



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 HBS EVO | SNK SNK EVO |
| HBS PLATE (HBSP) HBS PLATE EVO (HBSP EVO) | KGL KGL EVO |
| TBS TBS EVO | TLL 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 ANSII/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.

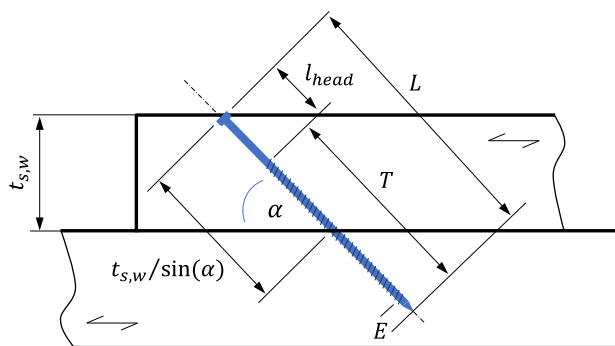
4.1.3 Design of Metal Parts: Design of connections using metal side plates must comply with Section 11.2.3 of the NDS (Section 10.2.3 of NDS-12 and NDS-05 for the 2012 and 2009 IBC).

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

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

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

| | |
|---|--|
| <p>LBS screws</p> <p>Alternative screws with different coating: LBS EVO</p> | <p>round head with cylindrical underhead</p> <p>"RU"</p> |
| | |

FIGURE 2—LBS TYPE FULLY THREADED SCREWS

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

FIGURE 3—VGS AND VGZ TYPE FULLY THREADED SCREWS

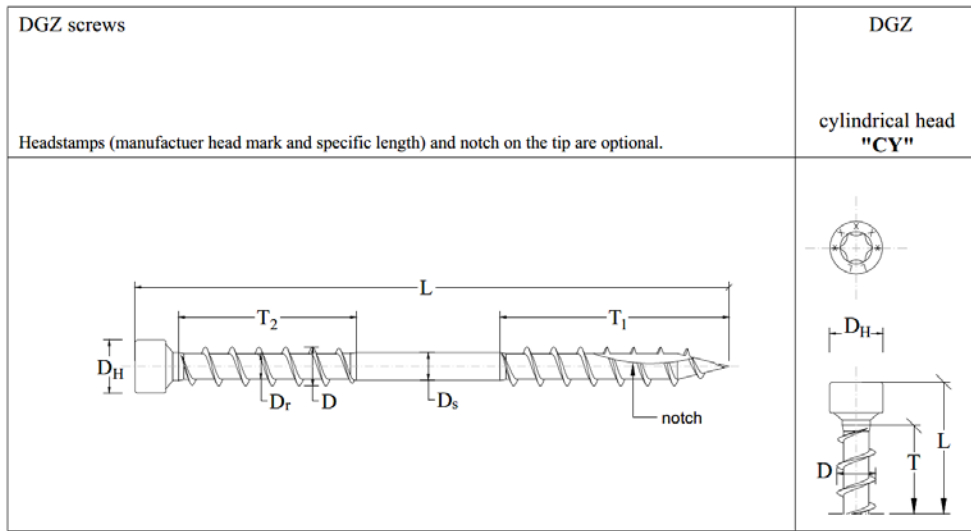
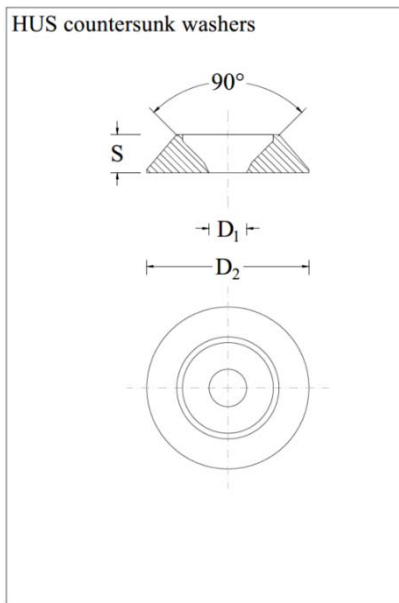


