B:** *pg.* 6-106 thru 6-107
Square Hollow Structural Sections Properties and Dimensions	**B:** *pg.* 6-108 thru 6-109
Round Hollow Structural Sections Properties and Dimensions	**B:** *pg.* 6-110 thru 6-111
Canadian Bolt Slip Resistance	**B:** *pg.* 3-8 & 3-15
Live and Concentrated Loads	
Uniform and Concentrated Loads IBC table 1607.1	**C:** *pg.* 285 & 286
Canada: Live loads on Area of Floor or Roof	**D:** *Division B,* 4-8 thru 4-10

Sources:

A. United States. American Institute of Steel Construction, Inc. Manual of Steel Construction: Allowable Stress Design; 9th Edition. Chicago, Illinois, 1989.

B. Canada. Canadian Institute of Steel Construction. Handbook of Steel Construction; 9th Edition. Toronto, Ontario, 2006.

C. United States. International Code Council, Inc. 2006 International Building Code. Country Club Hills, Illinois, 2006.

D. Canada. Institute for Research in Construction, National Research Council Canada. National Building Code of Canada 2005, Volume 1. Ottawa, Ontario, 2005.

E. United States. American Institute of Steel Construction, Inc. Steel Construction Manual; 13th Edition. Chicago, Illinois, 2005.

The International System of Units: SI
In Structural Engineering

The major difference between metric and SI:

In metric, the **kilogram (kg)** is a unit of mass and of force.

In SI, the **kilogram (kg)** is a unit of mass and the **newton (N)** is a unit of force.

Length – the meter

Dimensions may be in **millimeters (mm)** or in **meters (m)**. (Centimeters (cm) are not used.)

$$\textbf{1 m = 1 000 mm; 1 mm} = \frac{\textbf{1m}}{\textbf{1000}} = \textbf{1 m x } 10^{-3} \textbf{ = 0.001 m}$$

(When mm are used on drawings, the symbol "mm" may be omitted. Steel W shapes are designated by: nominal depth (mm) x mass (kg/m), e.g., W360 x 33 (≡ W14 x 22 in U.S. units).)

Force – the newton

By Newton's law: Force = mass x acceleration (F = ma)

and the **newton: 1 N = 1 kg x 1 m/sec^2**.

Acceleration on Earth is gravity = 9.81 m/sec^2 and
the **force** of gravity on a 1 kg mass = **1 kg x 9.81 m/sec^2 = 9.81 N**
i.e. a 1 kg mass weighs 9.81 N on Earth.

A kilonewton = 1 000 N = 10^3 N = 1 kN

A meganewton = 1 000 000 N = 10^6 N = 1 MN

Pressure, Stress – the pascal

The **pascal**: **1 Pa** = **1 N/m^2**

a **kilopascal: 1 kPa = 1 kN/m^2 = 10^3 N/m^2**

a **megapascal: 1 MPa = 1 MN/m^2 = 10^6 N/m^2**

(And since 1 m = 10^3 mm, 1 m^2 = 10^6 mm^2, **1 MPa = 10^6 N/10^6 mm^2 = 1 N/mm^2**)

Units Used

Loads: kPa ≡ kN/m²; or kN/m; or kN

Shear: kN

Bending Moment: kN · m

Stress: MPa ≡ N/mm²

Limit States Design (LSD)

Structural Design in Canada is by LSD, which is similar to Strength Design in concrete, or Load and Resistance Factor Design (LRFD) in steel, in U.S.A.

Factored loads are used for strength design and compared with factored resistances.

Unfactored ("specified") loads are used for deflection calculations.

Loads given in the exam are usually already factored where required. Design aids show factored resistances.

Note: SI to U.S. conversions in the ARE are not always direct, but are made to ensure the equivalent level of difficulty when performing calculations. Do not calculate in one system and convert to the other for an answer.

Approximate Conversions SI to U.S.

Length

1 m ≈ 3 ft (= 3.28 ft)

Pressure

1 kPa = 1 kN/m² ≈ 20 psf (= 20.9 psf)

5 kPa = 5 kN/m² ≈ 100 psf (= 105 psf)

Conversions for Calculations SI to SI

8 000 mm = 8 m

600 mm = 0.6 m