



DIVISION: 06 00 00—WOOD, PLASTICS AND COMPOSITES

Section: 06 05 23—Wood, Plastic, and Composite Fastenings

REPORT HOLDER:

ROTHO BLAAS S.R.L.

EVALUATION SUBJECT:

ROTHO BLAAS SELF-TAPPING WOOD SCREWS

1.0 EVALUATION SCOPE

Compliance with the following codes:

- 2021, 2018, 2015, 2012 and 2009 *International Building Code®* (IBC)
- 2021, 2018, 2015, 2012 and 2009 *International Residential Code®* (IRC)

Properties evaluated:

- Structural
- Corrosion resistance

2.0 USES

Rotho Blaas self-tapping screws are used for wood-to-wood and metal-to-wood connections that are designed in accordance with the IBC. For structures regulated under the IRC, the screws may be used where an engineered design is submitted in accordance with IRC Section R301.1.3. Rotho Blaas screws with EVO coating may be used where fasteners are required to exhibit corrosion resistance when exposed to adverse environmental conditions, in chemically treated wood (subject to the limitations of Sections 4.2, 5.4, 5.5 and Table 9) or both; and are alternates to hot-dip zinc galvanized fasteners with a coating weight in compliance with ASTM A153, Class D. Rotho Blaas screws with EVO coating have been evaluated for use with wood chemically treated with waterborne alkaline copper quaternary (ACQ). The EVO coated screws are intended for use in the Exposure Conditions 1 and 3, as shown in Table 9.

3.0 DESCRIPTION

3.1 Notation and Symbols:

- ASG : Assigned specific gravity for the applicable wood species
- a_{xx} : Screw spacings and distances [inches (mm)]
- C_M : Wet-service factor

- D_{nom} : Nominal screw diameter [inches] and/or [mm]
- D : Outside thread diameter [inch (mm)]
- D_r : Minor thread (root) diameter [inch (mm)]
- D_H : Head diameter [inch (mm)]
- D_S : Unthreaded shank diameter [inch (mm)]
- E : Tip length [inch (mm)]
- F_{yb} : Bending yield strength determined in accordance with ASTM F1575 using root diameter D_r [psi (MPa)]
- k_α : Withdrawal load reduction factor for inclined screws
- L : Screw length [inches (mm)]
- $l_{eff,s}$: Effective embedded thread length in the wood side member [inches (mm)]
- $l_{eff,m}$: Effective embedded thread length in the wood main member [inches (mm)]
- l_m : Screw penetration into the main member [inch (mm)]
- N_a : Allowable tension strength of the screw for use in ASD [lbf (N)]
- T : Threaded length including tip [inches (mm)]
- t_m : Thickness of wood main member [inches (mm)]
- $t_{s,w}$: Thickness of wood side member [inches (mm)]
- $t_{s,s}$: Thickness of steel side member [inch (mm)]
- W_{90} : Reference unit withdrawal design value for screws installed perpendicular to grain of the wood [lbf/inch (N/mm)]
- W_α : Reference unit withdrawal design value for screws installed at an angle α to the grain of the wood [lbf/inch (N/mm)]
- W_L : Total reference withdrawal design load [lbf (N)]
- W_H : Reference head pull-through design value for partially threaded screws [lbf (N)]
- $Z_{||}$: Reference lateral design values, loaded parallel to the grain [lbf (N)]
- $Z_{\perp}$: Reference lateral design values, loaded perpendicular to the grain [lbf (N)]
- $Z_{\perp/||}$: Reference lateral design values, loaded perpendicular to the grain (side member) and parallel (main member) [lbf (N)]

α : Angle between the axis of the fastener and the grain of the applicable wood member [degrees]

3.2 Screws:

The screws are dowel-type threaded fasteners designed to be installed in wood without drilling a lead hole due to their self-drilling point. The screws are manufactured from carbon steel wire according to the manufacturer's specifications. Following the head forming and the thread rolling process, the screws are heat-treated and coated. Screws are zinc plated or coated with EVO coating. EVO coating is a proprietary multi-layer corrosion-resistant coating. The screw dimensions and strengths are provided in Tables 1 through 3.

3.2.1 HBS and HBS EVO Screws: HBS and HBS EVO screws are partially threaded and available in various diameters and lengths as shown in Table 1 and Figure 1. The screws have a countersunk head with milling ribs under the head. HBS and HBS EVO screws have zinc plating and EVO coating, respectively. HBS and HBS EVO screws are compatible with HUS and HUS EVO countersunk washers shown in Figure 5.

3.2.2 HBS PLATE and HBS PLATE EVO Screws: HBS PLATE and HBS PLATE EVO screws are partially threaded and available in various diameters and lengths as shown in Table 1 and Figure 1. The screws have a washer head combined with a cylindrical feature under the head. HBS PLATE and HBS PLATE EVO screws have zinc plating and EVO coating, respectively.

3.2.3 TBS, TBS MAX and TBS EVO screws: TBS, TBS MAX and TBS EVO screws are partially threaded and available in various diameters and lengths as shown in Table 1 and Figure 1. TBS and TBS EVO screws have zinc plating and EVO coating, respectively. TBS MAX screws are zinc plated.

3.2.4 LBS and LBS EVO Screws: LBS and LBS EVO screws are fully threaded and available in various diameters and lengths as shown in Table 2 and Figure 2. The screws have a round head combined with a cylindrical feature under the head. LBS and LBS EVO screws have zinc plating and EVO coating, respectively.

3.2.5 VGZ and VGZ EVO Screws: VGZ and VGZ EVO screws are fully threaded and available in various diameters and lengths as shown in Table 2 and Figure 3. The screws have a cylindrical head. VGZ and VGZ EVO screws have a zinc plating and EVO coating, respectively.

3.2.6 VGS and VGS EVO Screws: VGS and VGS EVO screws are fully threaded and available in various diameters and lengths as shown in Table 2 and Figure 3. The screws have either a countersunk or hexagonal star drive head. VGS and VGS EVO screws have zinc plating and EVO coating, respectively. VGS and VGS EVO screws with a countersunk head are compatible with VGU 45° countersunk washers shown in Figure 6 and HUS and HUS EVO countersunk washers shown in Figure 5.

3.2.7 DGZ Screws: DGZ screws are double threaded and available in various diameters and lengths as shown in Table 3 and Figure 4. The screws have a cylindrical head, and are zinc plated. The outside thread diameter and root diameter are the same for both threaded portions of the screw.

3.2.8 Alternative Product Names: Some of the products addressed in this report are available with alternative product names, as shown in the table below:

PRODUCT DESIGNATION	ALTERNATIVE PRODUCT DESIGNATION
HBS	SNK
HBS EVO	SNK EVO
HBS PLATE (HBSP)	KGL
HBS PLATE EVO (HBSP EVO)	KGL EVO
TBS	TLL
TBS EVO	TLL EVO
LBS	SBL
DGZ	DWZ

3.3 Wood Members:

For purposes of connection design, sawn lumber members must have an assigned specific gravity (*ASG*) as indicated in the tables in this report. Assigned specific gravity for sawn lumber and timber must be determined in accordance with Table 12.3.3A of the ANSI/AWC National Design Specification for Wood Construction® (NDS) (Table 11.3.3A of the NDS for the 2012 IBC, Table 11.3.2 of the NDS for the 2009 IBC). Unless otherwise noted, sawn lumber members must have a moisture content of 19 percent or less.

For the purposes of connection design, structural glued laminated timber (GL) must have a Specific Gravity for Fastener Design (addressed in Tables 5A through 5D of the NDS Supplement), as indicated in the tables in this report. Unless otherwise noted, GL must have a moisture content of less than 16 percent.

When designing connections with screws installed into the face of cross-laminated timber (CLT) panels fabricated with sawn lumber laminations, all of the laminations must have a minimum assigned specific gravity in accordance with the NDS as indicated in the tables in this report. Moisture content must be less than 16 percent.

Use of the screws in engineered wood products (EWP) other than those addressed above is outside the scope of this report.

For wood-to-wood connections, the tabulated side member thickness, $t_{s,w}$, is an absolute value (not a minimum or maximum value). The thickness of the wood main member, t_m , must be adequate to fully encapsulate the screw in the wood.

3.4 Steel Members:

Steel side members must have a minimum tensile strength, F_u , equal to 58 ksi (400 MPa). The holes in the steel side member for the screws must be predrilled or prepunched. For application with VGU 45° countersunk washer, the geometry requirements of the slotted holes and the metal plate thickness are shown in Figure 6.

3.5 Steel washers:

HUS and HUS EVO countersunk washers are available for use with countersunk screws in wood-to-wood and steel-to-wood connections, as shown in Figure 5.

For VGS and VGS EVO screws oriented at 45° angle to the face of the member through metal side plates in metal-to-wood connections, VGU 45° countersunk washers must be used, as shown in Figure 6.

4.0 DESIGN AND INSTALLATION

4.1 Design:

The design values in this report are intended to aid the registered design professional in meeting the requirements of IBC Section 1604.2. For connections not completely

described in this report, determination of the suitability of the screws for the specific application is the responsibility of the registered design professional and is outside the scope of this report. The registered design professional is responsible for determining the available strengths for the connection, considering all applicable limit states, and for considering serviceability issues.

4.1.1 Screw Strength: Allowable screw tensile strength (N_a) and minimum specified bending yield strength (F_{yb}) for the screws are shown in Tables 1 through 3.

4.1.2 Adjustments to Reference Design Values: The reference design values must be adjusted in accordance with the requirements for dowel-type fasteners in Section 11.3 of the NDS (Section 10.3 of the NDS for the 2012 and 2009 IBC), including the wet service factor C_M , to determine allowable loads for use with ASD, design loads for use with LRFD, or both. The reference design values must also be adjusted in accordance with Section 12.5 of the NDS (Section 11.5 of the NDS for the 2012 and 2009 IBC), as applicable. When the capacity of a connection is controlled by the fastener strength, the allowable connection strength must not be increased by the adjustment factors specified in the NDS.

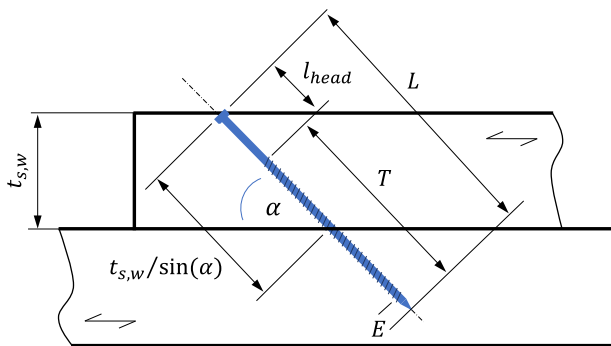
4.1.3 Design of Metal Parts: Design of connections using metal side plates must comply with Section 11.2.3 of the NDS (Section 10.2.3 of NDS-12 and NDS-05 for the 2012 and 2009 IBC).

4.1.4 Capacity Requirements for Wood Members: When designing a connection, the structural members must be checked for load-carrying capacity in accordance with Section 11.1.2 of the NDS (Section 10.1.2 of the NDS for the 2012 and 2009 IBC), and local stresses within multiple-fastener connections must be checked against Appendix E of the NDS to ensure the capacity of the connection and fastener group.

4.1.5 Connections with Multiple Screws: Connections made with multiple screws must be designed in accordance with Sections 11.2.2 and 12.6 of the NDS (Sections 10.2.2 and 11.6 of the NDS for the 2012 and 2009 IBC) and the requirements in Table 8 of this report.

4.1.6 Effective Embedded Thread Length: The effective embedded thread length is the portion of the thread in the applicable wood member, considering the tip length, head recess, washer thickness, etc. as applicable, and an installation tolerance, l_{tol} , according to the manufacturer recommendations.

