

# ICC-ES Evaluation Report


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| <p><b>DIVISION: 06 00 00—</b><br/> <b>WOOD, PLASTICS AND</b><br/> <b>COMPOSITES</b></p> <p><b>Section: 06 05 23—</b><br/> <b>Wood, Plastic and</b><br/> <b>Composite Fastenings</b></p> | <p><b>REPORT HOLDER:</b></p> <p><b>SCHRAUBENWERK</b><br/> <b>GAISBACH GmbH</b><br/> <b>(SWG)</b></p> | <p><b>EVALUATION SUBJECT:</b></p> <p><b>SWG ASSYPLUS VG</b><br/> <b>AND VG 4 WOOD-</b><br/> <b>DRILLING SCREWS</b></p> |  |
|---|--|--|---|

## 1.0 EVALUATION SCOPE

**Compliance with the following codes:**

- 2021, 2018, 2015, and 2012 [International Building Code® \(IBC\)](#)
- 2021, 2018, 2015, and 2012 [International Residential Code® \(IRC\)](#)

**Property evaluated:**

- Structural

## 2.0 USES

SWG ASSYplus VG and VG 4 Wood-drilling Screws are alternate dowel-type threaded fasteners used in engineered wood-to-wood and steel-to-wood connections designed in accordance with the IBC. For structures regulated under the IRC, the screws may be used when an engineered design is submitted in accordance with IRC Section R301.1.3.

## 3.0 DESCRIPTION

**3.1 Notation and Symbols:**

- $a$         ≡ Connection geometry parameter (See Table 7.)
- $D$          ≡ Outside thread diameter
- $D_H$        ≡ Diameter of screw head
- $D_{nom}$     ≡ Screw size designation (nominal diameter)
- $D_r$         ≡ Minor thread (root) diameter
- $F_{vb,spec}$  ≡ Specified bending yield strength determined in accordance with ASTM F1575 using  $D_r$ .
- $L$          ≡ Overall screw length (See Figures 1 through 5.)
- $L_{eff,m}$    ≡ Effective embedded thread length in the wood main member (See Section 4.1.3.)
- $L_{eff,s}$    ≡ Effective embedded thread length in the wood side member (See Section 4.1.3.)
- $L_{emb,w}$    ≡ Minimum required embedment length in holding member, applicable to tabulated withdrawal design values
- $L_{emb,l}$    ≡ Minimum required embedment length in holding member, applicable to tabulated lateral design values

|             |   |  |
|-------------|---|--|
| $L_m$       | ≡ | <u>Dowel bearing length in the main member</u>   |
| $L_{tip}$   | ≡ | <u>Length of tip. See <a href="#">Tables 1A</a> and <a href="#">1B</a>.</u>  |
| $L_{un}$    | ≡ | <u>Length of unthreaded portion of the screw, measured from the head of the screw to the start of the threads (See Section 4.1.3.)</u> |
| $L_w$       | ≡ | <u>Length of screw in the wedge washer.</u>  |
| $N_a$       | ≡ | <u>Allowable tension strength of the screw for use in ASD</u>  |
| $N_u$       | ≡ | <u>Design tension strength of the screw for use in LRFD</u>  |
| $R_\alpha$  | ≡ | <u>Reduction factor for withdrawal resistance of inclined fasteners (See Section 4.1.4.)</u>   |
| $SG_{eq}$   | ≡ | <u>Structural composite lumber equivalent specific gravity used for connection design</u>  |
| $SG_{NDS}$  | ≡ | <u>Assigned specific gravity for the applicable species combination, glulam or other wood material in accordance with</u>              |
| $t_{s,w}$   | ≡ | <u>Thickness of wood side member</u>   |
| $t_{s,s}$   | ≡ | <u>Thickness of steel side member</u>  |
| $t_m$       | ≡ | <u>Thickness of wood main member</u>   |
| $V_a$       | ≡ | <u>Allowable shear strength of the screw for use in ASD</u>  |
| $V_u$       | ≡ | <u>Design shear strength of the screw for use in LRFD</u>  |
| $W$         | ≡ | <u>Reference unit withdrawal design value for screws installed perpendicular to face of the wood</u>                                   |
| $W_H$       | ≡ | <u>Reference head pull-through design value</u>  |
| $Z$         | ≡ | <u>Reference lateral design value</u>  |
| $Z_{  }$    | ≡ | <u>Reference lateral design value for screws loaded parallel to the wood grain</u>   |
| $Z_{\perp}$ | ≡ | <u>Reference lateral design value for screws loaded perpendicular to the wood grain</u>  |
| $Z_{end}$   | ≡ | <u>Reference lateral design value for screws installed in end grain and loaded laterally.</u>  |
| $\alpha$    | ≡ | <u>Angle between the axis of the screw and the grain of the applicable wood member, degrees</u>  |

### 3.2 SWG ASSYplus VG and VG 4 Wood-drilling Screws:

SWG ASSYplus VG and VG 4 screws are self-drilling, self-tapping screws which have a drill point. Various head styles are available, as shown in [Figures 1](#) through [5](#). The VG screw heads typically have a recess for use with an AW drive, while the VG 4 screw heads typically have a recess for use with an RW drive. The AW and RW drive styles require proprietary driving bits, which are available from the report holder. The VG and VG 4 screws with the reverse head style have a star-shaped head with no recess. The screws are available with nominal diameters of  $1/4$ ,  $5/16$ ,  $3/8$ ,  $1/2$  and  $9/16$  inch (6, 8, 10, 12 and 14 mm). The screws are fully threaded and are available in varying lengths. The screws are available in boxes of loose fasteners. See [Tables 1A](#) and [1B](#) for screw dimensions and descriptions.