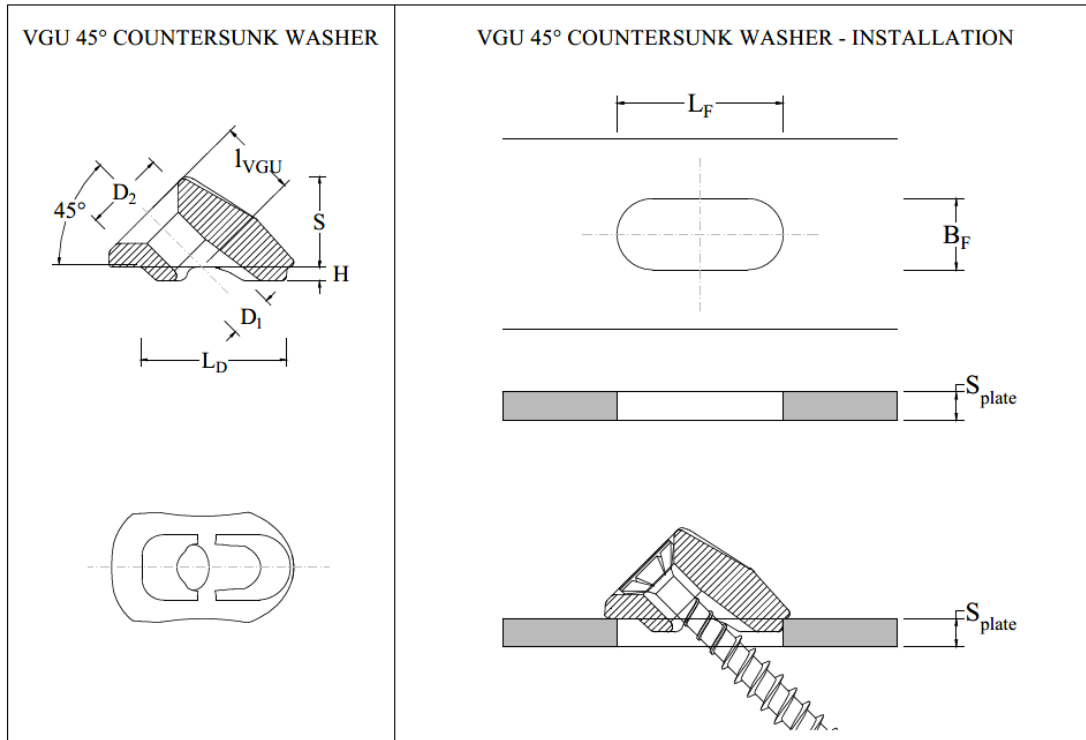
FIGURE 4—DGZ TYPE DOUBLE THREADED SCREWS



| 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) | l _{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) | 640 | 1 9/16 | 1 3/8 | Countersunk CS | 0.472 | TX 30 | 0.169 | 0.156 | 0.236 | 0.236 | 200,000 | 1,180 |
| | | 650 | 1 15/16 | 1 3/8 | | | | | | | | | |
| | | 660 | 2 3/8 | 1 3/16 | | | | | | | | | |
| | | 670 | 2 3/4 | 1 9/16 | | | | | | | | | |
| | | 680 | 3 1/8 | 1 9/16 | | | | | | | | | |
| | | 690 | 3 1/2 | 1 15/16 | | | | | | | | | |
| | | 6100 | 4 | 1 15/16 | | | | | | | | | |
| | | 6110 | 4 3/8 | 2 3/8 | | | | | | | | | |
| | | 6120 | 4 3/4 | 2 3/8 | | | | | | | | | |
| | | 6130 | 5 1/8 | 2 3/8 | | | | | | | | | |
| | | 6140 | 5 1/2 | 2 15/16 | | | | | | | | | |
| | | 6150 | 6 | 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 | 2 15/16 | | | | | | | | | |
| | | 6240 | 9 1/2 | 2 15/16 | | | | | | | | | |
| 6260 | 10 1/4 | 2 15/16 | | | | | | | | | | | |
| 6280 | 11 | 2 15/16 | | | | | | | | | | | |
| 6300 | 11 3/4 | 2 15/16 | | | | | | | | | | | |
| HBS.... HBS EVO.... | 0.32 (8mm) | 880 | 3 1/8 | 2 1/16 | Countersunk CS | 0.571 | TX 40 | 0.228 | 0.213 | 0.315 | 0.315 | 180,000 | 2,040 |
| | | 8100 | 4 | 2 1/16 | | | | | | | | | |
| | | 8120 | 4 3/4 | 2 3/8 | | | | | | | | | |
| | | 8140 | 5 1/2 | 2 3/8 | | | | | | | | | |
| | | 8160 | 6 1/4 | 3 1/8 | | | | | | | | | |
| | | 8180 | 7 1/8 | 3 1/8 | | | | | | | | | |
| | | 8200 | 8 | 3 1/8 | | | | | | | | | |
| | | 8220 | 8 5/8 | 3 1/8 | | | | | | | | | |