For example, for screws installed flush to the surface of a wood side member the determination is depicted below:



$$l_{eff,s} = (t_{s,w}/\sin(\alpha)) - l_{head} - l_{tol} \leq T - E \quad (\text{Eq. 1})$$

$$l_{eff,m} = (L - (t_{s,w}/\sin(\alpha))) - E - l_{tol} \leq T - E \quad (\text{Eq. 2})$$

Where:

l_{head} : the sum of the length of the fastener head and the unthreaded shank ($L - T$).

l_{tol} : $3/16$ inch (5 mm)

4.1.7 Reference Design Values for Limit States of Withdrawal and Pull-Through: Fasteners are typically installed perpendicular to the grain for tensile (axial) and lateral loading, but may also be installed at other angles to the grain (inclined fastening). Sections 4.1.7.1 and 4.1.7.2 address limit states of withdrawal and pull-through for both perpendicular-to-grain applications and inclined fastening.

4.1.7.1 Reference Withdrawal Design Values: Reference withdrawal design values, W_{90} , in pounds per inch of effective embedded thread, l_{eff} , for screws installed perpendicular ($\alpha = 90^\circ$) to the face of the wood member are shown in Table 6. The total reference withdrawal design load value, W_L , for a given angle, α , must be calculated using Equation 3.

$$W_L = W_{90} \cdot k_\alpha \cdot l_{eff} = W_\alpha \cdot l_{eff} \leq N_a \quad [\text{lbf}] \quad (\text{Eq. 3})$$

with $l_{eff} \geq 6D$

α	k_α	α	k_α
90	1.00	35	0.84
85	1.00	30	0.77
80	0.99	25	0.69
75	0.99	20	0.61
70	0.98	15	0.53
65	0.97	α	k_α
60	0.95	(at least four screws required)	
55	0.94	14	0.52
50	0.92	10	0.46
45	0.91	5	0.38
40	0.89	0	0.30

Calculation of the adjustment factor k_α :

$$35^\circ < \alpha \leq 90^\circ; \quad k_\alpha = \frac{1}{1.2 \times \cos^2(\alpha) + \sin^2(\alpha)} \quad (\text{Eq. 4})$$

$$0^\circ \leq \alpha \leq 35^\circ; \quad k_\alpha = 0.3 + 0.7 \times \frac{\alpha}{45} \quad (\text{Eq. 5})$$

4.1.7.2 Reference Head Pull-through Design Values: Reference head pull-through values, W_H , for partially threaded fasteners are shown in Table 7 for $90^\circ \geq \alpha \geq 30^\circ$. Angles $30^\circ > \alpha \geq 0^\circ$ are outside the scope of this evaluation. No reduction factor is applied for inclined fasteners. For DGZ fasteners, reference head pull-through values for screws installed at an angle to grain of 60° are shown in Table 7. For fully threaded screws, the reference pull-through design value is the reference withdrawal design value, W_L , for $l_{eff,s}$, determined in accordance with Section 4.1.7.1.

4.1.8 Lateral Connections Designed in Accordance with the NDS: Reference lateral design values determined in accordance with the NDS for selected wood-to-wood and steel-to-wood connections are shown in Tables 4 and 5, respectively, for fasteners installed perpendicular to the faces of the wood members. For other connection configurations, the reference lateral design values may be determined in accordance with the NDS, subject to the following conditions:

1. The applicable specified bending yield strength from Tables 1 through 3 must be used for design.

2. The minor thread diameter, D_r , must be used where 'D' is referenced in Tables 12.3.1A, 12.3.1B and 12.3.3 of the NDS (Tables 11.3.1A, 11.3.1B and 11.3.3 of the 2012 NDS for the 2015 and 2012 IBC; Tables 11.3.1A, 11.3.1B and 11.3.2 of the 2005 NDS for the 2009 IBC).
3. Assigned specific gravity (ASG) must be 0.55 or less.
4. The wood side member thickness, $t_{s,w}$, must be in accordance with the manufacturer recommendations.
5. The steel side member thickness, $t_{s,s}$, must be in accordance with the manufacturer recommendations and must have properties complying with Section 3.4.
6. The minimum screw penetration l_{min} into the main member must be 6 times the outside thread diameter D :

$$l_{min} \geq 6 \cdot D \quad (\text{Eq. 6})$$

7. Dowel bearing length in the main member is equal to the screw penetration minus one half the tip length ($l_m - E/2$).
8. Spacing, edge and end distance must be in accordance with Table 8 and as needed to prevent splitting of the wood.

4.1.9 Combined Lateral and Withdrawal Loading:

Where the screws are subjected to combined lateral and withdrawal loads, connections must be designed in accordance with Section 12.4.1 of the NDS (Section 11.4.1 of the NDS for the 2012 and 2009 IBC).

4.1.10 Design of Lateral Connections with Screws Installed at an Angle to the Grain: Connections used to transfer lateral load between side members and a main member using groups of Rotho Blaas screws installed at an angle between 90° and 0° to the wood grain must be designed in accordance with this section.

4.1.10.1 Design method: The design method applies to wood-to-wood and metal-to-wood connections where the lateral load is transferred between the side and main member through the axial capacity of the screw installed at an angle $90^\circ > \alpha \geq 0^\circ$ to the wood grain. The following conditions apply:

- The connection consists of one or two side members, either wood or metal, and a wood main member.
- The conditions reported in Section 3.3 on the members made of sawn lumber, GL and CLT apply.
- For metal-to-wood connections with VGU 45° countersunk washers, VGS or VGS EVO screws must be used and installed at 45° angle to the metal side member as shown in Figure 6.
- The minimum screw penetration in both the wood main and a wood side member must be $8D$, measured along the axis of the screw.
- A minimum of two screws must be used in each connection.
- The minimum spacing, edge and end distance must comply with the connection geometry requirements of Table 8 and Figures A, B and C.
- The minimum thickness of the wood main and side member must be in accordance with the manufacturer's published design manual for the respective application.
- The metal thickness ($t_{s,s}$) of the side plate used in combination with VGU 45° countersunk washer must comply with Figure 6.
- A minimum of four screws must be used in connections with screws installed at an angle less than 15 degrees between the grain direction and the screw axis.

- For the effective number of screws loaded axially refer to the manufacturer's published recommendation.

4.1.10.2 Wood-to-wood Connections: The allowable lateral load for a wood-to-wood connection must be determined as follows:

- Determine the effective embedded thread length of the screw in accordance with Section 4.1.6.
- Determine the total reference withdrawal design value, W_L , in accordance with Section 4.1.7.1 for the main member, and apply adjustment factors in accordance with the NDS to determine allowable withdrawal strength.
- Determine the reference pull-through design value in accordance with Section 4.1.7.2 for the side member, and apply adjustment factors in accordance with the NDS to determine allowable pull-through strength.
- The allowable axial capacity of the screw is the least of the allowable withdrawal strength, the allowable pull-through strength and the allowable screw tension strength.
- The allowable lateral design load for one screw in a wood-to-wood connection is the allowable axial capacity of the screw, projected along the load vector.
- The structural wood members must be checked for load-carrying capacity in accordance with Section 4.1.4.
- Group effects must be considered when using multiple screws in one connection.

4.1.10.3 Metal-to-wood Connections: The allowable lateral load for a metal-to-wood connection with a metal side member and a wood main member must be determined as follows:

- Determine the effective embedded thread length of the screw in accordance with Section 4.1.6.
- Determine the total reference withdrawal design value in the wood member, W_L , in accordance with Section 4.1.7.1, and apply adjustment factors in accordance with the NDS to determine allowable withdrawal strength.
- The allowable axial capacity of the screw is the least of the allowable withdrawal strength, the metal pull-over strength (outside the scope of this report) and the allowable screw tension strength.
- The allowable lateral design load for one screw in a metal-to-wood connection is the allowable axial capacity of the screw, projected along the load vector.
- The steel member must be checked for load-carrying capacity in accordance with Section 4.1.3 and the wood member in accordance with section 4.1.4.
- Group effects must be considered when using multiple screws in one connection.

4.1.10.4 The expected axial slip modulus (K_{axial}) between the side member and the main member at the allowable load level must be determined in accordance with Equation 7 as follows:

$$K_{axial} = 92000 \times D \times l_{eff,min} \quad [\text{lbf/inch}] \quad (\text{Eq. 7})$$

$l_{eff,min}$: minimum of $l_{eff,m}$ and $l_{eff,s}$ for wood-to-wood connections. $l_{eff,m}$ for metal-to-wood connections [inch]

4.2 Corrosion Resistance:

The EVO coated screws may be used in wood treated with ACQ preservative with a maximum retention of 0.40 pcf (6.4 kg/m³) and in other treated wood products that have been demonstrated to have a lower level of corrosivity. EVO coated screws can be considered as an equivalent alternative to hot-dip galvanized fasteners complying with ASTM A153 Class D. EVO coated fasteners must be limited to use in the Exposure Conditions 1 and 3, as shown in Table 9.

4.3 Installation:

Rotho Blaas self-tapping screws must be installed in accordance with the report holder's published installation instructions and this report. Screws must be installed with the minimum spacing, end distances, and edge distances needed to prevent splitting of the wood or as noted in Table 8, whichever is more restrictive.

For TBS, TBS MAX and TBS EVO screws, the underside of the flat screw head must bear against the surface of the wood side member. For LBS, LBS EVO, HBS PLATE and HBS PLATE EVO screws, and VGS and VGS EVO screws with a hexagonal head, the underside of the flat portion of the screw head must bear against the surface of the metal plate.

For HBS, HBS EVO, HBS PLATE and HBS PLATE EVO screws; VGS and VGS EVO screws with a countersunk head; and VGZ, VGZ EVO and DGZ screws, the top of the screw head must either be flush with the surface of the wood side member or recessed into the wood side member, if a pre-drilled hole of the size of the screw head is made. For screws with countersunk heads (HBS, HBS EVO, VGS, VGS EVO) installed in combination with HUS and HUS EVO countersunk washer, the underside of the countersunk washer must bear against the wood or metal side member with the underside of the screw head seated in the washer.

For wood-to-wood and metal-to-wood connections with screws installed at 45° angle to the grain, a 45° angle assembly jig is offered and recommended by the manufacturer to facilitate the installation.

Predrilling is required for assigned specific gravities $ASG > 0.55$. For $ASG \leq 0.55$ predrilling is optional. The respective drill hole diameter requirements are given below.

Nominal Diameter D_{nom} (inch)	Drill Hole Diameter for $ASG \leq 0.55$ (inch)	Drill Hole Diameter for $ASG > 0.55$ (inch)
0.20	1/8	9/64
0.21	9/64	5/32
0.23	9/64	5/32
0.24	5/32	5/32
0.28	5/32	13/64
0.32	13/64	15/64
0.36	13/64	15/64
0.40	15/64	9/32
0.44	15/64	9/32
0.48	9/32	5/16
0.52	5/16	23/64

Screws must not be overdriven. The screws must be installed by turning with a power driver, not by driving with a hammer, using the bit size provided by the report holder.

5.0 CONDITIONS OF USE

The screws described in this report comply with, or are suitable alternatives to what is specified in, those codes listed in Section 1.0 of this report, subject to the following conditions:

- 5.1 The screws must be installed in accordance with the report holder's installation instructions and this report. In the case of a conflict between this report and the report holder's instructions, this report governs.
- 5.2 Design loads for the screws must not exceed the available strengths described in Section 4.1.
- 5.3 Calculations and details demonstrating compliance with this report must be submitted to the code official. The calculations and details must be prepared by a registered design professional where required by the statutes of the jurisdiction in which the project is to be constructed.
- 5.4 Use of fasteners in locations exposed to saltwater or saltwater spray is outside the scope of this evaluation report.
- 5.5 Use of the EVO coated screws in contact with fire-retardant-treated wood is outside the scope of this report.
- 5.6 The screws are manufactured under a quality control program with inspections by ICC-ES.