### 3.3 Materials:

**3.3.1 SWG ASSYplus VG and VG 4 Screws:** The screws are manufactured from carbon steel wire complying with the manufacturer's specifications. After the heads are formed and the threads are rolled, the screws are hardened, in accordance with the manufacturer's specifications. The screws have a zinc or zinc flake coating.

**3.3.2 Wood Members:** Wood members may be sawn lumber; structural glued laminated timber (glulam); laminated veneer lumber (LVL) or parallel strand lumber (PSL), which are types of structural composite lumber (SCL); and cross-laminated timber (CLT) panels. See Sections 4.1.4 through 4.1.7 for specific wood materials considered in the determination of design values. Use of the screws in engineered wood products other than those addressed above is outside the scope of this report.

For purposes of connection design, sawn lumber, glulam and CLT members must have  $SG_{NDS}$  as indicated in the tables in this report, and the moisture content must be less than or equal to 19 percent at the time of screw installation and while in service.  $SG_{NDS}$  for sawn lumber is the assigned specific gravity for the applicable

grade mark, 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) or in accordance with the latest NDS Supplement.  $SG_{NDS}$  for glulam members is the Specific Gravity for Fastener Design addressed in Tables 5A through 5D of the NDS Supplement. When designing connections with screws installed into CLT panels, all of the laminations must have a minimum  $SG_{NDS}$  as indicated in the tables in this report.

For SCL, the moisture content at the time of installation and in service must be in accordance with the applicable ICC-ES evaluation report on the SCL. The SCL must have a minimum equivalent specific gravity,  $SG_{eq}$ , given in the applicable ICC-ES evaluation report, of 0.50.

The thickness of the wood main member,  $t_m$ , must be sufficient to ensure that the tip of the screw is embedded in the wood, with a minimum thickness of wood beyond the tip (cover) of  $3/8$  inch (9.5 mm). Unless noted otherwise, the minimum thickness of both main and side members must also be as follows:  $15/16$  inch (24 mm) for  $1/4$ -inch-diameter (6 mm) screws;  $13/16$  inches (30 mm) for  $5/16$ -inch-diameter (8 mm) screws;  $19/16$  inches (40 mm) for  $3/8$ -inch-diameter (10 mm) screws;  $33/16$  inches (80 mm) for  $1/2$ -inch-diameter (12 mm) screws; and  $3^{15}/16$  (100 mm) for  $9/16$ -inch-diameter (14 mm) screws.

**3.3.3 Steel Side Plates:** Steel side plates must be designed in accordance with AISI S100 or AISC 360, as applicable, and must comply with the minimum requirements of ASTM A36. Steel plate thickness and predrilled hole geometry must be as required by Section 4.1.11 or [Table 5](#), as applicable.

**3.3.4 Wedge Washers:** Steel wedge washers are available from MTC Solutions for use with inclined screws installed through steel side plates. See [Figures 11](#) and [12](#).

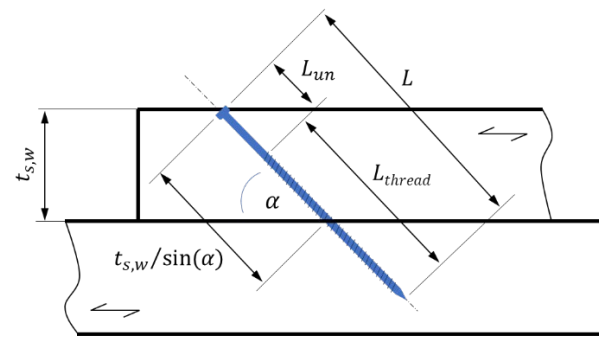
## 4.0 DESIGN AND INSTALLATION

### 4.1 Design:

**4.1.1 General:** The design values in this report are intended to aid the designer in meeting the requirements of IBC Section 1604.2. For connections not completely described in this report, determination of the suitability of the ASSYplus VG and VG 4 screws for the specific application is the responsibility of the designer and is outside the scope of this report. The designer is responsible for determining the available strengths for the connection, considering all applicable limit states, and for considering serviceability issues. The designer is responsible for determining the required spacing, edge distance and end distance for the screws, based on the characteristics of the connected building materials.

**4.1.2 Screw Strength:** Allowable screw shear and tension strengths (ASD), design screw shear and tension strengths (LRFD) and minimum specified bending yield strengths for the screws are shown in [Tables 1A](#) and [1B](#), as applicable.

**4.1.3 Effective Embedded Thread Length:** The effective embedded thread length is the length of fastener thread in a wood member that is completely surrounded by the wood. For example, for a wood-to-wood connection the effective lengths in the side and main members are determined as follows:



$$L_{eff,s} = \left( \frac{t_{s,w}}{\sin(\alpha)} \right) - L_{un} \quad \text{(Eq. 4.1.3-1)}$$

$$L_{eff,m} = \left( L - \left( \frac{t_{s,w}}{\sin(\alpha)} \right) - L_{tip} \right) \leq L_{thread} \quad \text{(Eq. 4.1.3-2)}$$

**4.1.4 Reference Withdrawal Design Values:** Reference withdrawal ( $W$ ) design values in pounds per inch of thread penetration, for screws installed perpendicular to the face of a sawn lumber, glulam, CLT or PSL member, with a minimum embedment depth of  $8D$  are shown in [Table 2](#). For inclined fastening, the applicable reduction factor from the following table must be applied:

| $\alpha$ | $R_\alpha$ |
|----------|------------|
| 90       | 1.00       |
| 85       | 1.00       |
| 80       | 0.99       |
| 75       | 0.99       |
| 70       | 0.98       |
| 65       | 0.97       |
| 60       | 0.95       |
| 55       | 0.94       |
| 50       | 0.92       |
| 45       | 0.91       |
| 40       | 0.89       |
| 35       | 0.84       |
| 30       | 0.77       |

**4.1.5 Reference Pull-through Design Values:** Reference head pull-through values ( $W_H$ ) for sawn lumber, glulam, CLT and PSL are shown in [Table 3](#) for installation with  $90^\circ \geq \alpha \geq 30^\circ$ . Lesser angles of installation are outside the scope of this report. Alternatively, the reference pull-through design value may be determined on the basis of the thread withdrawal from the side member, determined in accordance with Sections 4.1.3 and 4.1.4.

