SYMBOLS

Various disciplines of engineering, hydraulics, physics, chemistry, etc. have established standard symbols or letters to denote various factors or dimensions in formulas, tables, drawing and texts. Some of these are found in dictionaries; others have been published by technical associations. Some of the symbols used in this handbook are listed here. For others, reference should be made to sources such as are listed for the preceding Glossary.

Symbol	Definition or Use
a	Area, cross-sectional, culvert
a	Constant in an Intensity-Duration Frequency Curve
A	Area, cross-sectional, of waterway, m^2
A	Area of long span structure, m^2
A	Drainage area
A	Area of section, mm^2
A	Width of roadway surface or roadbed in determining culvert length
A	Required wall area
A	Cross-sectional area of flow in m^2 at right angles to the direction of flow
A	Area to be subdrained
A	Cross-sectional area of liner plate, mm^2/m
A	Cross-sectional area of a corrugated metal conduit wall per unit length, in the longitudinal direction, mm^2/mm
A_c	Partial flow area
A_c	Axle load during construction, kN
A_f	Factor used to calculate the thrust due to dead load in the conduit wall
A_r	Recurring annual amount
A_H	Horizontal acceleration ratio due to earthquake loading, equal to the zonal acceleration ratio, dimensionless.
A_L	Weight of a single axle of the CHBDC truck for $D_h<3.6$ m; or the combined weight of the two closely-spaced axles of the CHBDC truck for $D_h \geq 3.6$ m, kN.
A_V	Vertical acceleration ratio due to earthquake loading, equal to two-thirds the horizontal acceleration ratio, A_H, dimensionless
b	Constant in an Intensity-Duration Frequency Curve
b	Bottom width of a trapezoidal channel
b	Developed width factor
B	Invert to spring line
B	Slope width from roadway to top of culvert on a flat grade
B	Long span structure length, m
B_1	Slope width from roadway to top of upstream end of culvert on a steep grade

Symbol	Definition or Use
B_2	Slope width from roadway to top of downstream end of culvert on a steep grade
c	Constant in an Intensity-Duration Frequency Curve
c	Coefficient of roughness whose value depends on the surface over which water flows
*c*L	Centerline
C	Coefficient, runoff
C	Compression in pipe wall
C	Long span dimension between centers of inside radii
C	Ring compression, thrust, N/m
C	Elevation from bottom of culvert to top of roadway
C	Subsurface runoff factor, m^3/s
C_a	Recommended antecedent precipitation factor for the rational formula
C_d	Soil coefficient for tunnel liner
CO	Carryover design for slotted drain pipes
C*s*	Axial stiffness parameter for soil-metal structures
C_1	Difference in elevation from roadway surface to top of the upstream end of a culvert on a steep grade
C_2	Difference in elevation from roadway surface to the top of the downstream end of a culvert on a steep grade
d	Depth of channel
d	Depth of flow in gutter
d	Internal diameter of pipe, mm
d	Depth of corrugation, mm
d_c	Critical depth
d_n	Nominal discount rate
d_r	Discount rate
D	Diameter of conduit, inside—or maximum span
D	Depth of corrugation, mm
D	Minimum cover from top surface of flexible pavement to corrugated steel pipe for airplane wheel loads
D	Horizontal diameter or span of a tunnel
D	Long span structure height, mm
D	Delta, tangent angle, corrugation
D	Equivalent diameter = (1/p)x(perimeter of the conduit in metres), m
D_c	Critical pipe diameter, mm
D_h,D_v	Dimensions relating to the conduit as defined in Figure 6.10
DLA	Dynamic load allowance expressed as a fraction of live load
DL	Dead load
E	Railroad live load
E	Modulus of elasticity, MPa
E_m	Modified modulus of soil stiffness, MPa
E_s	Secant modulus of soil stiffness, MPa
EOS	Equivalent Opening Size, geotextiles