6.0 EVIDENCE SUBMITTED

- 6.1 Data in accordance with the ICC-ES Acceptance Criteria for Dowel-type Threaded Fasteners Used in Wood (AC233), dated February 2022.
- 6.2 Data in accordance with the ICC-ES Acceptance Criteria for Corrosion-resistant Fasteners and Evaluation of Corrosion Effects of Wood Treatments (AC257), dated October 2009 (editorially revised March 2018).

7.0 IDENTIFICATION

- 7.1 The packaging for the self-tapping wood screws is labeled with the report holder name (Rotho Blaas srl), the product designation (or alternative product designation shown in Section 3.2.8), the screw size and length (in both inches and millimeters), the thread length, head type and drive size, and the ICC-ES evaluation report number (ESR-4645). The screw head is marked with the product family type and the screw length, except for the LBS, SBL, LBS EVO, VGZ, DGZ and DWZ screws. The packaging for the countersunk washers HUS, HUS EVO and VGU is labeled with the report holder name (Rotho Blaas srl), the product type and the ICC-ES evaluation report number (ESR-4645). "EVO coating" is either reported on the label or in the leaflet inside the container of the self-tapping wood screws with EVO coating.

- 7.2 The report holder's contact information is the following:

ROTHO BLAAS S.R.L.
VIA DELL'ADIGE 2/1
39040 CORTACCIA (BZ)
ITALY
+39 0471 818400
www.rothoblaas.com

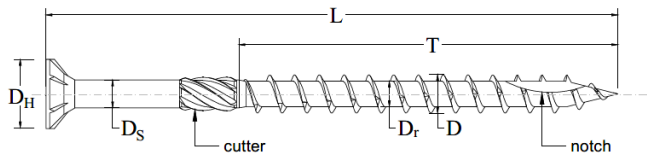
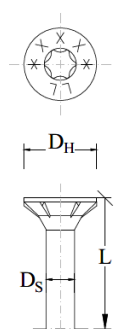
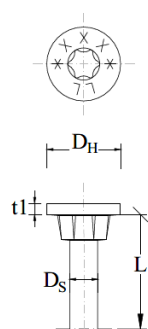
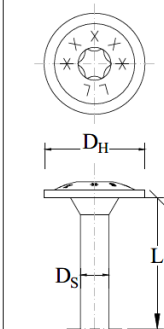
HBS screws	Alternative head types:		
	HBS, HBS EVO countersunk head "CS"	HBS PLATE, HBS PLATE EVO washer head "WU"	TBS, TBS MAX, TBS EVO large washer head "LW"
Alternative screws with different head type and coating: HBS EVO, HBS PLATE, HBS PLATE EVO, TBS, TBS MAX, TBS EVO Headstamps (manufacturer head mark and specific length), notch on the tip and cutter are optional. 			

FIGURE 1—HBS, HBS PLATE AND TBS TYPE PARTIALLY THREADED SCREWS

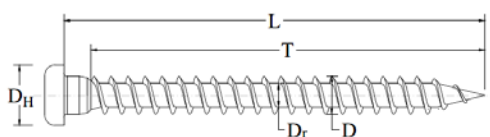
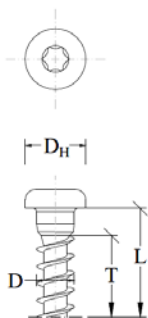
LBS screws	round head with cylindrical underhead "RU"
Alternative screws with different coating: LBS EVO 	

FIGURE 2—LBS TYPE FULLY THREADED SCREWS

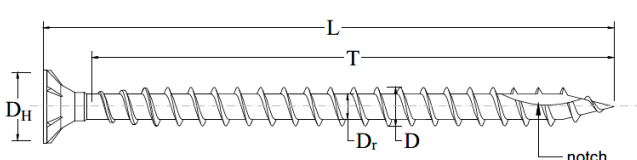
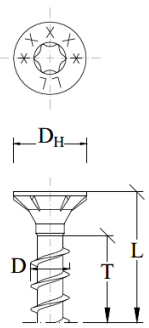
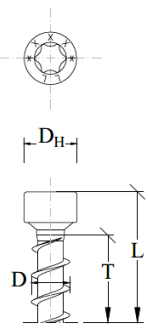
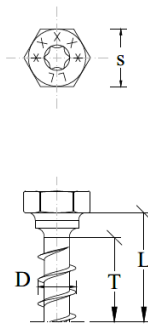
VGS screws	Alternative head types:		
	VGS, VGS EVO countersunk head "CS"	VGZ, VGZ EVO cylindrical head "CY"	VGS, VGS EVO hexagonal torx head "EXA"
Alternative screws with different head type and coating: VGS EVO, VGZ, VGZ EVO Headstamps (manufacturer head mark and specific length) and notch on the tip are optional. 			

FIGURE 3—VGS AND VGZ TYPE FULLY THREADED SCREWS

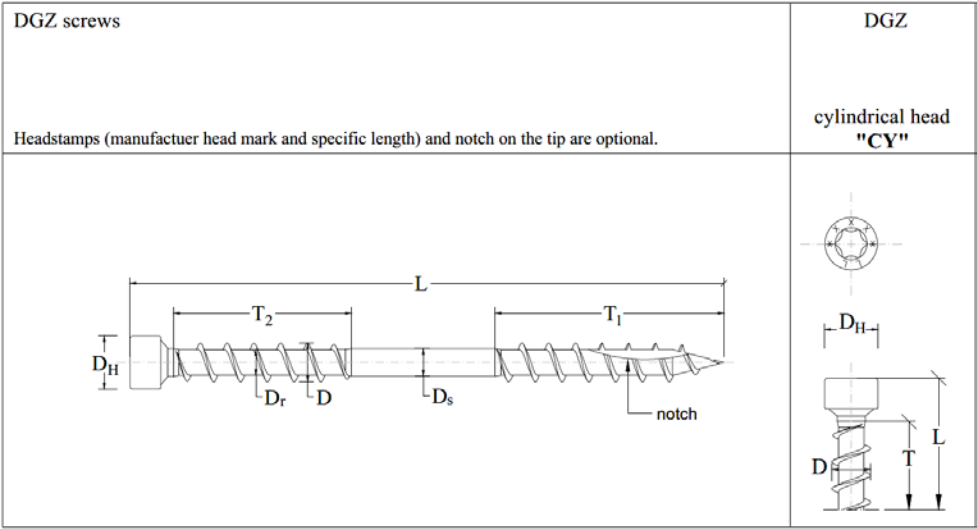
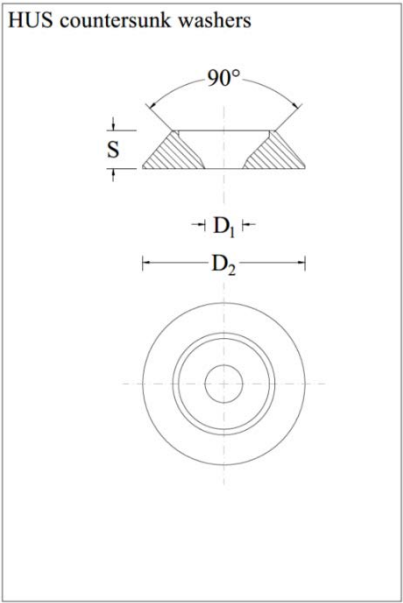


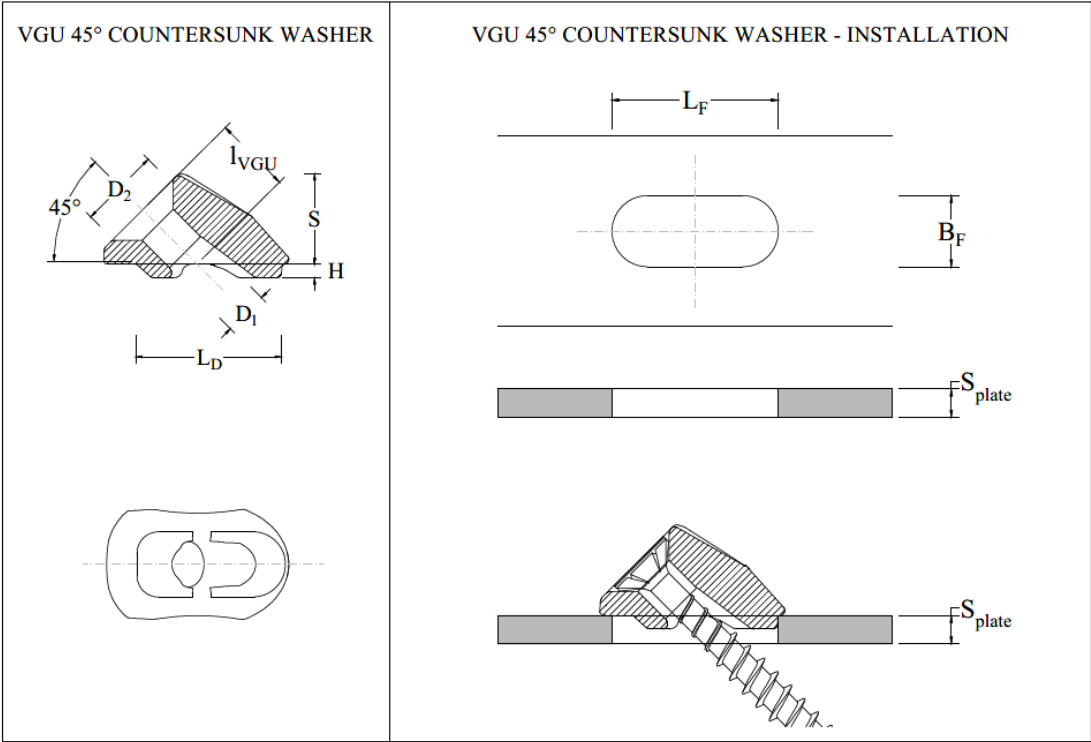
FIGURE 4—DGZ TYPE DOUBLE THREADED SCREWS



DESIGNATION	APPLICABLE SCREW TYPE	D ₁ (inch)	D ₂ (inch)	S (inch)
HUS6, HUSEVO6	HBS6, HBSEVO6	0.295	0.787	0.177
HUS8, HUSEVO8	HBS8, HBSEVO8, VGS9, VGSEVO9	0.335	0.984	0.217
HUS10, HUSEVO10	HBS10, HBSEVO10, VGS11, VGSEVO11	0.425	1.181	0.256
HUS12, HUSEVO12	HBS12, HBSEVO12 VGS13, VGSEVO13	0.551	1.457	0.335

For SI: 1 inch = 25.4 mm.

FIGURE 5—HUS COUNTERSUNK WASHER



DESIGNATION	SCREW TYPE	D ₁ (inch)	D ₂ (inch)	S (inch)	H (inch)	L _D (inch)	I _{VGU} (inch)	Slotted hole length L _F (inch)	Slotted hole width B _F (inch)	Steel plate thickness S _{plate} (inch) ¹
VGU945	VGS9, VGSEVO9	0.382	0.748	0.787	0.118	1.252	0.740	min. 1.299 max. 1.339	min. 0.551 max. 0.591	min. 0.118 max. 0.472
VGU1145	VGS11, VGSEVO11	0.465	0.906	0.961	0.142	1.528	0.906	min. 1.614 max. 1.654	min. 0.669 max. 0.709	min. 0.157 max. 0.591
VGU1345	VGS13, VGSEVO13	0.551	1.079	1.130	0.169	1.803	1.059	min. 1.929 max. 1.969	min. 0.787 max. 0.827	min. 0.197 max. 0.591

For SI: 1 inch = 25.4 mm.