**4.1.6 Reference Lateral Design Values Based on Testing:** Reference lateral design values for steel-to-wood connections based on testing are shown in [Table 5](#).

**4.1.7 Lateral Connections Designed in Accordance with the NDS:** Reference lateral design values for select wood-to-wood connection configurations are given in [Table 4](#) based on calculations in accordance with the NDS. For other connection configurations, reference lateral design values for single shear connections with the screws installed perpendicular to the face of the member or panel, loaded parallel or perpendicular to grain, may be determined in accordance with Section 12.3.1 of the NDS (Section 11.3.1 of the NDS for the 2012 IBC) using the following parameters and limitations:

1.  $F_{yb,spec}$  from [Table 1A](#) or [1B](#) must be used for design.
2. The wood side member thickness,  $t_{s,w}$ , must be a minimum of  $1\frac{3}{4}$  inches (45 mm).
3. The minimum effective screw penetration into the main member, excluding tip length, must be  $6D$ .
4.  $D_r$  must be used where 'D' is referenced in Tables 12.3.1A, 12.3.1B and 12.3.3 of the NDS (Tables 11.3A, 11.3.1B and 11.3.3 of the NDS for the 2012 IBC).
5.  $L_m$  must be taken as  $L_{eff,m}$ .
6.  $SG_{NDS}$  must be 0.55 or less.
7. For PSL or LVL, the specific gravity used for design purposes must be the  $SG_{eq}$  for the PSL or LVL given in the applicable ICC-ES evaluation report.
8. Spacing, edge and end distance for connections designed in accordance with the NDS must be in accordance with Section 4.2.2.

**4.1.8 Adjustments to Reference Design Values:** Reference design values must be adjusted in accordance with the NDS provisions for dowel-type fasteners to determine allowable strengths for use with ASD and design strengths for use with LRFD.

**4.1.9 Connections with Multiple Screws:** See Sections 11.1.2, 11.2.2 and 12.6 of the NDS (Sections 10.1.2, 10.2.2 and 11.6 of the NDS for the 2012 IBC) regarding multiple fastener connections and consideration of local stresses in the wood members.

**4.1.10 Combined Loading:** Where SWG ASSYplus VG and VG 4 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 IBC), as applicable.

**4.1.11 Lateral Connections with Multiple Inclined Screws:**

**4.1.11.1 General:** Connections used to transfer lateral loads between side members and a main member using groups of SWG ASSYplus VG or VG 4 screws installed at a 45-degree angle to the grain of the wood members must be designed in accordance with this section. Specific design procedures for steel-to-wood connections are addressed in Section 4.1.11.3. Specific design procedures for wood-to-wood connections are addressed in Section 4.1.11.4. The expected slip between the side member(s) and the main member at design load is less than  $\frac{1}{16}$  inch (1.6 mm).

**4.1.11.2 Applicable Parameters:** The design methods presented in Section 4.1.11 apply under the following conditions:

1. The connections are two or three member connections with a wood main member and either wood or steel side member(s).
2.  $SG_{NDS}$  for sawn lumber and glulam, and  $SG_{eq}$  for PSL, must be within the ranges shown in [Tables 2](#) and [3](#).
3. Screws used with steel side plates must be ASSYplus VG or VG 4 screws with countersunk heads, installed using wedge washers in slotted holes.
4. The screws must be installed at a 45-degree angle to the wood grain, which is parallel to the direction of the force being transferred between the members.
5. The effective screw penetration in both the wood main member,  $L_{eff,m}$ , and the wood side member,  $L_{eff,s}$ , must be a minimum of 8D, measured along the axis of the screw.
6. A minimum of 2 screws through each side member must be used in each connection.
7. Spacing, edge distance and end distance must be in accordance with Section 4.2.2.
8. Wood side members must be of sufficient thickness to accommodate a minimum thread length of 8D plus  $L_{un}$ , shown in [Table 1A](#) or [1B](#), as applicable.
9. For connections of steel side plates to wood main members, the spacing between the outermost screws perpendicular to grain must not exceed 5 inches (127 mm).
10. Steel side plate thickness must be as shown in the following table, to accommodate the available wedge washers:

| NOMINAL SCREW DIAMETER (inch) | MIN. PLATE THICKNESS (inch) | MAX. PLATE THICKNESS (inch) |
|-------------------------------|-----------------------------|-----------------------------|
| 5/16                          | 3/16                        | 1/2                         |
| 3/8                           | 1/4                         | 3/4                         |
| 1/2                           | 1/4                         | 1                           |

For SI: 1 inch = 25.4 mm

**4.1.11.3 Steel-to-Wood Connections:**

**4.1.11.3.1 Two-member Connections:** The allowable lateral load for a two-member connection with a steel side member and a wood main member must be determined as follows:

1. Determine the length of the screw in the side member as follows:

$$L_s = L_w + t_{s,s} / \cos 45^\circ$$

Where:

$L_w$  = the length of the screw in the wedge washer. (See [Figure 12](#))

$t_{s,s}$  = the thickness of the steel side member.