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) | |
|--------------------------|--|--|----------------------------------|-----------|-----------------------------------|---------------------|--|----------------------------------|--|-----------------------------|---|---|-------|
| HBS.... HBS EVO.... | 0.32 (8mm) (cont.) | 8240 | 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.... | 0.40 (10mm) | 1080 | | | | | | | | | |
| 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 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) |
|--------------------------|--|--|----------------------------------|--|-----------------------------------|---------------------|--|----------------------------------|--|-----------------------------|---|---|
| HBS.... HBS EVO.... | 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 |
| | | 12120 | 3 1/8 | | | | | | | | | |
| | | 12160 | 3 1/8 | | | | | | | | | |
| | | 12200 | 3 1/8 | | | | | | | | | |
| | | 12240 | 3 1/8 | | | | | | | | | |
| | | 12280 | 3 1/8 | | | | | | | | | |
| | | 12320 | 4 3/4 | | | | | | | | | |
| | | 12360 | 4 3/4 | | | | | | | | | |
| | | 12400 | 4 3/4 | | | | | | | | | |
| | | 12440 | 4 3/4 | | | | | | | | | |
| | | 12480 | 4 3/4 | | | | | | | | | |
| | | 12520 | 4 3/4 | | | | | | | | | |
| | | 12560 | 4 3/4 | | | | | | | | | |
| 12600 | 4 3/4 | | | | | | | | | | | |
| HBSP.... HBSP EVO.... | 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 |
| | | 680 | 1 15/16 | | | | | | | | | |
| 690 | 2 3/16 | 2 3/16 | | | | | | | | | | |
| HBSP.... HBSP EVO.... | 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 |
| | | 840 | 1 1/4 | | | | | | | | | |
| | | 860 | 2 1/16 | | | | | | | | | |
| | | 880 | 2 3/16 | | | | | | | | | |
| | | 8100 | 2 15/16 | | | | | | | | | |
| | | 8120 | 3 3/4 | | | | | | | | | |
| | | 8140 | 4 3/8 | | | | | | | | | |
| 8160 | 5 1/8 | | | | | | | | | | | |