¹Special shaping of the hole in the lower part of the steel plate is required if the thickness of the steel plate is greater than maximum value shown.

FIGURE 6—VGU 45° COUNTERSUNK WASHER

TABLE 1—PARTIALLY THREADED FASTENER DIMENSIONS AND STRENGTHS

DESIGNATION ¹	NOMINAL DIAMETER D_{nom} [inch (mm)]	OVERALL LENGTH ² L (inches)	THREAD LENGTH T (inches)	HEAD TYPE	HEAD DIAMETER, D_H (inch)	DRIVE TYPE AND SIZE	UNTHREADED SHANK DIAMETER D_S (inch)	ROOT DIAMETER D_r (inch)	OUTSIDE THREAD DIAMETER D (inch)	TIP LENGTH E (inch)	SPECIFIED BENDING YIELD STRENGTH F_{yb} (psi)	ALLOWABLE FASTENER TENSION STRENGTH N_a (lbf)	
HBS.... HBS EVO....	0.24 (6mm)	1 9/16	1 3/8	Countersunk CS	0.472	TX 30	0.169	0.156	0.236	0.236	200,000	1,180	
		640	1 15/16										1 3/8
		650	2 3/8										1 3/16
		660	2 3/4										1 9/16
		670	3 1/8										1 9/16
		680	3 1/2										1 15/16
		690	4										1 15/16
		6100	4 3/8										2 3/8
		6110	4 3/4										2 3/8
		6120	5 1/8										2 3/8
		6130	5 1/2										2 15/16
		6140	6										2 15/16
		6150	6 1/4										2 15/16
		6160	7 1/8										2 15/16
		6180	8										2 15/16
		6200	8 5/8										2 15/16
6220	9 1/2	2 15/16											
6240	10 1/4	2 15/16											
6260	11	2 15/16											
6280	11 3/4	2 15/16											
HBS.... HBS EVO....	0.32 (8mm)	3 1/8	2 1/16	Countersunk CS	0.571	TX 40	0.228	0.213	0.315	0.315	180,000	2,040	
		880	4										2 1/16
		8100	4 3/4										2 3/8
		8120	5 1/2										2 3/8
		8140	6 1/4										3 1/8
		8160	7 1/8										3 1/8
		8180	8										3 1/8
		8200	8 5/8										3 1/8

TABLE 1—PARTIALLY THREADED FASTENER DIMENSIONS AND STRENGTHS (cont.)

DESIGNATION ²		NOMINAL DIAMETER <i>D_{nom}</i> [inch (mm)]	OVERALL LENGTH ¹ <i>L</i> (inches)	THREAD LENGTH <i>T</i> (inches)	HEAD TYPE	HEAD DIAMETER, <i>D_H</i> (inch)	DRIVE TYPE AND SIZE	UNTHREADED SHANK DIAMETER <i>D_S</i> (inch)	ROOT DIAMETER <i>D_r</i> (inch)	OUTSIDE THREAD DIAMETER <i>D</i> (inch)	TIP LENGTH <i>E</i> (inch)	SPECIFIED BENDING YIELD STRENGTH <i>F_{yb}</i> (psi)	ALLOWABLE FASTENER TENSION STRENGTH <i>N_a</i> (lbf)
HBS... HBS EVO ...	8240	0.32 (8mm) (cont.)	9 1/2	3 1/8	Countersunk CS	0.571	TX 40	0.228	0.213	0.315	0.315	180,000	2,040
	8260		10 1/4	3 1/8									
	8280		11	3 1/8									
	8300		11 3/4	4									
	8320		12 5/8	4									
	8340		13 3/8	4									
	8360		14 1/4	4									
	8380		15	4									
	8400		15 3/4	4									
	8440		17 1/4	4									
	8480		19	4									
	8520		20 1/2	4									
HBS... HBS EVO ...	1080	0.40 (10mm)	3 1/8	2 1/16	Countersunk CS	0.719	TX40	0.276	0.252	0.394	0.394	185,000	2,700
	10100		4	2 1/16									
	10120		4 3/4	2 3/8									
	10140		5 1/2	2 3/8									
	10160		6 1/4	3 1/8									
	10180		7 1/8	3 1/8									
	10200		8	3 1/8									
	10220		8 5/8	3 1/8									
	10240		9 1/2	3 1/8									
	10260		10 1/4	3 1/8									
	10280		11	3 1/8									
	10300		11 3/4	4									
	10320		12 5/8	4									
	10340		13 3/8	4									
	10360		14 1/4	4									
	10380		15	4									
	10400		15 3/4	4									

TABLE 1—PARTIALLY THREADED FASTENER DIMENSIONS AND STRENGTHS (cont.)

DESIGNATION ²		NOMINAL DIAMETER <i>D_{nom}</i> [inch (mm)]	OVERALL LENGTH ¹ <i>L</i> (inches)	THREAD LENGTH <i>T</i> (inches)	HEAD TYPE	HEAD DIAMETER, <i>D_H</i> (inch)	DRIVE TYPE AND SIZE	UNTHREADED SHANK DIAMETER <i>D_S</i> (inch)	ROOT DIAMETER <i>D_r</i> (inch)	OUTSIDE THREAD DIAMETER <i>D</i> (inch)	TIP LENGTH <i>E</i> (inch)	SPECIFIED BENDING YIELD STRENGTH <i>F_{yb}</i> (psi)	ALLOWABLE FASTENER TENSION STRENGTH <i>N_a</i> (lbf)
HBS... HBSP EVO...	12120	0.48 (12mm)	4 3/4	3 1/8	Countersunk CS	0.817	TX 50	0.315	0.268	0.472	0.472	190,000	3,060
	12160		6 1/4	3 1/8									
	12200		8	3 1/8									
	12240		9 1/2	3 1/8									
	12280		11	3 1/8									
	12320		12 5/8	4 3/4									
	12360		14 1/4	4 3/4									
	12400		15 3/4	4 3/4									
	12440		17 1/4	4 3/4									
	12480		19	4 3/4									
	12520		20 1/2	4 3/4									
	12560		22	4 3/4									
12600	23 5/8	4 3/4											
HBSP... HBSP EVO...	680	0.24 (6mm)	3 1/8	1 15/16	Washer head with cylindrical underhead WU	0.472	TX 30	0.169	0.156	0.236	0.236	200,000	1,180
	690		3 1/2	2 3/16									
HBSP... HBSP EVO...	840	0.32 (8mm)	1 9/16	1 1/4	Washer head with cylindrical underhead WU	0.571	TX 40	0.228	0.213	0.315	0.315	180,000	2,040
	860		2 3/8	2 1/16									
	880		3 1/8	2 3/16									
	8100		4	2 15/16									
	8120		4 3/4	3 3/4									
	8140		5 1/2	4 3/8									
	8160		6 1/4	5 1/8									

TABLE 1—PARTIALLY THREADED FASTENER DIMENSIONS AND STRENGTHS (cont.)

DESIGNATION ²		NOMINAL DIAMETER <i>D_{nom}</i> [inch (mm)]	OVERALL LENGTH ¹ <i>L</i> (inches)	THREAD LENGTH <i>T</i> (inches)	HEAD TYPE	HEAD DIAMETER, <i>D_H</i> (inch)	DRIVE TYPE AND SIZE	UNTHREADED SHANK DIAMETER <i>D_S</i> (inch)	ROOT DIAMETER <i>D_r</i> (inch)	OUTSIDE THREAD DIAMETER <i>D</i> (inch)	TIP LENGTH <i>E</i> (inch)	SPECIFIED BENDING YIELD STRENGTH <i>F_{yb}</i> (psi)	ALLOWABLE FASTENER TENSION STRENGTH <i>N_a</i> (lbf)
HBSP... HBSP EVO...	1060	0.40 (10mm)	2 3/8	2 1/16	Washer head with cylindrical underhead WU	0.719	TX 40	0.276	0.252	0.394	0.394	185,000	2,700
	1080		3 1/8	2 3/8									
	10100		4	2 15/16									
	10120		4 3/4	3 3/4									
	10140		5 1/2	4 3/8									
	10160		6 1/4	5 1/8									
	10180		7 1/8	6									
HBSP... HBSP EVO...	12100	0.48 (12mm)	4	2 15/16	Washer head with cylindrical underhead WU	0.817	TX 50	0.315	0.268	0.472	0.472	190,000	3,060
	12120		4 3/4	3 1/2									
	12140		5 1/2	4 3/8									
	12160		6 1/4	4 3/4									
	12180		7 1/8	5 1/2									
	12200		8	6 1/4									
TBS... TBS EVO...	660	0.24 (6mm)	2 3/8	1 9/16	Large washer head LW	0.610	TX 30	0.169	0.156	0.236	0.236	200,000	1,180
	670		2 3/4	1 9/16									
	680		3 1/8	1 15/16									
	690		3 1/2	1 15/16									
	6100		4	2 3/8									
	6120		4 3/4	2 15/16									
	6140		5 1/2	2 15/16									
	6160		6 1/4	2 15/16									
	6180		7 1/8	2 15/16									
	6200		8	2 15/16									
	6220		8 5/8	4									
	6240		9 1/2	4									
	6260		10 1/4	4									
	6280		11	4									
	6300		11 3/4	4									

TABLE 1—PARTIALLY THREADED FASTENER DIMENSIONS AND STRENGTHS (cont.)

DESIGNATION ²		NOMINAL DIAMETER <i>D_{nom}</i> [inch (mm)]	OVERALL LENGTH ¹ <i>L</i> (inches)	THREAD LENGTH <i>T</i> (inches)	HEAD TYPE	HEAD DIAMETER, <i>D_H</i> (inch)	DRIVE TYPE AND SIZE	UNTHREADED SHANK DIAMETER <i>D_S</i> (inch)	ROOT DIAMETER <i>D_r</i> (inch)	OUTSIDE THREAD DIAMETER <i>D</i> (inch)	TIP LENGTH <i>E</i> (inch)	SPECIFIED BENDING YIELD STRENGTH <i>F_{yb}</i> (psi)	ALLOWABLE FASTENER TENSION STRENGTH <i>N_a</i> (lbf)
TBS.... TBS EVO....	840	0.32 (8mm)	1 9/16	1 1/4	Large washer head LW	0.748	TX 40	0.228	0.213	0.315	0.315	180,000	2,040
	860		2 3/8	2 1/16									
	880		3 1/8	2 1/16									
	8100		4	2 1/16									
	8120		4 3/4	3 1/8									
	8140		5 1/2	3 1/8									
	8160		6 1/4	4									
	8180		7 1/8	4									
	8200		8	4									
	8220		8 5/8	4									
	8240		9 1/2	4									
	8260		10 1/4	4									
	8280		11	4									
	8300		11 3/4	4									
	8320		12 5/8	4									
	8340		13 3/8	4									
	8360		14 1/4	4									
	8380		15	4									
	8400		15 3/4	4									
	8440		17 1/4	4									
8480	19	4											
8520	20 1/2	4											
TBS MAX....	8200	0.32 (8mm)	8	4 3/4	Large washer head LW	0.965	TX 40	0.228	0.213	0.315	0.315	180,000	2,040
	8220		8 5/8	4 3/4									
	8240		9 1/2	4 3/4									

TABLE 1— PARTIALLY THREADED FASTENER DIMENSIONS AND STRENGTHS (cont.)