2. Determine the effective length of the screw in the main member as follows:

$$L_{eff,m} = L - L_s - L_{tip}$$

3. Determine the applicable reference withdrawal design value for the screw installed at 45° to the grain of the wood, in pounds-force per inch, in accordance with Section 4.1.4. Then determine the allowable withdrawal strength in the main member,  $W'_m$ , taking into account  $L_{eff,m}$  and the applicable adjustment factors in the NDS.
4. If  $W'_m$  is less than  $N_a$  (shown in [Table 1](#)), the allowable lateral strength of the multiple fastener connection,  $P_a$ , must be determined as follows:

$$P_a = n \cdot W'_m \cdot \cos 45^\circ$$

Where:

$n$  = the number of screws acting together in the shear plane.

5. If  $W'_m$  exceeds  $N_a$ , the allowable lateral strength of the multiple fastener connection must be determined as follows:

$$P_a = n \cdot N_a \cdot \cos 45^\circ$$

6. The structural members must be checked for load-carrying capacity along the entire load path in accordance with the code. This verification must include, but not be limited to, verifying the longitudinal shear capacity of the wood member; the cross tension capacity of the wood member; and the fastener group or individual fastener wood tear out capacities.

**4.1.11.3.2 Three-member Connections:** The allowable lateral load for a three-member connection with two steel side members and a wood main member is equal to two times the allowable lateral load for a two-member connection with a steel side member and a wood main member, determined in accordance with Section 4.1.11.3.1.

**4.1.11.4 Wood-to-wood Connections:**

**4.1.11.4.1 Two-member Connections:** The allowable lateral load for a two-member connection with a wood side member and a wood main member must be determined as follows:

1. Determine  $L_{eff,s}$  and  $L_{eff,m}$  in accordance with Section 4.1.3.
2. Determine the applicable reference withdrawal design value for the screw installed at  $45^\circ$  to the grain of the wood, in pounds-force per inch, in accordance with Section 4.1.4. Then determine the allowable withdrawal strength in the side and main members,  $W'_s$  and  $W'_m$ , taking into account  $L_{eff,s}$  and  $L_{eff,m}$ , respectively, along with the applicable adjustment factors in the NDS.
3. If either  $W'_s$  or  $W'_m$  (or both) is less than  $N_a$ , the allowable lateral strength of the multiple fastener connection must be determined as follows:

$$P_a = n \cdot \min \left[ \frac{W'_s}{W'_m} \right] \cdot \cos 45^\circ$$

4. If both  $W'_s$  and  $W'_m$  exceed  $N_a$ , the allowable lateral strength of the connection must be determined as follows:

$$P_a = n \cdot N_a \cdot \cos 45^\circ$$

5. The structural members must be checked for load-carrying capacity in accordance with Section 4.1.11.3.1.

**4.1.11.4.2 Three-member Connections:** The allowable lateral load for a three-member connection with two wood side members and a wood main member is equal to 2 times the allowable lateral load for a two-member connection with a wood side member and a wood main member, determined in accordance with Section 4.1.11.4.1.

**4.2 Installation:**

**4.2.1 General:** SWG ASSYplus VG and VG 4 screws must be installed in accordance with the MTC Solutions published installation instructions, the approved plans, and this report. In the event of a conflict between this report and the MTC Solutions published installation instructions, the more severe requirements govern.

Screws must be installed using the manufacturer-recommended drive bit, with a rotary drill, or a percussion drill set to rotary only mode. Unless noted otherwise in the construction documents, the flat surface of the countersunk heads and the top of the cylindrical heads must be flush with the surface of the side member, for screws installed perpendicular to wood side members. Side member thickness requirements given in this report apply to the wood dimension below the top of the screw head.

**4.2.2 End Distance, Edge Distance and Spacing:** Unless otherwise noted, minimum wood member end distances, edge distances and spacing of the screws must be sufficient to prevent splitting of the wood, or as required by [Table 7](#), whichever is greater. When the screws are used in SCL, the minimum screw end and edge distances and spacing must be in accordance with [Table 7](#) or in accordance with the ICC-ES evaluation report on the SCL, whichever is more restrictive.

Unless otherwise noted, steel plate edge and end distance must be a minimum of 1.5 times the diameter of the screw and spacing between screws in a row and between rows of screws must be a minimum of 3 times the diameter of the screw. For slotted holes, the minimum edge distance must be measured from the end of the slot.

Spacing, edge distance and end distance for the connections addressed in Section 4.1.11 must be in accordance with [Table 8](#).

**4.2.3 Pilot Holes and Predrilled Holes:** Typical installation of SWG ASSYplus VG and VG 4 screws does not require predrilled holes through the entire thickness of the wood member. Use of minimum 1-inch-long (25.4 mm) pilot holes to reduce splitting is recommended by the manufacturer for certain situations, including the following conditions:

1. For species which are prone to splitting, including fir, Douglas fir and spruce.
2. For lumber with thickness  $\leq 1\frac{1}{2}$  inches (35 mm).
3. For laterally loaded screws installed in lumber with a thickness  $\leq 7D$  ( $\leq 14D$  for fir, Douglas fir and spruce).
4. For axially loaded screws installed in lumber with a thickness  $\leq 10D$  and/or a width of less than  $8D$  or  $2\frac{3}{8}$  inches (60 mm), whichever is greater.
5. For  $\frac{9}{16}$  inch (14 mm) screws.

Contact MTC Solutions for additional guidance. For recommended sizes of pilot holes, see [Table 6](#).