Symbol	Definition or Use
f	Friction factor
f	The rate of infiltration at a specific period of time
f_a	Allowable wall stress, MPa
f_b	factored failure stress in compression in the metal conduit wall, MPa
f_c	Compressive stress, MPa
f_c	Minimum rate of infiltration
f_c	Buckling stress, MPa
f_o	Initial rate of infiltration
f_u	Minimum specified tensile strength, MPa
F_m	Reduction factor for modifying buckling stress in multi-conduit structures
F_{sr}	Stress range for fatigue resistance
F_y	Cold-formed yield stress of the metal conduit wall, MPa
FF	Flexibility factor
FS	Factor of safety for buckling
g	Gravitational acceleration
h	Height of fill over pipe
h_o	Tailwater depth (TW)
H	Drop of weir notch, mm
H	Difference in elevation between the most remote point on the basin and the outlet
H	Head, m
H	Height of soil over the top of a tunnel
H	Depth of cover, m
H_c	Depth of cover at intermediate stages of construction, m
H_e	Critical head
H_e	Head, entrance loss
H_e	Increment of head above the critical head, m
H_f	Head, friction loss
H_{min}	Minimum allowable depth of cover above the conduit, m
H_o	Head, exit loss
H_v	Velocity head
HC	Height of cover
HW	Headwater depth
$H20$	Highway live load
i	Intensity, rainfall, mm/hr
i	Transverse slope
i_b	Intensity after peak rainfall
I	General rate of inflation
I	Imperviousness, relative
I	Moment of inertia, mm^4/unit of width
I	Intensity, mm/hr
I	Second moment of cross-sectional area, A, about the neutral axis of corrugated section in the longitudinal direction of the conduit, mm^4/mm
I_a	Intensity before peak rainfall
k	Long span entrance coefficient
k	Rate of decrease in rate of infiltration, f, per unit of time

Symbol	Definition or Use
k_e	Entrance loss coefficient
k_{dg}, k_p	Coefficients based on long span inlet type
k_o	Outlet loss coefficient
k_R	Haunch moment reduction factor for metal box structures
k_{M1},k_{M2},k_{M3}	Factors used in calculating moments in soil-metal structures during construction
k_1,k_2,k_3,k_4	Factors used in calculating dead load and live load moments in soil-metal and metal box structures
K	Soil stiffness factor; load factor
K	Constant equal to l/S_d
K	Conveyance
K	Factor representing the relative stiffness of the conduit wall with respect to the adjacent soil
l	Length of pipe, m
l	Length of opening, m
l_t	Length of dispersed live load at crown level measured transversely, m
L	Length of weir notch, mm
L	Maximum length of travel of water, mm
L	Length of culvert, m
L_c	Line load equivalent to the construction load acting on a metal structure, kN/m
L_1, L_2, L_3	Lengths used for live load pressure distribution calculations for pipe arches, mm
L'	Adjusted value for length
LL	Live load
L_A	Actual slot length
L_L	Line load equivalent to the live load acting on a metal structure, kN/m
L_R	Length of slot with no carryover
m	Long span entrance coefficient
m_f	Modification factor for multi-lane loading
M	Unfactored moment in a soil-metal structure, kN.m/m
M_{cf}	Total factored crown bending moment in a metal box structure, kN.m/m
M_{cD}	Crown bending moment in a metal box structure due to dead load, kN.m/m
M_{hD}	Haunch bending moment in a metal box structure due to dead load, kN.m/m
M_{hf}	Total factored haunch bending moment in a metal box structure, kN.m/m.
M_{hL}	Haunch bending moment in a metal box structure due to live load, kN.m/m
M_B	Additional moment in the wall of a soil-metal structure due to a height of fill, H_c, above the crown, kN.m/m.
M_C	Additional moment in a soil-metal structure due to construction live loads, kN.m/m

Symbol	Definition or Use
M_D	Sum of the intensities of bending moments at the crown and haunch in a metal box structure due to dead load, kN.m/m
M_E	Additional moment in a metal box structure due to earthquake loading, kN.m/m
M_L	Sum of the crown and haunch bending moments in a metal box structure due to live load
M_P	Unfactored plastic moment capacity of a corrugated metal section, kN.m/m
M_{Pf}	Factored plastic moment capacity of a corrugated metal section, kN.m/m
M_l	Moment in a soil-metal structure resulting from fill to the crown level, kN.m/m
n	Number of years
n	Roughness factor
n	Storm frequency
n	Coefficient of roughness
n'	Actual value of Manning's *n*
N	Circumferential bolt space (= 3 p or 244 mm)
NF	Flexibility number used in calculating moments in a soil-metal structure during construction
P	Pressure, external load
P	Corrugation pitch, (125 x 26 mm corrugation)
P	The external load on tunnel liner
P	Unfactored thrust in the wall of a soil-metal structure, kN/m
pi	p = 3.141592654
pH	Hydrogen ion concentration
P_c	Pressure acting on soil at pipe-arch corners, kN/m^2
P_{cr}	Critical pressure, MPa
P_d	Design pressure, liner plate
P_e	Rainfall excess equal to gross rainfall minus evaporation interception and infiltration
P_{Pf}	Factored compressive strength of a corrugated metal section, without buckling, kN/m
P_t	Accumulated depth of precipitation at time, t
P_{tot}	Total depth of precipitation
P_v	Design pressure, kN/m^2
P_v	Design pressure, ring compression
P_l	The vertical load at the level of the top of the tunnel liner due to dead load
PE	Collapse pressure
PV	Present Value
F	Diameter
F	Index of recharge based on constant rate of infiltration
Q	Discharge, m^3/s (peak, volume rate of flow, or quantity reaching a drain); peak runoff rate
Q_D	Total flow
Q_O	Flow in a gutter, m^3/s