DESIGNATION ²	NOMINAL DIAMETER D_{nom} [inch (mm)]	OVERALL LENGTH ¹ L (inches)	THREAD LENGTH T (inches)	HEAD TYPE	HEAD DIAMETER, D_H (inch)	DRIVE TYPE AND SIZE	UNTHREADED SHANK DIAMETER D_S (inch)	ROOT DIAMETER D_r (inch)	OUTSIDE THREAD DIAMETER D (inch)	TIP LENGTH E (inch)	SPECIFIED BENDING YIELD STRENGTH F_{yb} (psi)	ALLOWABLE FASTENER TENSION STRENGTH N_a (lbf)
TBS.... TBS EVO....	0.40 (10mm)	4	2 1/16	Large washer head LW	0.984	TX 50	0.276	0.252	0.394	0.394	185,000	2,700
10100		4 3/4	2 3/8									
10120		5 1/2	2 3/8									
10140		6 1/4	3 1/8									
10160		7 1/8	3 1/8									
10180		8	4									
10200		8 5/8	4									
10220		9 1/2	4									
10240		10 1/4	4									
10260		11	4									
10280		11 3/4	4									
10300		12 5/8	4 3/4									
10320		13 3/8	4 3/4									
10340		14 1/4	4 3/4									
10360		15	4 3/4									
10380		15 3/4	4 3/4									
10400		17 1/4	4 3/4									
10440		19	4 3/4									
10480		20 1/2	4 3/4									
10520												

For **SI**: 1 inch = 25.4 mm, 1 psi = 6.89 kPa, 1 lbf = 4.45 N.

¹The fastener designation is expressed combining the fastener name and the associated size (e.g., HBS640 where 6 is the nominal diameter, D_{nom} , in mm and 40 the overall length, L , in mm).

²For HBS PLATE, HBS PLATE EVO, TBS, TBS MAX and TBS EVO screws the overall length is measured from the underside of the washer head to the screw tip. For HBS and HBS EVO screws the overall length is measured from the top of the head to the screw tip. See Figure 1.

TABLE 2— FULLY THREADED FASTENER DIMENSIONS AND STRENGTH

DESIGNATION ¹		NOMINAL DIAMETER D_{nom} [inch (mm)]	OVERALL LENGTH ² L (inches)	THREAD LENGTH T (inches)	HEAD TYPE	HEAD DIAMETER, D_H (inch)	DRIVE TYPE AND SIZE	ROOT DIAMETER D_r (inch)	OUTSIDE THREAD DIAMETER D (inch)	TIP LENGTH E (inch)	SPECIFIED BENDING YIELD STRENGTH ³ F_{yb} (psi)	ALLOWABLE FASTENER TENSION STRENGTH N_o (lbf)
LBS.... LBS EVO....	525	0.20 (5mm)	1	13/16	Round head with cylindrical underhead RU	0.307	TX 20	0.118	0.197	0.197	180,000	740
	540		1 9/16	1 7/16								
	550		1 15/16	1 13/16								
	560		2 3/8	2 3/16								
	570		2 3/4	2 5/8								
LBS.... LBS EVO....	760	0.28 (7mm)	2 3/8	2 3/16	Round head with cylindrical underhead RU	0.433	TX 30	0.173	0.276	0.276	192,000	1,600
	780		3 1/8	2 15/16								
	7100		4	3 3/4								
VGZ.... VGZ EVO....	580	0.21 (5.3mm)	3 1/8	2 3/4	Cylindrical head CY	0.315	TX25	0.142	0.209	0.209	168,000	1,000
	5100		4	3 1/2								
	5120		4 3/4	4 3/8								
VGZ.... VGZ EVO....	5140	0.23 (5.6mm)	5 1/2	5 1/8	Cylindrical head CY	0.315	TX25	0.150	0.220	0.220	168,000	1,100
	5160		6 1/4	6								
VGZ.... VGZ EVO....	780	0.28 (7mm)	3 1/8	2 3/4	Cylindrical head CY	0.374	TX30	0.181	0.276	0.276	195,000	1,450
	7100		4	3 1/2								
	7120		4 3/4	4 3/8								
	7140		5 1/2	5 1/8								
	7160		6 1/4	6								
	7180		7 1/8	6 3/4								
	7200		8	7 1/2								
	7220		8 5/8	8 1/4								
	7240		9 1/2	9 1/16								
	7260		10 1/4	10								
	7280		11	10 5/8								
	7300		11 3/4	11 7/16								
	7340		13 3/8	13								
	7380		15	14 9/16								

TABLE 2— FULLY THREADED FASTENER DIMENSIONS AND STRENGTH (cont.)

DESIGNATION ²		NOMINAL DIAMETER D_{nom} [inch (mm)]	OVERALL LENGTH ¹ L (inches)	THREAD LENGTH T (inches)	HEAD TYPE	HEAD DIAMETER, D_H (inch)	DRIVE TYPE AND SIZE	ROOT DIAMETER D_r (inch)	OUTSIDE THREAD DIAMETER D (inch)	TIP LENGTH E (inch)	SPECIFIED BENDING YIELD STRENGTH ³ F_{yb} (psi)	ALLOWABLE FASTENER TENSION STRENGTH N_a (lbf)
VGZ ... VGZ EVO ...	9160	0.36 (9mm)	6 1/4	6	Cylindrical head CY	0.453	TX40	0.232	0.354	0.354	180,000	2,450
	9180		7 1/8	6 3/4								
	9200		8	7 1/2								
	9220		8 5/8	8 1/4								
	9240		9 1/2	9 1/16								
	9260		10 1/4	10								
	9280		11	10 5/8								
	9300		11 3/4	11 7/16								
	9320		12 5/8	12 3/16								
	9340		13 3/8	13								
	9360		14 1/4	13 3/4								
	9380		15	14 9/16								
	9400		15 3/4	15 3/8								
	9440		17 1/4	16 15/16								
	9480		19	18 1/2								
9520	20 1/2	20 1/16										
VGZ ... VGZ EVO ...	11250	0.44 (11mm)	10	9 1/2	Cylindrical head CY	0.531	TX50	0.260	0.433	0.433	170,000	3,200
	11300		11 3/4	11 7/16								
	11350		13 3/4	13 3/8								
	11400		15 3/4	15 3/8								
	11450		17 3/4	17 1/4								
	11500		19 3/4	19 5/16								
	11550		21 5/8	21 1/4								
	11600		23 5/8	23 1/4								
VGS ... VGSEVO ...	9100	0.36 (9mm)	4	3 1/2	Countersunk head CS	0.630	TX40	0.232	0.354	0.354	180,000	2,450
	9120		4 3/4	4 3/8								
	9140		5 1/2	5 1/8								
	9160		6 1/4	6								
	9180		7 1/8	6 3/4								

TABLE 2— FULLY THREADED FASTENER DIMENSIONS AND STRENGTH (cont.)

DESIGNATION ²	NOMINAL DIAMETER D_{nom} [inch (mm)]	OVERALL LENGTH ¹ L (inches)	THREAD LENGTH T (inches)	HEAD TYPE	HEAD DIAMETER, D_H (inch)	DRIVE TYPE AND SIZE	ROOT DIAMETER D_r (inch)	OUTSIDE THREAD DIAMETER D (inch)	TIP LENGTH E (inch)	SPECIFIED BENDING YIELD STRENGTH ³ F_{yb} (psi)	ALLOWABLE FASTENER TENSION STRENGTH N_a (lbf)	
VGS.... VGSEVO....	9200	0.36 (9mm) (cont.)	8	Countersunk head CS	0.630	TX40	0.232	0.354	0.354	180,000	2,450	
	9220		8 5/8									8 1/4
	9240		9 1/2									9 1/16
	9260		10 1/4									10
	9280		11									10 5/8
	9300		11 3/4									11 7/16
	9320		12 5/8									12 3/16
	9340		13 3/8									13
	9360		14 1/4									13 3/4
	9380		15									14 9/16
	9400		15 3/4									15 3/8
	9440		17 1/4									16 15/16
	9480		19									18 1/2
	9520		20 1/2									20 1/16
VGS.... VGSEVO....	11100	0.44 (11mm)	4	Countersunk head CS	0.760	TX50	0.260	0.433	0.433	170,000	3,200	
	11125		4 15/16									4 1/2
	11150		6									5 1/2
	11175		6 7/8									6 1/2
	11200		8									7 1/2
	11225		8 7/8									8 7/16
	11250		10									9 1/2
	11275		10 7/8									10 7/16
	11300		11 3/4									11 7/16
	11325		12 3/4									12 3/8
	11350		13 3/4									13 3/8
	11375		14 3/4									14 3/8
	11400		15 3/4									15 3/8
	11450		17 3/4									17 1/4
	11500		19 3/4									19 5/16
	11550		21 5/8									21 1/4
	11600		23 5/8									23 1/4

TABLE 2— FULLY THREADED FASTENER DIMENSIONS AND STRENGTH (cont.)

DESIGNATION ²	NOMINAL DIAMETER D_{nom} [inch (mm)]	OVERALL LENGTH ¹ L (inches)	THREAD LENGTH T (inches)	HEAD TYPE	HEAD DIAMETER, (inch) D_H	DRIVE TYPE AND SIZE	ROOT DIAMETER D_r (inch)	OUTSIDE THREAD DIAMETER D (inch)	TIP LENGTH E (inch)	SPECIFIED BENDING YIELD STRENGTH ³ F_{yb} (psi)	ALLOWABLE FASTENER TENSION STRENGTH N_t (lbf)
VGS.... VGS EVO.... 11700	0.44 (11mm)	27 1/2	27 3/16	Hexagonal star drive head EXA	0.669	SW17	0.260	0.433	0.433	170,000	3,200
11800		31 1/2	31 1/8								
VGS.... VGS EVO.... 13100 13150 13200 13250 13300 13350 13400 13450 13500 13600 13700 13800 13900 131000 131100 131200	0.52 (13mm)	4	3 1/2	Countersunk head CS	0.866	TX50	0.315	0.512	0.512	161,000	4,400
		6	5 1/2								
		8	7 1/2								
		10	9 1/2								
		11 3/4	11								
		13 3/4	13								
		15 3/4	15								
		17 3/4	16 15/16								
		19 3/4	19								
		23 5/8	22 13/16								
		27 1/2	26 3/4	Hexagonal star drive head EXA	0.748	SW19					
		31 1/2	30 11/16								
		35 1/2	34 5/8								
		39 3/8	38 9/16								
		43 5/16	42 1/2								
		47 1/4	46 7/16								

For **SI**: 1 inch = 25.4 mm, 1 psi = 6.89 kPa, 1 lbf = 4.45 N.

¹The fastener designation is expressed combining the fastener name and the associated size (e.g., LBS525 where 5 is the nominal diameter, D_{nom} , in mm and 25 the overall length, L , in mm).

²For LBS, LBS EVO screws and VGS and VGS EVO screws with hexagonal star drive head the overall length is measured from the underside of the head to the screw tip. For VGZ, VGZ EVO screws and VGS and VGS EVO screws with countersunk head the overall length is measured from the top of the head to the screw tip. See Figures 2 and 3.