**4.2.4 Three-member Connections:** Opposing screws installed through the side members with their respective axes perpendicular to one another must be offset from each other a minimum of  $1.5D$ , to allow them to overlap. It is recommended that opposing screws overlap a minimum of  $4D$  measured along the axis of the screws, to minimize cross-grain tension effects.

## 5.0 CONDITIONS OF USE:

The SWG ASSYplus VG and VG 4 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 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.
- 5.2 Connection geometry for inclined fastening must be justified to the satisfaction of the code official, including the minimum required wood thickness between crossing fasteners.
- 5.3 SWG ASSYplus VG and VG 4 screws have only been evaluated for use in dry service conditions. Use in wet service conditions is outside the scope of this report.
- 5.4 Use of the screws in contact with preservative-treated or fire-retardant-treated wood is outside the scope of this report.
- 5.5 ASSYplus VG and VG 4 screws are manufactured under a quality control program with inspections by ICC-ES.

## 6.0 EVIDENCE SUBMITTED

Data in accordance with the [ICC-ES Acceptance Criteria for Dowel-type Threaded Fasteners Used in Wood \(AC233\)](#), dated June 2023, including data in accordance with Sub-Annex CA to AC233.

## 7.0 IDENTIFICATION

- 7.1 The ICC-ES mark of conformity, electronic labeling, or the evaluation report number (ICC-ES ESR-3178) along with the name, registered trademark, or registered logo of the report holder must be included in the product label.
- 7.2 In addition, packages of screws are identified with the product name (ASSYplus VG or ASSYplus VG 4); head type and drive size; and the screw diameter and length (in both inches and millimeters) Individual SWG ASSYplus VG and VG 4 screws are identified in the field by their unique configurations. In addition, the countersunk and hex washer screw heads are marked with the letters "ASSY," as shown in [Figures 2, 3 and 5](#).

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

**SCHRAUBENWERK GAISBACH GmbH (SWG)**  
**AM BAHNHOF 50**  
**D-74638 WALDENBURG**  
**GERMANY**  
**+49 7942-9472-0**  
[info@swg-produktion.de](mailto:info@swg-produktion.de)  
[www.swg-produktion.de](http://www.swg-produktion.de)

- 7.4 The technical support company and official supplier contact information is the following:

**MASS TIMBER CONNECTIONS (MTC) SOLUTIONS INC.**  
**(866) 899-4090**  
[info@mtcsolutions.com](mailto:info@mtcsolutions.com)  
[www.mtcsolutions.com](http://www.mtcsolutions.com)

TABLE 1A—FASTENER SPECIFICATIONS AND STRENGTHS—SWG ASSYPLUS VG SCREWS

| $D_{nom}$<br>(inch) | HEAD<br>STYLE | $D$<br>(inch) | $D_r$<br>(inch) | $D_H$<br>(inch)       | DRIVE TYPE<br>AND SIZE | $L^1$<br>(inch)  | $L_{un}$<br>(inch) | $L_{tip}$<br>(inch) | $F_{yb,spec}^2$<br>(psi) | ALLOWABLE<br>FASTENER<br>STRENGTH<br>(ASD) |                          | DESIGN<br>FASTENER<br>STRENGTH<br>(LRFD) |                          |
|---------------------|---------------|---------------|-----------------|-----------------------|------------------------|------------------|--------------------|---------------------|--------------------------|--|--------------------------|--|--------------------------|
|                     |               |               |                 |                       |                        |                  |                    |                     |                          | Tension,<br>$N_a$<br>(lbf)                 | Shear,<br>$V_a$<br>(lbf) | Tension,<br>$N_u$<br>(lbf)               | Shear,<br>$V_u$<br>(lbf) |
| 1/4                 | Cylindrical   | 0.236         | 0.150           | 0.317                 | AW 30                  | 3 1/2 to 4 3/4   | 0.394              | 0.236               | 129,200                  | 1165                                       | 590                      | 1750                                     | 885                      |
|                     |               |               |                 |                       |                        | 5 1/2 to 10 1/4  | 0.472              |                     |                          |  |                          |  |                          |
| 5/16                | Cylindrical   | 0.315         | 0.197           | 0.390                 | AW 40                  | 3 7/8 to 11      | 0.551              | 0.315               | 150,000                  | 1775                                       | 1105                     | 2665                                     | 1660                     |
|                     |               |               |                 |                       |                        | 11 3/4 to 17 3/4 | 0.590              |                     |                          |  |                          |  |                          |
|                     |               |               |                 |                       |                        | 18 7/8 to 23 5/8 | 0.787              |                     |                          |  |                          |  |                          |
|                     | Countersunk   | 0.315         | 0.197           | 0.583                 | AW 40                  | 3 7/8 to 11      | 0.551              | 0.315               | 150,000                  | 1775                                       | 1105                     | 2665                                     | 1660                     |
|                     |               |               |                 |                       |                        | 11 3/4 to 17 3/4 | 0.590              |                     |                          |  |                          |  |                          |
|                     |               |               |                 |                       |                        | 18 7/8 to 23 5/8 | 0.787              |                     |                          |  |                          |  |                          |
| 3/8                 | Cylindrical   | 0.394         | 0.244           | 0.528                 | AW 50                  | 4 3/4 to 17 3/4  | 0.709              | 0.394               | 160,000                  | 2550                                       | 1835                     | 3825                                     | 2755                     |
|                     |               |               |                 |                       |                        | 18 7/8 to 31 1/2 | 0.905              |                     |                          |  |                          |  |                          |
|                     | Countersunk   | 0.394         | 0.244           | 0.772                 | AW 50                  | 4 3/4 to 17 3/4  | 0.709              | 0.394               | 160,000                  | 2550                                       | 1835                     | 3825                                     | 2755                     |
|                     |               |               |                 |                       |                        | 18 7/8 to 31 1/2 | 0.905              |                     |                          |  |                          |  |                          |
| 1/2                 | Cylindrical   | 0.472         | 0.280           | 0.559                 | AW 50                  | 5 1/2 to 9 1/2   | 0.827              | 0.472               | 166,300                  | 3470                                       | 2095                     | 5205                                     | 3145                     |
|                     |               |               |                 |                       |                        | 12 1/4 to 23 5/8 | 1.024              |                     |                          |  |                          |  |                          |
|                     | Countersunk   | 0.472         | 0.280           | 0.868                 | AW 50                  | 5 1/2 to 9 1/2   | 0.827              | 0.472               | 166,300                  | 3470                                       | 2095                     | 5205                                     | 3145                     |
|                     |               |               |                 |                       |                        | 12 1/4 to 23 5/8 | 1.024              |                     |                          |  |                          |  |                          |
| 9/16                | Reverse       | 0.551         | 0.335           | 0.709                 | TX E12                 | 4 3/4 to 7 7/8   | 0.699              | 0.551               | 181,300                  | 5135                                       | 3200                     | 7700                                     | 4800                     |
|                     |               |               |                 |                       |                        | 8 1/4 to 59      | 0.866              |                     |                          |  |                          |  |                          |
|                     | Hex Washer    | 0.551         | 0.335           | 0.846<br>Across flats | AW 50                  | 4 3/4 to 7 7/8   | 0.699              | 0.551               | 181,300                  | 5135                                       | 3200                     | 7700                                     | 4800                     |
|                     |               |               |                 |                       |                        | 8 1/4 to 59      | 0.866              |                     |                          |  |                          |  |                          |