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) |
|--------------------------|--|--|----------------------------------|-----------|---|---------------------|--|----------------------------------|--|-----------------------------|---|---|
| HBSP... HBSP EVO... | 0.40 (10mm) | 1060 | 2 3/8 | 2 1/16 | Washer head with cylindrical underhead WU | 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... | 0.48 (12mm) | 12100 | 4 | 2 15/16 | Washer head with cylindrical underhead WU | 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... | 0.24 (6mm) | 660 | 2 3/8 | 1 9/16 | Large washer head LW | 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 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 | | | | | | | | | | |
| | | 10120 | | | | | | | | | | |
| | | 10140 | | | | | | | | | | |
| | | 10160 | | | | | | | | | | |
| | | 10180 | | | | | | | | | | |
| | | 10200 | | | | | | | | | | |
| | | 10220 | | | | | | | | | | |
| | | 10240 | | | | | | | | | | |
| | | 10260 | | | | | | | | | | |
| | | 10280 | | | | | | | | | | |
| | | 10300 | | | | | | | | | | |
| | | 10320 | | | | | | | | | | |
| | | 10340 | | | | | | | | | | |
| | | 10360 | | | | | | | | | | |
| | | 10380 | | | | | | | | | | |
| 10400 | | | | | | | | | | | | |
| 10440 | | | | | | | | | | | | |
| 10480 | | | | | | | | | | | | |
| 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_a (lbf) |
|--------------------------|--|--|----------------------------------|-----------|---|---------------------|-------------------------------|--|-----------------------------|--|--|
| LBS.... LBS EVO... | 0.20 (5mm) | 525 | 1 | 13/16 | Round head with cylindrical underhead RU | TX 20 | 0.307 | 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... | 0.28 (7mm) | 760 | 2 3/8 | 2 3/16 | Round head with cylindrical underhead RU | TX 30 | 0.433 | 0.276 | 0.276 | 192,000 | 1,600 |
| | | 780 | 3 1/8 | 2 15/16 | | | | | | | |
| | | 7100 | 4 | 3 3/4 | | | | | | | |
| VGZ.... VGZ EVO.... | 0.21 (5.3mm) | 580 | 3 1/8 | 2 3/4 | Cylindrical head CY | TX25 | 0.315 | 0.209 | 0.209 | 168,000 | 1,000 |
| | | 5100 | 4 | 3 1/2 | | | | | | | |
| | | 5120 | 4 3/4 | 4 3/8 | | | | | | | |
| VGZ.... VGZ EVO... | 0.23 (5.6mm) | 5140 | 5 1/2 | 5 1/8 | Cylindrical head CY | TX25 | 0.315 | 0.220 | 0.220 | 168,000 | 1,100 |
| | | 5160 | 6 1/4 | 6 | | | | | | | |
| VGZ.... VGZ EVO.... | 0.28 (7mm) | 780 | 3 1/8 | 2 3/4 | Cylindrical head CY | TX30 | 0.374 | 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.... VGZEVO.... | 0.36 (9mm) | 6 1/4 | 6 | Cylindrical head CY | 0.453 | TX40 | 0.232 | 0.354 | 0.354 | 180,000 | 2,450 |
| | | 9160 | | | | | | | | | |
| | | 9180 | | | | | | | | | |
| | | 9200 | | | | | | | | | |
| | | 9220 | | | | | | | | | |
| | | 9240 | | | | | | | | | |
| | | 9260 | | | | | | | | | |
| | | 9280 | | | | | | | | | |
| | | 9300 | | | | | | | | | |
| | | 9320 | | | | | | | | | |
| | | 9340 | | | | | | | | | |
| | | 9360 | | | | | | | | | |
| | | 9380 | | | | | | | | | |
| | | 9400 | | | | | | | | | |
| | | 9440 | | | | | | | | | |
| 9480 | | | | | | | | | | | |
| 9520 | | | | | | | | | | | |
| VGZ.... VGZEVO.... | 0.44 (11mm) | 10 | 9 1/2 | Cylindrical head CY | 0.531 | TX50 | 0.260 | 0.433 | 0.433 | 170,000 | 3,200 |
| | | 11250 | | | | | | | | | |
| | | 11300 | | | | | | | | | |
| | | 11350 | | | | | | | | | |
| | | 11400 | | | | | | | | | |
| | | 11450 | | | | | | | | | |
| | | 11500 | | | | | | | | | |
| | | 11550 | | | | | | | | | |
| 11600 | | | | | | | | | | | |
| VGS.... VGSEVO.... | 0.36 (9mm) | 4 | 3 1/2 | Countersunk head CS | 0.630 | TX40 | 0.232 | 0.354 | 0.354 | 180,000 | 2,450 |
| | | 9100 | | | | | | | | | |
| | | 9120 | | | | | | | | | |
| | | 9140 | | | | | | | | | |
| | | 9160 | | | | | | | | | |
| 9180 | | | | | | | | | | | |