TABLE 3— DOUBLE THREADED FASTENERS DIMENSIONS AND TENSION STRENGTH

DESIGNATION ¹		NOMINAL DIAMETER D_{nom} [inch (mm)]	OVERALL LENGTH ² L (inches)	THREAD LENGTH ³ $T_1 - T_2$ (inches)	HEAD TYPE	HEAD DIAMETER, D_H (inch)	DRIVE TYPE AND SIZE	UNTHREADED SHANK DIAMETER D_S (inch)	ROOT DIAMETER D_r (inch)	OUTSIDE THREAD DIAMETER D (inch)	TIP LENGTH E (inch)	SPECIFIED BENDING YIELD STRENGTH F_{yb} (psi)	ALLOWABLE FASTENER TENSION STRENGTH N_a (lbf)
DGZ....	7220	0.28 (7mm)	8 5/8	4 – 2 3/8	Cylindrical head CY	0.374	TX30	0.197	0.181	0.276	0.276	195,000	1750
	7260		10 1/4	4 – 2 3/8									
	7300		11 3/4	4 – 2 3/8									
	7340		13 3/8	4 – 2 3/8									
	7380		15	4 – 2 3/8									
DGZ....	9240	0.36 (9mm)	9 1/2	4 – 2 3/8	Cylindrical head CY	0.453	TX40	0.256	0.232	0.354	0.354	180,000	2900
	9280		11	4 – 2 3/8									
	9320		12 5/8	4 – 2 3/8									
	9360		14 1/4	4 – 2 3/8									
	9400		15 3/4	4 – 2 3/8									
	9440		17 1/4	4 – 2 3/8									
	9480		19	4 – 2 3/8									
	9520		20 1/2	4 – 2 3/8									

For SI: 1 inch = 25.4 mm, 1 psi = 6.89 kPa, 1 lbf = 4.45 N.

¹The fastener designation is expressed combining the fastener name and the associated size (e.g., DGZ7220 where 7 is the nominal diameter, D_{nom} , in mm and 220 the overall length, L , in mm).²The overall length is measured from the top of the head to the screw tip. See Figure 4.

³Length of thread T_1 includes tip. Length of thread T_2 is located towards the fastener head, as shown in Figure 4.

**TABLE 4—REFERENCE LATERAL DESIGN VALUES (Z) FOR WOOD-TO-WOOD CONNECTIONS
WITH PARTIALLY THREADED FASTENERS**

FASTENER DESIGNATION ¹		OVERALL SCREW LENGTH, <i>L</i> (inches)	SIDE MEMBER THICKNESS <i>t_{s,w}</i> (inches)	Z (lbf) FOR ASSIGNED SPECIFIC GRAVITIES (ASG) OF:											
				0.35			0.42			0.49			0.55		
				Z	Z _L	Z _⊥	Z	Z _L	Z _⊥	Z	Z _L	Z _⊥	Z	Z _L	Z _⊥
HBS.... HBS EVO....	650	1 15/16	3/8	64	64	64	89	89	89	118	118	118	146	146	146
	660	2 3/8	3/4	86	86	86	120	120	120	142	142	142	163	163	163
	670	2 3/4	1	97	97	97	129	129	129	156	156	156	182	182	182
	680	3 1/8	1 1/2	107	107	107	149	149	149	190	190	190	211	211	211
	690	3 1/2	1 1/2	120	120	120	154	154	154	190	190	190	211	211	211
	6100	4	1 3/4	129	129	129	165	165	165	190	190	190	211	211	211
	6110	4 3/8	1 3/4	129	129	129	165	165	165	190	190	190	211	211	211
	6120	4 3/4	2	139	139	139	165	165	165	190	190	190	211	211	211
	6130	5 1/8	2 1/2	139	139	139	165	165	165	190	190	190	211	211	211
	6140	5 1/2	2 1/2	139	139	139	165	165	165	190	190	190	211	211	211
	6150	6	2 3/4	139	139	139	165	165	165	190	190	190	211	211	211
	6160	6 1/4	3 1/4	139	139	139	165	165	165	190	190	190	211	211	211
	6180	7 1/8	4	139	139	139	165	165	165	190	190	190	211	211	211
	6200	8	4 3/4	139	139	139	165	165	165	190	190	190	211	211	211
	6220	8 5/8	5 1/2	139	139	139	165	165	165	190	190	190	211	211	211
	6240	9 1/2	6 1/4	139	139	139	165	165	165	190	190	190	211	211	211
	6260	10 1/4	7	139	139	139	165	165	165	190	190	190	211	211	211
	6280	11	8	139	139	139	165	165	165	190	190	190	211	211	211
	6300	11 3/4	8 3/4	139	139	139	165	165	165	190	190	190	211	211	211
HBS.... HBS EVO....	880	3 1/8	1	132	105	105	179	143	143	213	170	170	244	195	195
	8100	4	1 3/4	153	123	123	214	171	171	270	216	216	313	251	251
	8120	4 3/4	2 1/4	184	147	147	245	196	196	282	225	225	313	251	251
	8140	5 1/2	3	196	157	157	245	196	196	282	225	225	313	251	251
	8160	6 1/4	3	207	165	165	245	196	196	282	225	225	313	251	251
	8180	7 1/8	3 3/4	207	165	165	245	196	196	282	225	225	313	251	251
	8200	8	4 1/2	207	165	165	245	196	196	282	225	225	313	251	251
	8220	8 5/8	5 1/2	207	165	165	245	196	196	282	225	225	313	251	251
	8240	9 1/2	6 1/4	207	165	165	245	196	196	282	225	225	313	251	251
	8260	10 1/4	7	207	165	165	245	196	196	282	225	225	313	251	251
	8280	11	7 3/4	207	165	165	245	196	196	282	225	225	313	251	251
	8300	11 3/4	7 3/4	207	165	165	245	196	196	282	225	225	313	251	251
	8320	12 5/8	8 1/2	207	165	165	245	196	196	282	225	225	313	251	251
	8340	13 3/8	9 1/4	207	165	165	245	196	196	282	225	225	313	251	251
	8360	14 1/4	10	207	165	165	245	196	196	282	225	225	313	251	251
	8380	15	11	207	165	165	245	196	196	282	225	225	313	251	251
	8400	15 3/4	11 1/2	207	165	165	245	196	196	282	225	225	313	251	251
	8440	17 1/4	13 1/4	207	165	165	245	196	196	282	225	225	313	251	251
	8480	19	14 3/4	207	165	165	245	196	196	282	225	225	313	251	251
	8520	20 1/2	16 1/2	207	165	165	245	196	196	282	225	225	313	251	251

**TABLE 4—REFERENCE LATERAL DESIGN VALUES (Z) FOR WOOD-TO-WOOD CONNECTIONS
WITH PARTIALLY THREADED FASTENERS (cont.)**

FASTENER DESIGNATION ¹		OVERALL SCREW LENGTH, <i>L</i> (inches)	SIDE MEMBER THICKNESS <i>t_{s,w}</i> (inches)	Z (lbf) FOR ASSIGNED SPECIFIC GRAVITIES (<i>ASG</i>) OF:											
				0.35			0.42			0.49			0.55		
				Z	Z _{L/}	Z _⊥	Z	Z _{L/}	Z _⊥	Z	Z _{L/}	Z _⊥	Z	Z _{L/}	Z _⊥
HBS.... HBS EVO....	1080	3 1/8	1/2	123	67	67	148	87	87	173	109	109	194	129	129
	10100	4	1	222	134	134	247	174	166	270	198	188	290	216	207
	10120	4 3/4	2 1/8	258	176	140	310	218	182	361	258	228	387	292	269
	10140	5 1/2	2 3/4	302	199	164	338	249	213	365	274	259	387	295	282
	10160	6 1/4	3	308	220	188	338	249	232	365	274	259	387	295	282
	10180	7 1/8	3 3/4	308	222	203	338	249	232	365	274	259	387	295	282
	10200	8	4 1/2	308	222	203	338	249	232	365	274	259	387	295	282
	10220	8 5/8	5 1/2	308	222	203	338	249	232	365	274	259	387	295	282
	10240	9 1/2	6 1/4	308	222	203	338	249	232	365	274	259	387	295	282
	10260	10 1/4	7	308	222	203	338	249	232	365	274	259	387	295	282
	10280	11	7 3/4	308	222	203	338	249	232	365	274	259	387	295	282
	10300	11 3/4	7 3/4	308	222	203	338	249	232	365	274	259	387	295	282
	10320	12 5/8	8 1/2	308	222	203	338	249	232	365	274	259	387	295	282
	10340	13 3/8	9 1/4	308	222	203	338	249	232	365	274	259	387	295	282
	10360	14 1/4	10	308	222	203	338	249	232	365	274	259	387	295	282
	10380	15	11	308	222	203	338	249	232	365	274	259	387	295	282
	10400	15 3/4	11 1/2	308	222	203	338	249	232	365	274	259	387	295	282
HBS.... HBS EVO....	12120	4 3/4	1 1/2	273	183	155	308	211	197	342	240	228	372	266	255
	12160	6 1/4	3	353	235	192	387	282	250	418	311	292	442	334	317
	12200	8	4 1/2	353	251	226	387	282	261	418	311	292	442	334	317
	12240	9 1/2	6 1/4	353	251	218	387	282	261	418	311	292	442	334	317
	12280	11	7 3/4	353	251	221	387	282	261	418	311	292	442	334	317
	12320	12 5/8	7 3/4	353	251	229	387	282	261	418	311	292	442	334	317
	12360	14 1/4	9 1/4	353	251	229	387	282	261	418	311	292	442	334	317
	12400	15 3/4	11	353	251	229	387	282	261	418	311	292	442	334	317
	12440	17 1/4	12 1/2	353	251	229	387	282	261	418	311	292	442	334	317
	12480	19	14	353	251	229	387	282	261	418	311	292	442	334	317
	12520	20 1/2	15 1/2	353	251	229	387	282	261	418	311	292	442	334	317
	12560	22	17	353	251	229	387	282	261	418	311	292	442	334	317
	12600	23 5/8	18 1/2	353	251	229	387	282	261	418	311	292	442	334	317
TBS.... TBS EVO....	660	2 3/8	1/2	85	85	85	116	116	116	135	135	135	151	151	151
	670	2 3/4	1	99	99	99	129	129	129	156	156	156	182	182	182
	680	3 1/8	1	104	104	104	129	129	129	156	156	156	182	182	182
	690	3 1/2	1 1/4	111	111	111	140	140	140	174	174	174	206	206	206
	6100	4	1 1/4	111	111	111	140	140	140	174	174	174	206	206	206
	6120	4 3/4	1 1/2	120	120	120	154	154	154	190	190	190	211	211	211
	6140	5 1/2	2 1/4	139	139	139	165	165	165	190	190	190	211	211	211
	6160	6 1/4	3 1/4	139	139	139	165	165	165	190	190	190	211	211	211
	6180	7 1/8	4	139	139	139	165	165	165	190	190	190	211	211	211
	6200	8	4 3/4	139	139	139	165	165	165	190	190	190	211	211	211