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

<sup>1</sup>Overall fastener length is measured from top of head to bottom of tip.

<sup>2</sup>Bending yield strength determined in accordance with ASTM F1575 using the root diameter.



TABLE 1B—FASTENER SPECIFICATIONS AND STRENGTHS—SWG ASSYPLUS VG 4 SCREWS

| $D_{nom}$<br>(inch) | HEAD<br>STYLE                          | $D$<br>(inch) | $D_r$<br>(inch) | $D_H$<br>(inch)       | DRIVE TYPE<br>AND SIZE | $L^1$<br>(inch)  | $L_{un}$<br>(inch) | $L_{tip}$<br>(inch) | $F_{yb,spec}^2$<br>(psi) | ALLOWABLE<br>FASTENER<br>STRENGTH<br>(ASD) |                          | DESIGN<br>FASTENER<br>STRENGTH<br>(LRFD) |                          |
|---------------------|--|---------------|-----------------|-----------------------|------------------------|------------------|--------------------|---------------------|--------------------------|--|--------------------------|--|--------------------------|
|                     |  |               |                 |                       |                        |                  |                    |                     |                          | Tension,<br>$N_a$<br>(lbf)                 | Shear,<br>$V_a$<br>(lbf) | Tension,<br>$N_u$<br>(lbf)               | Shear,<br>$V_u$<br>(lbf) |
| 1/4                 | Cylindrical                            | 0.236         | 0.150           | 0.317                 | RW 30                  | 2 3/4 to 4 3/4   | 0.394              | 0.236               | 129,200                  | 1165                                       | 590                      | 1750                                     | 885                      |
|                     |  |               |                 |                       |                        | 5 1/2 to 10 1/4  | 0.472              |                     |                          |  |                          |  |                          |
| 5/16                | Cylindrical                            | 0.315         | 0.197           | 0.390                 | RW 40                  | 3 1/8 to 11      | 0.551              | 0.315               | 150,000                  | 1775                                       | 1105                     | 2665                                     | 1660                     |
|                     |  |               |                 |                       |                        | 11 3/4 to 17 3/4 | 0.590              |                     |                          |  |                          |  |                          |
|                     |  |               |                 |                       |                        | 18 7/8 to 23 5/8 | 0.787              |                     |                          |  |                          |  |                          |
|                     | Countersunk<br>with milling<br>pockets | 0.315         | 0.197           | 0.583                 | RW 40                  | 3 1/8 to 11      | 0.551              | 0.315               |                          |  |                          |  |                          |
|                     |  |               |                 |                       |                        | 11 3/4 to 17 3/4 | 0.590              |                     |                          |  |                          |  |                          |
|                     |  |               |                 |                       |                        | 18 7/8 to 23 5/8 | 0.787              |                     |                          |  |                          |  |                          |
| 3/8                 | Cylindrical                            | 0.394         | 0.244           | 0.528                 | RW 50                  | 3 7/8 to 17 3/4  | 0.709              | 0.394               | 160,000                  | 2550                                       | 1835                     | 3825                                     | 2755                     |
|                     |  |               |                 |                       |                        | 18 7/8 to 31 1/2 | 0.905              |                     |                          |  |                          |  |                          |
|                     | Countersunk<br>(no milling<br>pockets) | 0.394         | 0.244           | 0.774                 | RW 50                  | 3 7/8 to 17 3/4  | 0.709              | 0.394               |                          |  |                          |  |                          |
|                     |  |               |                 |                       |                        | 18 7/8 to 31 1/2 | 0.905              |                     |                          |  |                          |  |                          |
| 1/2                 | Cylindrical                            | 0.472         | 0.280           | 0.559                 | RW 50                  | 4 3/4 to 9 1/2   | 0.827              | 0.472               | 166,300                  | 3470                                       | 2095                     | 5205                                     | 3145                     |
|                     |  |               |                 |                       |                        | 10 1/4 to 23 5/8 | 1.024              |                     |                          |  |                          |  |                          |
|                     | Countersunk<br>with milling<br>pockets | 0.472         | 0.280           | 0.868                 | RW 50                  | 4 3/4 to 9 1/2   | 0.827              | 0.472               |                          |  |                          |  |                          |
|                     |  |               |                 |                       |                        | 10 1/4 to 23 5/8 | 1.024              |                     |                          |  |                          |  |                          |
| 9/16                | Reverse                                | 0.551         | 0.335           | 0.709                 | TX E12                 | 4 3/4 to 7 7/8   | 0.699              | 0.551               | 181,300                  | 5135                                       | 3200                     | 7700                                     | 4800                     |
|                     |  |               |                 |                       |                        | 8 1/4 to 59      | 0.866              |                     |                          |  |                          |  |                          |
|                     | Hex Washer                             | 0.551         | 0.335           | 0.846<br>Across flats | RW 50                  | 4 3/4 to 7 7/8   | 0.699              | 0.551               |                          |  |                          |  |                          |
|                     |  |               |                 |                       |                        | 8 1/4 to 59      | 0.866              |                     |                          |  |                          |  |                          |