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.... | 0.36 (9mm) (cont.) | 8 | 7 1/2 | Countersunk head CS | 0.630 | TX40 | 0.232 | 0.354 | 0.354 | 180,000 | 2,450 |
| | | 9200 | | | | | | | | | |
| | | 9220 | | | | | | | | | |
| | | 9240 | | | | | | | | | |
| | | 9260 | | | | | | | | | |
| | | 9280 | | | | | | | | | |
| | | 9300 | | | | | | | | | |
| | | 9320 | | | | | | | | | |
| | | 9340 | | | | | | | | | |
| | | 9360 | | | | | | | | | |
| | | 9380 | | | | | | | | | |
| | | 9400 | | | | | | | | | |
| | | 9440 | | | | | | | | | |
| | | 9480 | | | | | | | | | |
| 9520 | | | | | | | | | | | |
| VGS.... VGSEVO.... | 0.44 (11mm) | 4 | 3 1/2 | Countersunk head CS | 0.760 | TX50 | 0.260 | 0.433 | 0.433 | 170,000 | 3,200 |
| | | 11100 | | | | | | | | | |
| | | 11125 | | | | | | | | | |
| | | 11150 | | | | | | | | | |
| | | 11175 | | | | | | | | | |
| | | 11200 | | | | | | | | | |
| | | 11225 | | | | | | | | | |
| | | 11250 | | | | | | | | | |
| | | 11275 | | | | | | | | | |
| | | 11300 | | | | | | | | | |
| | | 11325 | | | | | | | | | |
| | | 11350 | | | | | | | | | |
| | | 11375 | | | | | | | | | |
| | | 11400 | | | | | | | | | |
| | | 11450 | | | | | | | | | |
| | | 11500 | | | | | | | | | |
| | | 11550 | | | | | | | | | |
| 11600 | | | | | | | | | | | |

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.... VGS EVO.... | 11700 | 0.44 (11mm) | 27 1/2 | 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 | 0.52 (13mm) | 4 | Countersunk head CS | 0.866 | TX50 | 0.315 | 0.512 | 0.512 | 161,000 | 4,400 | |
| | 13150 | | 6 | | | | | | | | | 5 1/2 |
| | 13200 | | 8 | | | | | | | | | 7 1/2 |
| | 13250 | | 10 | | | | | | | | | 9 1/2 |
| | 13300 | | 11 3/4 | | | | | | | | | 11 |
| | 13350 | | 13 3/4 | | | | | | | | | 13 |
| | 13400 | | 15 3/4 | | | | | | | | | 15 |
| | 13450 | | 17 3/4 | | | | | | | | | 16 15/16 |
| | 13500 | | 19 3/4 | 19 | Hexagonal star drive head EXA | 0.748 | SW19 | 0.315 | 0.512 | 0.512 | 161,000 | 4,400 |
| | 13600 | | 23 5/8 | 22 13/16 | | | | | | | | |
| | 13700 | | 27 1/2 | 26 3/4 | | | | | | | | |
| | 13800 | | 31 1/2 | 30 11/16 | | | | | | | | |
| | 13900 | | 35 1/2 | 34 5/8 | | | | | | | | |
| | 131000 | | 39 3/8 | 38 9/16 | | | | | | | | |
| | 131100 | | 43 5/16 | 42 1/2 | | | | | | | | |
| | 131200 | | 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 | 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 | 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, L (inches) | SIDE MEMBER THICKNESS $t_{S,W}$ (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, L (inches) | SIDE MEMBER THICKNESS $t_{s,w}$ (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... | 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, L (inches) | SIDE MEMBER THICKNESS $t_{s,w}$ (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 _⊥ | |
| 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) | 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 _⊥ | |
| 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 (ASG) 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_{α}) 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 (ASG) 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 $D^{1,2,3}$

| CONDITION | | MINIMUM DISTANCE OR SPACING | | |
|--|--|-----------------------------|-----------------|-----------------|
| | | Self-drilled | | Predrilled Hole |
| | | $ASG < 0.50$ | $ASG \geq 0.50$ | |
| For screws with D_s of less than $1/4$ 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 $1/4$ 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.