**TABLE 4—REFERENCE LATERAL DESIGN VALUES (Z) FOR WOOD-TO-WOOD CONNECTIONS
WITH PARTIALLY THREADED FASTENERS (cont.)**

FASTENER DESIGNATION ¹	OVERALL SCREW LENGTH, <i>L</i> (inches)	SIDE MEMBER THICKNESS <i>t_{s,w}</i> (inches)	Z (lbf) FOR ASSIGNED SPECIFIC GRAVITIES (<i>AS_G</i>) OF:												
			0.35			0.42			0.49			0.55			
			Z	Z _{L/}	Z _⊥	Z	Z _{L/}	Z _⊥	Z	Z _{L/}	Z _⊥	Z	Z _{L/}	Z _⊥	
TBS.... TBS EVO....	6220	8 5/8	4 1/2	139	139	139	165	165	165	190	190	190	211	211	211
	6240	9 1/2	5 1/4	139	139	139	165	165	165	190	190	190	211	211	211
	6260	10 1/4	6	139	139	139	165	165	165	190	190	190	211	211	211
	6280	11	7	139	139	139	165	165	165	190	190	190	211	211	211
	6300	11 3/4	7 3/4	139	139	139	165	165	165	190	190	190	211	211	211
TBS.... TBS EVO....	860	2 3/8	1/8	24	19	19	34	27	27	45	36	36	56	45	45
	880	3 1/8	1	135	108	108	179	143	143	213	170	170	244	195	195
	8100	4	1 3/4	155	124	124	216	173	173	270	216	216	313	251	251
	8120	4 3/4	1 1/4	153	122	122	189	151	151	228	183	183	266	213	213
	8140	5 1/2	2 1/4	191	153	153	245	196	196	282	225	225	313	251	251
	8160	6 1/4	2 1/4	191	153	153	245	196	196	282	225	225	313	251	251
	8180	7 1/8	3	207	165	165	245	196	196	282	225	225	313	251	251
	8200	8	3 3/4	207	165	165	245	196	196	282	225	225	313	251	251
	8220	8 5/8	4 1/2	207	165	165	245	196	196	282	225	225	313	251	251
	8240	9 1/2	5 1/4	207	165	165	245	196	196	282	225	225	313	251	251
	8260	10 1/4	6	207	165	165	245	196	196	282	225	225	313	251	251
	8280	11	6 7/8	207	165	165	245	196	196	282	225	225	313	251	251
	8300	11 3/4	7 3/4	207	165	165	245	196	196	282	225	225	313	251	251
	8320	12 5/8	8 1/2	207	165	165	245	196	196	282	225	225	313	251	251
	8340	13 3/8	9 1/4	207	165	165	245	196	196	282	225	225	313	251	251
	8360	14 1/4	10 1/8	207	165	165	245	196	196	282	225	225	313	251	251
	8380	15	10 7/8	207	165	165	245	196	196	282	225	225	313	251	251
	8400	15 3/4	11 1/2	207	165	165	245	196	196	282	225	225	313	251	251
	8440	17 1/4	13 1/4	207	165	165	245	196	196	282	225	225	313	251	251
	8480	19	14 3/4	207	165	165	245	196	196	282	225	225	313	251	251
	8520	20 1/2	16 1/4	207	165	165	245	196	196	282	225	225	313	251	251
TBS MAX....	8200	8	3	207	165	165	245	196	196	282	225	225	313	251	251
	8220	8 5/8	3 3/4	207	165	165	245	196	196	282	225	225	313	251	251
	8240	9 1/2	4 1/2	207	165	165	245	196	196	282	225	225	313	251	251
TBS.... TBS EVO....	10100	4	1 1/4	231	159	128	260	182	167	287	206	197	311	227	219
	10120	4 3/4	2	264	178	143	317	213	186	361	249	233	387	281	272
	10140	5 1/2	2 3/4	306	202	165	338	249	215	365	274	259	387	295	282
	10160	6 1/4	3	308	220	190	338	249	232	365	274	259	387	295	282
	10180	7 1/8	3 3/4	308	222	203	338	249	232	365	274	259	387	295	282
	10200	8	3 3/4	308	222	203	338	249	232	365	274	259	387	295	282
	10220	8 5/8	4 1/2	308	222	203	338	249	232	365	274	259	387	295	282
	10240	9 1/2	5 1/4	308	222	203	338	249	232	365	274	259	387	295	282
	10260	10 1/4	6	308	222	203	338	249	232	365	274	259	387	295	282
	10280	11	6 7/8	308	222	203	338	249	232	365	274	259	387	295	282
	10300	11 3/4	7 3/4	308	222	203	338	249	232	365	274	259	387	295	282

**TABLE 4—REFERENCE LATERAL DESIGN VALUES (Z) FOR WOOD-TO-WOOD CONNECTIONS
WITH PARTIALLY THREADED FASTENERS (cont.)**

FASTENER DESIGNATION ¹		OVERALL SCREW LENGTH, <i>L</i> (inches)	SIDE MEMBER THICKNESS <i>t_{s,w}</i> (inches)	<i>Z</i> (lbf) FOR ASSIGNED SPECIFIC GRAVITIES (<i>ASG</i>) OF:											
				0.35			0.42			0.49			0.55		
				<i>Z</i>	<i>Z</i> _L	<i>Z</i> _⊥	<i>Z</i>	<i>Z</i> _L	<i>Z</i> _⊥	<i>Z</i>	<i>Z</i> _L	<i>Z</i> _⊥	<i>Z</i>	<i>Z</i> _L	<i>Z</i> _⊥
TBS.... TBS EVO....	10320	12 5/8	7 3/4	308	222	203	338	249	232	365	274	259	387	295	282
	10340	13 3/8	8 1/2	308	222	203	338	249	232	365	274	259	387	295	282
	10360	14 1/4	9 1/4	308	222	203	338	249	232	365	274	259	387	295	282
	10380	15	10	308	222	203	338	249	232	365	274	259	387	295	282
	10400	15 3/4	10 7/8	308	222	203	338	249	232	365	274	259	387	295	282
	10440	17 1/4	12 1/4	308	222	203	338	249	232	365	274	259	387	295	282
	10480	19	14	308	222	203	338	249	232	365	274	259	387	295	282
	10520	20 1/2	15 1/2	308	222	203	338	249	232	365	274	259	387	295	282

For **SI**: 1 inch = 25.4 mm, 1 lbf = 4.45 N.

¹The fastener designation is expressed combining the fastener name and the associated size (e.g., HBS650 where 6 is the nominal diameter *D_{nom}* in mm and 50 the overall length *L* in mm).

TABLE 5—REFERENCE LATERAL DESIGN VALUES (Z) FOR STEEL-TO-WOOD CONNECTIONS

FASTENER DESIGNATION ¹		OVERALL SCREW LENGTH, <i>L</i> (inches)	STEEL SIDE MEMBER THICKNESS ² <i>t_{s,s}</i> (inches)	Z (lbf) FOR ASSIGNED SPECIFIC GRAVITIES (<i>ASG</i>) OF:							
				0.35		0.42		0.49		0.55	
				Z	Z _⊥	Z	Z _⊥	Z	Z _⊥	Z	Z _⊥
LBS.... LBS EVO...	525	1 9/16	1/8	85	85	110	110	124	124	136	136
	540	1 15/16	1/8	94	94	110	110	124	124	136	136
	550	2 3/8	1/8	94	94	110	110	124	124	136	136
	560	2 3/4	1/8	94	94	110	110	124	124	136	136
	570	2 3/8	1/8	172	138	212	170	241	193	265	212
	760	3 1/8	1/8	182	145	212	170	241	193	265	212
	780	4	1/8	182	145	212	170	241	193	265	212
LBS.... LBS EVO...	525	1 9/16	1/4	89	89	115	115	143	143	158	158
	540	1 15/16	1/4	105	105	125	125	143	143	158	158
	550	2 3/8	1/4	106	106	125	125	143	143	158	158
	560	2 3/4	1/4	106	106	125	125	143	143	158	158
	570	2 3/8	1/4	202	161	262	209	309	247	338	271
	760	3 1/8	1/4	233	186	273	219	309	247	338	271
	780	4	1/4	233	186	273	219	309	247	338	271

For **SI**: 1 inch = 25.4 mm, 1 lbf = 4.45 N.

¹The fastener designation is expressed combining the fastener name and the associated size (e.g., LBS525 where 5 is the nominal diameter *D_{nom}* in mm and 25 the overall length *L* in mm).

²Tabulated values apply to steel with a minimum tensile strength of to 58 ksi (400 MPa).

TABLE 6—REFERENCE WITHDRAWAL DESIGN VALUES (W_{90}) FOR INSTALLATION PERPENDICULAR THE FACE OF THE WOOD MEMBER¹

FASTENER DESIGNATION	NOMINAL DIAMETER D_{nom} (inch - mm)	MINIMUM EMBEDDED THREAD LENGTH, T_{min} (inches)	REFERENCE WITHDRAWAL DESIGN VALUE, W_{90} (lbf/in) FOR ASSIGNED SPECIFIC GRAVITY (SG) OF:			
			0.35	0.42	0.49	0.55
HBS / HBS EVO / TBS / TBS EVO / HBS PLATE / HBS PLATE EVO	0.24 (6mm)	1 7/16	77	89	131	143
HBS / HBS EVO / TBS / TBS EVO / TBS MAX / HBS PLATE / HBS PLATE EVO	0.32 (8mm)	1 7/8	109	125	160	174
HBS / HBS EVO / TBS / TBS EVO / HBS PLATE / HBS PLATE EVO	0.40 (10mm)	2 3/8	140	161	188	205
HBS / HBS EVO / TBS / TBS EVO / HBS PLATE / HBS PLATE EVO	0.48 (12mm)	2 13/16	206	236	266	290
VGZ / VGZ EVO	0.21 (5.3mm)	1 1/4	102	118	132	145
VGZ / VGZ EVO	0.23 (5.6mm)	1 5/16	107	123	139	152
VGZ / VGZ EVO / DGZ	0.28 (7mm)	1 5/8	129	148	166	182
VGZ / VGZ EVO / VGS / VGS EVO / DGZ	0.36 (9mm)	2 1/8	129	149	173	189
VGZ / VGZ EVO / VGS / VGS EVO	0.44 (11mm)	2 5/8	148	171	192	210
VGS / VGS EVO	0.52 (13mm)	3 1/16	208	239	270	294
LBS / LBS EVO	0.20 (5mm)	1 3/16	99	114	128	140
LBS / LBS EVO	0.28 (7mm)	1 5/8	115	132	149	162

For **SI**: 1 inch = 25.4 mm, 1 lbf/in = 175N/m; 1 lbf = 4.45 N.

¹ The determination of the reference withdrawal design values (W_{90}) for screws installed at an angle to the grain between 0 and 90° is addressed in Section 4.1.7.1.

TABLE 7—REFERENCE HEAD PULL-THROUGH DESIGN VALUES (W_H)^{1,2}

FASTENER DESIGNATION	NOMINAL DIAMETER D_{nom} (inch - mm)	HEAD DIAMETER D_H (inch)	MINIMUM SIDE MEMBER THICKNESS $t_{s,w}$ (inches)	REFERENCE PULL-THROUGH DESIGN VALUE, W_H (lbf) FOR ASSIGNED SPECIFIC GRAVITY (SG) OF:			
				0.35	0.42	0.49	0.55
TBS - TBS EVO	0.24 (6mm)	0.610	1 1/2	125	144	162	177
TBS - TBS EVO	0.32 (8mm)	0.748	1 1/2	166	216	243	265
TBS - TBS EVO	0.40 (10mm)	0.984	1 1/2	166	239	325	410
TBS MAX	0.32 (8mm)	0.965	1	421	484	545	594
HBS + HUS6	0.24 (6mm)	0.787	1 1/2	166	239	270	294
HBS + HUS8	0.32 (8mm)	0.984	1 1/2	166	239	325	410
HBS + HUS10	0.40 (10mm)	1.181	1 1/2	166	239	325	410
HBS + HUS12	0.48 (12mm)	1.457	1 1/2	166	239	325	410
DGZ	0.28 (7mm)	0.374	1	191	220	248	270
DGZ	0.36 (9mm)	0.453	1	196	225	253	277

For **SI**: 1 inch = 25.4 mm, 1 lbf = 4.45 N.

¹ Tabulated values for TBS, TBS EVO, HBS in combination with HUS countersunk washer and TBS MAX are applicable to screws installed perpendicular to the faces of the wood members. Tabulated values for DGZ screws are applicable to screws installed at 60° angle to the grain.

² Tabulated values for TBS, TBS EVO, and HBS screws with HUS countersunk washers are conservatively based on a head diameter of 1/2 inch, determined in accordance with the NDS. Tabulated values for other fastener designations are based on testing.