Symbol	Definition or Use
r	Ratio of time before the peak intensity occurs to total time duration
r	Radius of gyration
r	Radius of gyration of corrugation profile, mm
R	Resistivity, electrical
R	Hydraulic radius
R	Ratio of rise to span
R	Radius of conveyor cover
R	Radius of curvature in hook bolt
R	Radius of pipe, mm
R	Radius of curvature of the conduit wall, at the mid-depth of corrugations, at a transverse section, mm; or the rise of a metal box structure, m
R_b	Radius of bottom (plates)
R_c	R at crown, mm
R_c	Radius of corner (plates)
R_e	Equivalent radius, mm
R_s	Radius of side (plates)
R_t	Radius of top (plates)
R_1	Long-span inside radius
R_2	Long-span inside radius
R_B,R_L	Parameters used in calculating moments in the wall of a soil-metal structure during construction
s	Hydraulic gradient of gutter
S	Span of arch or pipe-arch (or maximum horizontal diameter of any shaped structure)
S	Slope (of ground, channel, invert), m/m
S	Slope, equal to H/L where H is the difference in the elevation between the most remote point on the basin and the outlet, m/m
S	Side slope
S	Section modulus, mm^3
S	Least transverse clear spacing between adjacent conduits, m
S_d	Maximum storage capacity of depression
S_o	Slope, bed (at outlet)
SF	Safety factor (or FS)
S_M	Flexural strength of a longitudinal connection, per unit length, kN.m/m
S_S	Axial strength of a longitudinal connection, per unit length, kN/m
t	Time
T, t	Uncoated thickness of sheet or plate, mm
T_c	Time of concentration of flow
T_f	Maximum thrust in the conduit wall due to factored loads per unit length, kN/m
T_C	Additional thrust in the wall of a soil-metal structure due to construction live loads, kN/m
T_E	Additional thrust in the wall of a soil-metal structure due to earthquake loading kN/m

Symbol	Definition or Use
TL	Tangent length
TW	Tailwater depth
T_D, T_L	Maximum thrust in the conduit wall per unit length due to unfactored dead and live loads, respectively, kN/m
T	Thrust per lineal, m
T	Width of water surface, m
t_a	Time after peak
t_b	Time before peak
V	Velocity, mean, m/sec
V	Volume of storage at any particular time
V	Mean velocity of flow, m/sec
V_a, V_l	Approach velocity
V_c	Velocity head
S*V*	Summation of vertical forces in ring compression calculations
w	Unit weight of soil, kN/m^3
W	Width, conveyor cover
W	Weight of moist soil
W, WP	Wetted perimeter
W	Total weight of soil and live loads over a structure
W	Dead weight of the column of material above the conduit per unit length of conduit kN/m for soil-metal structures.
WS	Water surface
X	Distance from neutral axis to outer fiber
Υ	unit weight of soil, kN/m^3
z	Transverse slope reciprocal
θ	Skew angle of the conduit, degrees
κ	Crown moment coefficient used to calculate the crown and haunch bending moments in a metal box structure
λ	Factor used in calculating K
p	Reduction factor for buckling stress in metal conduit wall
σ	Stress due to thrust in a conduit wall due to factored loads, MPa
σ_L	Equivalent uniformly-distributed pressure at the crown due to unfactored dispersed live load, kPa
ϕ_h	Resistance factor for plastic hinge
ϕ_j	Resistance factor for failure of seams
ϕ_t	Resistance factor for compressive strength of soil-metal and metal box structures
v	Poissson's ratio