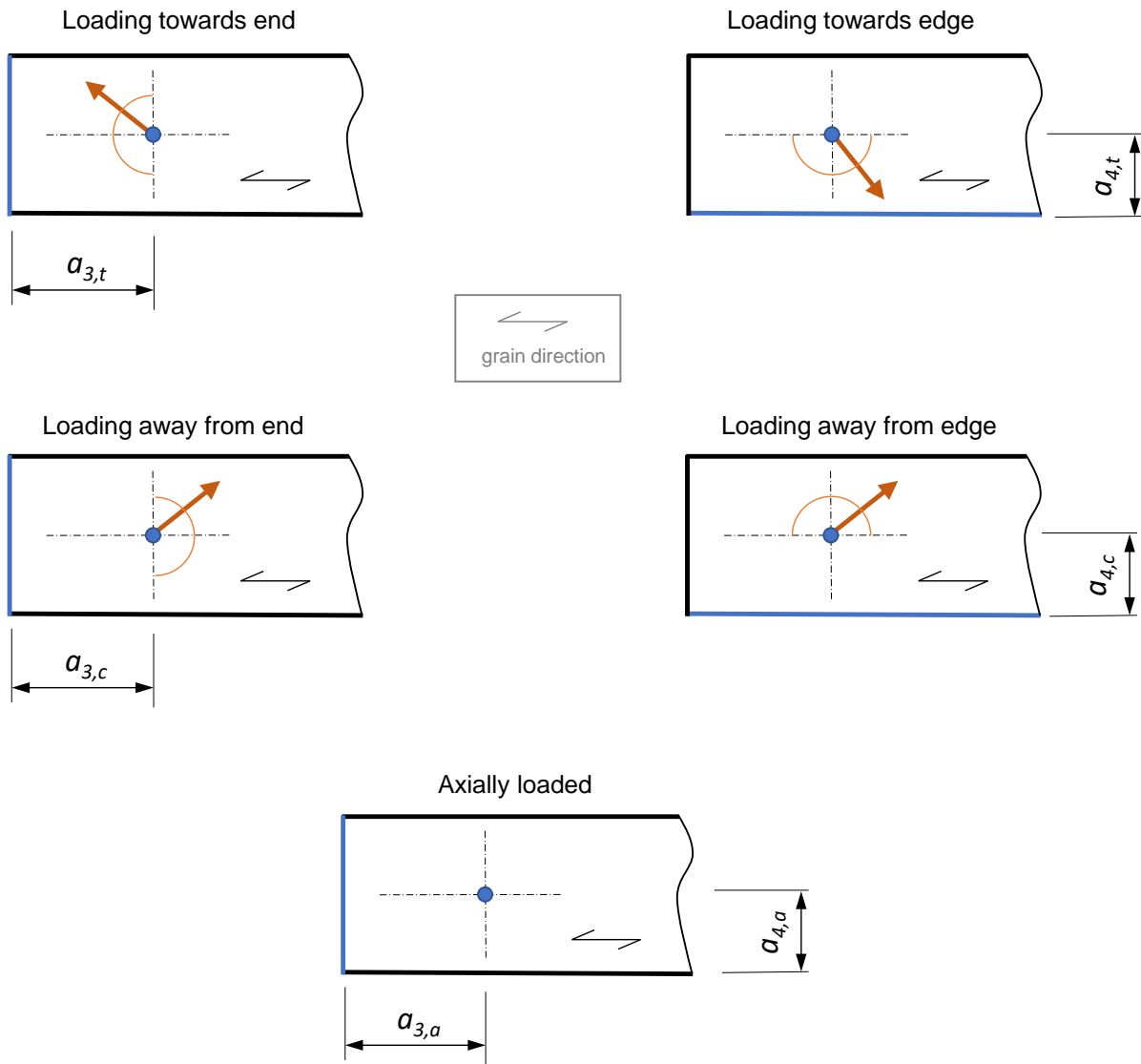


FIGURE A—END AND EDGE DISTANCE DEFINITIONS FOR SCREWS INSTALLED PERPENDICULAR TO GRAIN

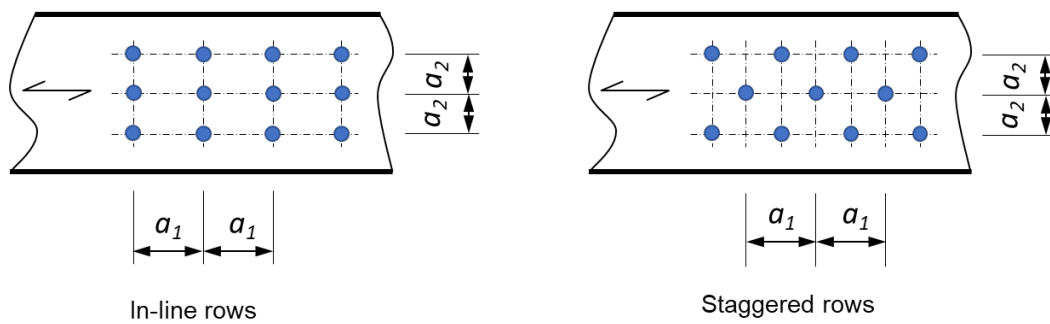