TABLE 8—CONNECTION GEOMETRY REQUIREMENTS BASED ON $D_s^{1,2,3}$

CONDITION		MINIMUM DISTANCE OR SPACING		
		Self-drilled		Predrilled Hole
		ASG < 0.50	ASG ≥ 0.50	
For screws with D_s of less than $\frac{1}{4}$ inch, installed into sawn lumber, structural glued laminated timber (GL) and cross laminated timber (CLT) panels				
End distance (Figure A)	Tension loading parallel to grain (fastener bearing toward end), $a_{3,t}$	15D	20D	12D
	Compression loading parallel to grain (fastener bearing away from end), $a_{3,c}$	10D	15D	7D
	Loading perpendicular to grain, $a_{3,c}$	10D	15D	7D
	Axial loading (fastener withdrawal or pull-through), $a_{3,a}$ Inclined fastener $a_{1,CG}$ (Figure C)	10D	10D	7D
Edge distance (Figure A)	Loading parallel to grain, $a_{4,c}$	5D	7D	3D
	Loading toward edge, $a_{4,t}$	10D	12D	7D
	Loading away from edge, $a_{4,c}$	5D	7D	3D
	Axial Loading, $a_{4,a}$ Inclined fastener $a_{2,CG}$ (Figure C)	4D	4D	3D
Spacing between fasteners, parallel to grain, a_1 (Figures B and C)	Loading parallel to grain	15D	15D	10D
	Loading perpendicular to grain	10D	10D	5D
	Axial loading	7D	7D	7D
Spacing between fasteners, perpendicular to grain, a_2 (Figures B and C)	Lateral loading	5D	7D	4D
	Axial loading	4D	4D	3D
	Axial loading for crossed screws $a_{2,cross}$ (Figure C)	1.5D	1.5D	1.5D
For screws with D_s equal to or greater than $\frac{1}{4}$ inch, installed into sawn lumber, structural glued laminated timber (GL) and cross laminated timber (CLT) panels				
End distance (Figure A)	Tension loading parallel to grain (fastener bearing toward end), $a_{3,t}$	15D	20D	7D
	Compression loading parallel to grain (fastener bearing away from end), $a_{3,c}$	10D	15D	4D
	Loading perpendicular to grain, $a_{3,c}$	10D	15D	4D
	Axial loading (fastener withdrawal or pull-through), $a_{3,a}$ Inclined fastener $a_{1,CG}$ (Figure C)	10D	10D	4D
Edge distance (Figure A)	Loading parallel to grain, $a_{4,c}$	5D	7D	3D
	Loading toward edge, $a_{4,t}$	10D	12D	4D
	Loading away from edge, $a_{4,c}$	5D	7D	3D
	Axial Loading, $a_{4,a}$ Inclined fastener $a_{2,CG}$ (Figure C)	4D	4D	3D
Spacing between fasteners, parallel to grain, a_1 (Figures B and C)	Loading parallel to grain	15D	15D	5D
	Loading perpendicular to grain	10D	10D	5D
	Axial loading	7D	7D	5D
Spacing between fasteners, perpendicular to grain, a_2 (Figures B and C)	Lateral loading	5D	7D	5D
	Axial loading	5D	5D	5D
	Axial loading for crossed screws $a_{2,cross}$ (Figure C)	1.5D	1.5D	1.5D

For SI: 1 inch = 25.4 mm.

¹End distances, edge distances and fastener spacing must be sufficient to prevent splitting of the wood, or as required by this table, whichever is the more restrictive.

²Wood member stresses must be checked in accordance with Section 11.1.2 and Appendix E of the NDS, and end distances, edge distances and fastener spacing may need to be increased accordingly.

³Values in Table 8 are applicable for wood-to-wood and metal-to-wood connections.

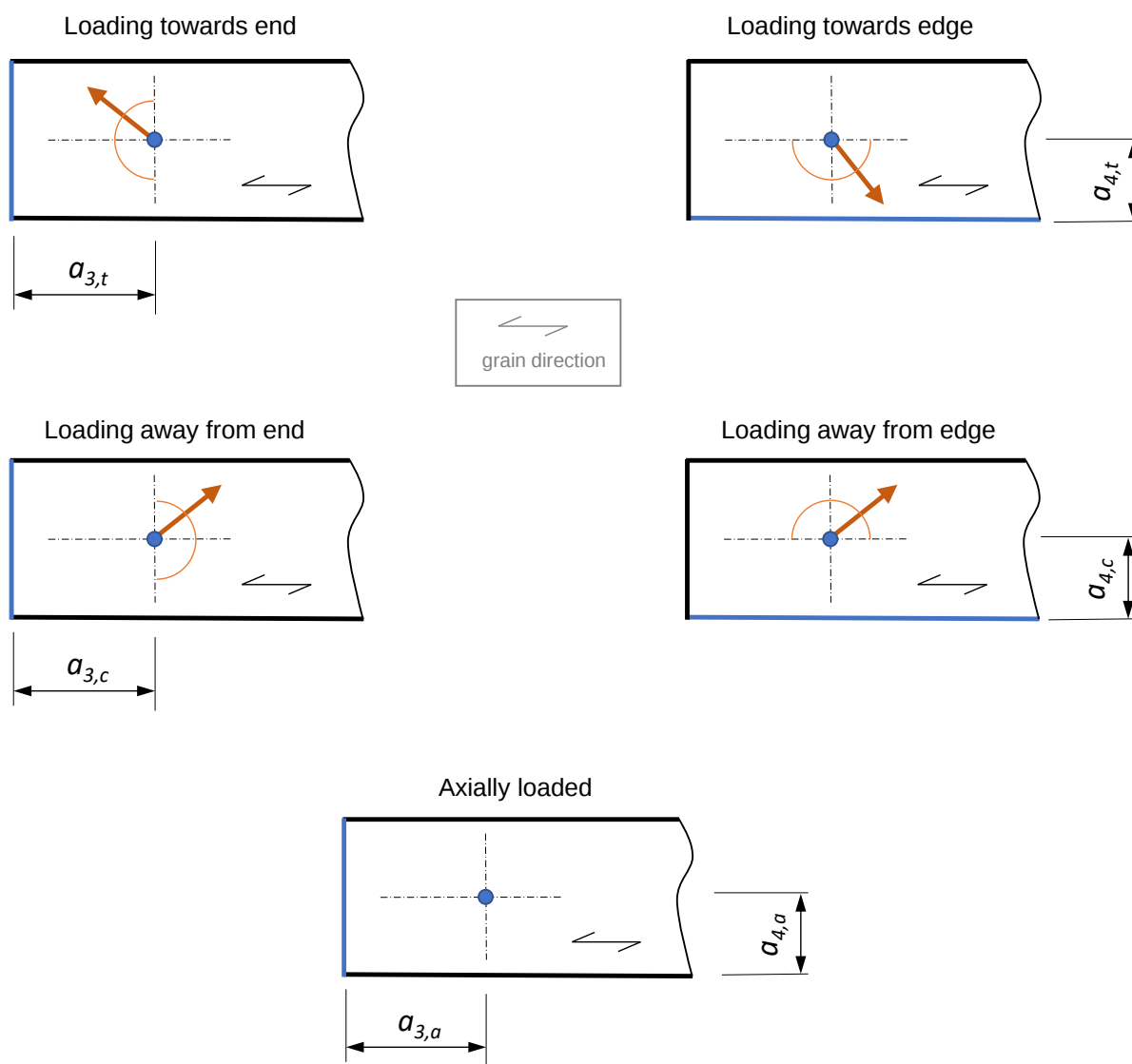


FIGURE A—END AND EDGE DISTANCE DEFINITIONS FOR SCREWS INSTALLED PERPENDICULAR TO GRAIN

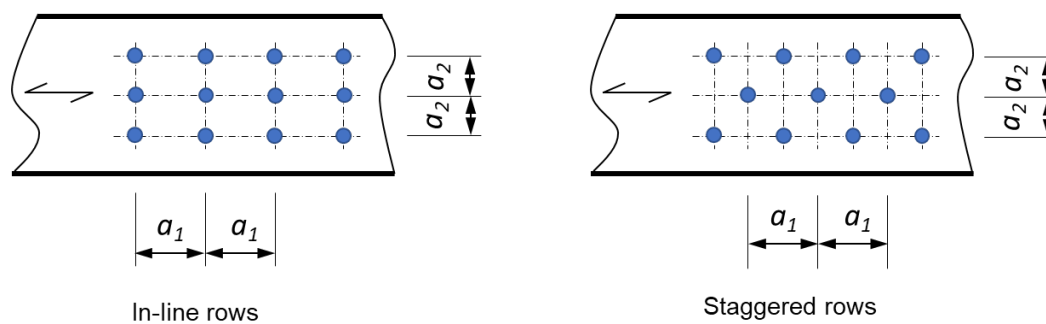


FIGURE B—SPACING DEFINITIONS FOR SCREWS INSTALLED PERPENDICULAR TO GRAIN

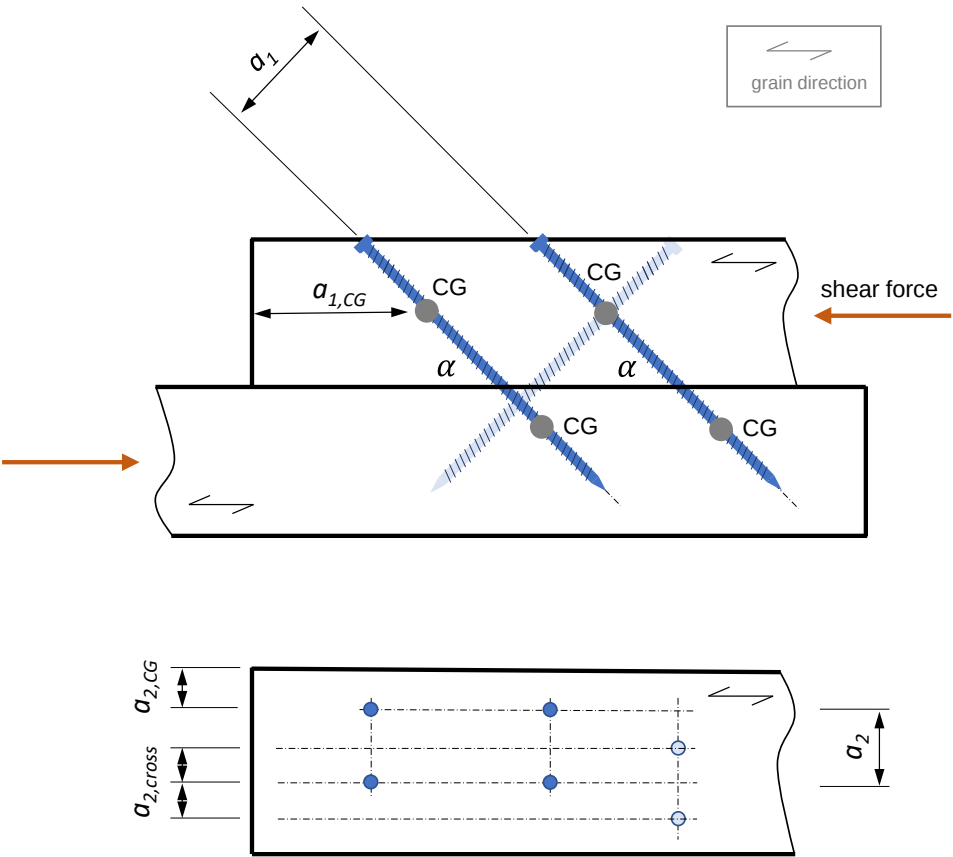


FIGURE C—SPACING DEFINITIONS FOR INCLINED AND CROSSED SCREWS

TABLE 9—APPLICABLE EXPOSURE CONDITIONS

EXPOSURE CONDITION	TYPICAL APPLICATIONS	LIMITATIONS
1	Treated wood in dry use applications	Limited to use where equilibrium moisture content of the chemically treated wood meets the dry service conditions as described in the NDS.
3	General construction	Limited to freshwater and chemically treated wood exposure, i.e., no saltwater exposure.