FIGURE B—SPACING DEFINITIONS FOR SCREWS INSTALLED PERPENDICULAR TO GRAIN

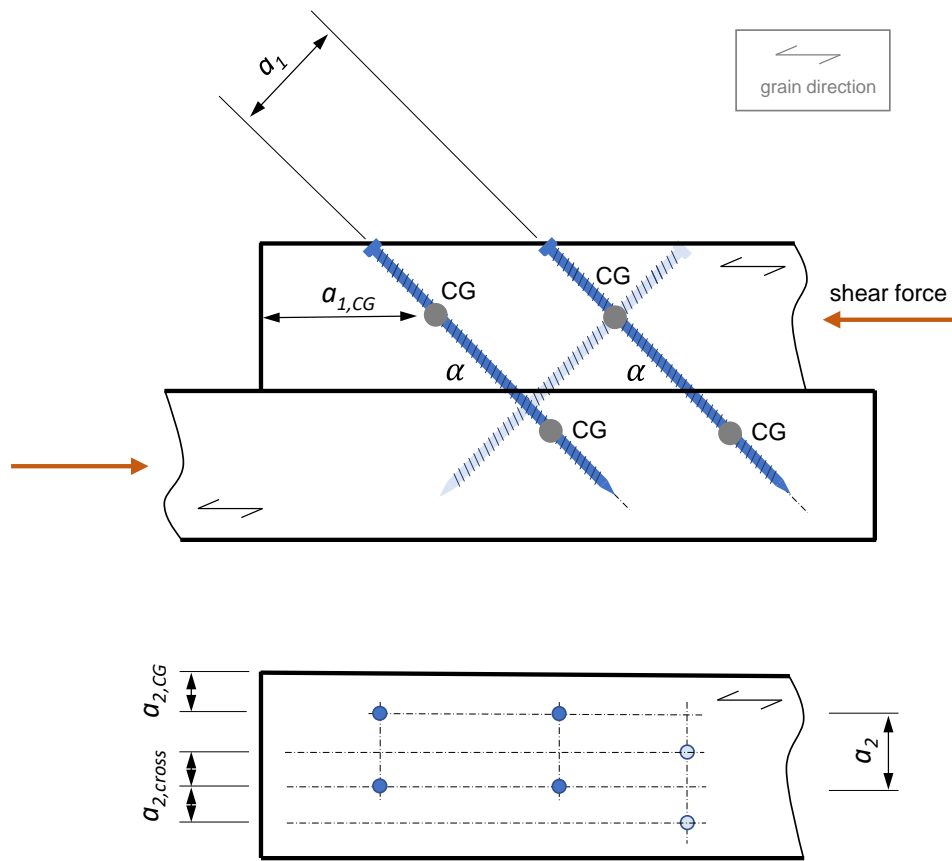


FIGURE C—SPACING DEFINITIONS FOR INCLINED AND CROSSED SCREWS

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. |