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

<sup>1</sup>For countersunk and cylindrical head screws, the overall fastener length is measured from top of head to bottom of tip. For the reverse head and hex washer head screws, the overall fastener length is measured from the underside of the integral washer to the bottom of the tip.

<sup>2</sup>Bending yield strength determined in accordance with ASTM F1575 using the root diameter.

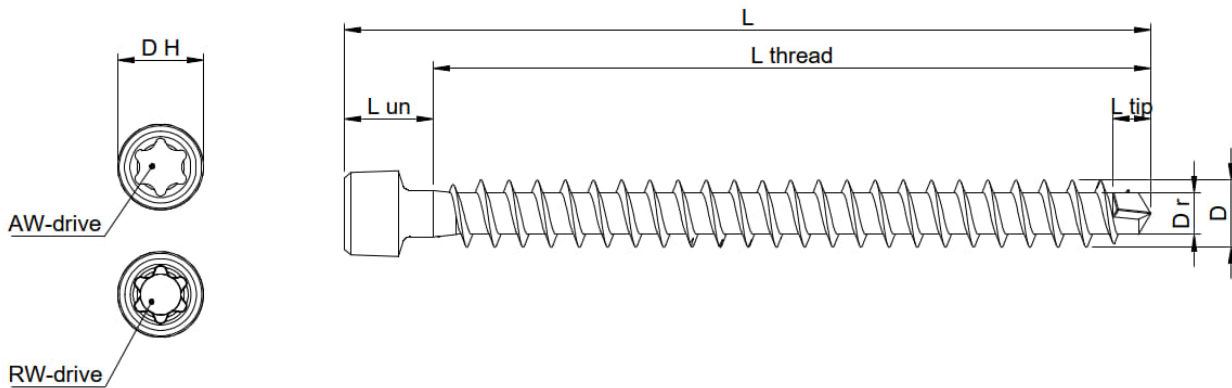


FIGURE 1 --- ASSYplus VG and ASSYplus VG 4 SCREW WITH CYLINDRICAL HEAD

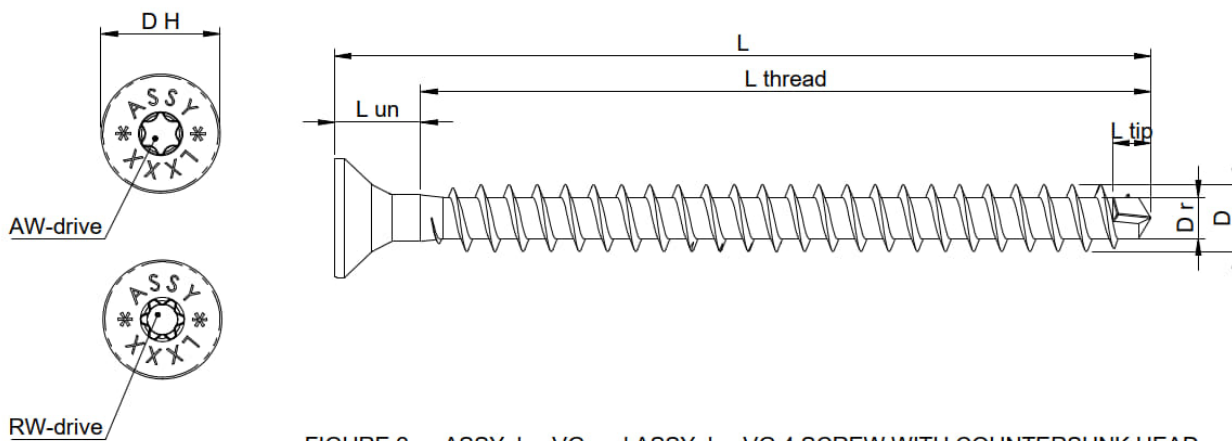


FIGURE 2 --- ASSYplus VG and ASSYplus VG 4 SCREW WITH COUNTERSUNK HEAD

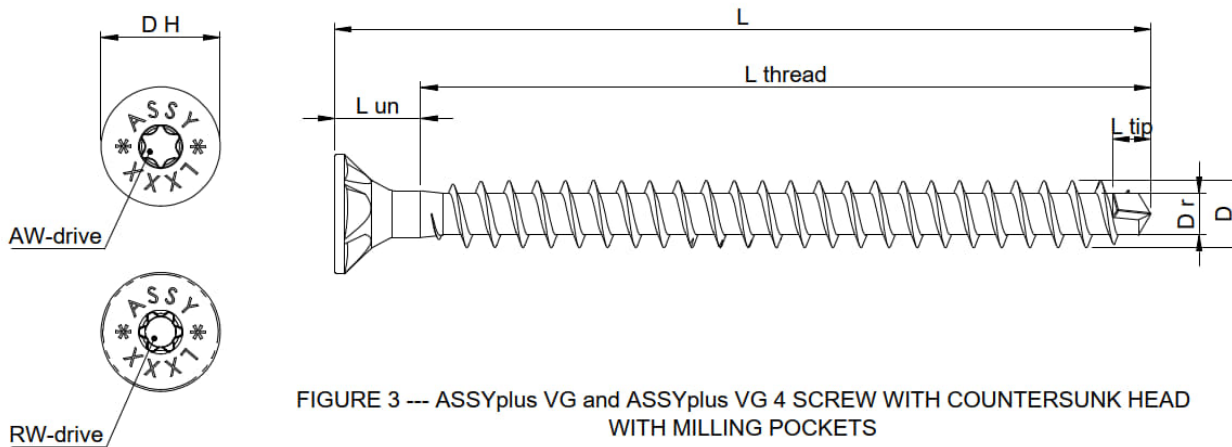


FIGURE 3 --- ASSYplus VG and ASSYplus VG 4 SCREW WITH COUNTERSUNK HEAD WITH MILLING POCKETS

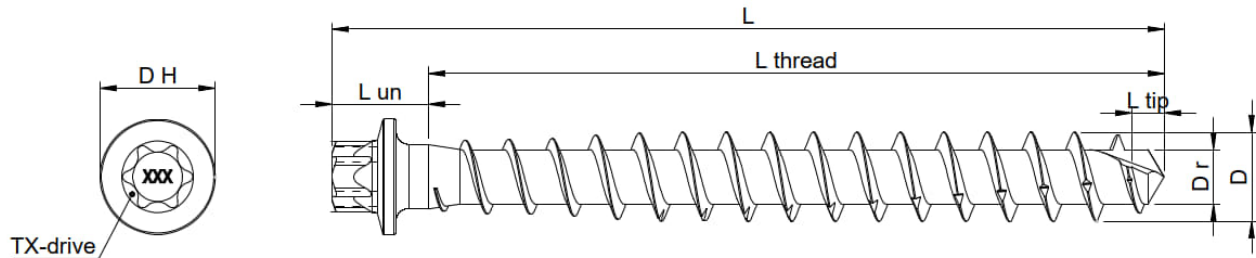


FIGURE 4 - ASSYPLUS VG AND ASSYPLUS VG 4 SCREW WITH REVERSE HEAD

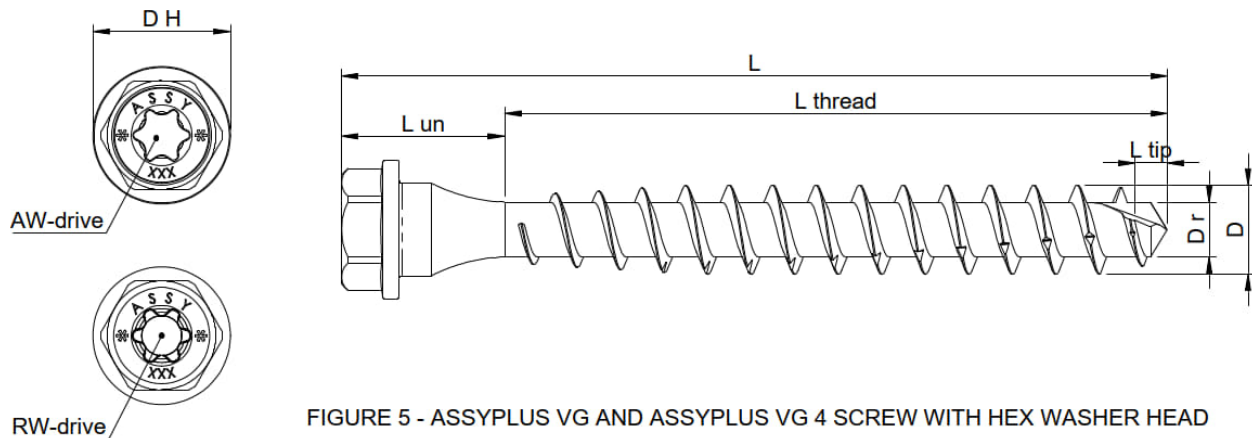


FIGURE 5 - ASSYPLUS VG AND ASSYPLUS VG 4 SCREW WITH HEX WASHER HEAD

TABLE 2—REFERENCE WITHDRAWAL DESIGN VALUES (*W*)<sup>1,2,3</sup>

| <i>D<sub>nom</sub></i><br>(inch) | <i>L<sub>emb,w</sub></i> | <i>W</i> FOR SELECTED <i>SG<sub>NDS</sub></i> AND <i>SG<sub>eq</sub></i> VALUES (lbf/in): |      |      |      |                  |
|----------------------------------|--------------------------|---|------|------|------|------------------|
|                                  |                          | Faces of Sawn Lumber, Glulam and CLT Panels   |      |      |      | PSL <sup>4</sup> |
|                                  |                          | 0.55  | 0.49 | 0.42 | 0.35 | 0.50             |
| 1/4                              | See Note 2               | 230   | 202  | 169  | 137  | 156              |
| 5/16                             |                          | 279   | 248  | 212  | 176  | 179              |
| 3/8                              |                          | 317   | 280  | 237  | 188  | 211              |
| 1/2                              |                          | 331   | 297  | 251  | 209  | 223              |
| 9/16                             |                          | 430   | 347  | 300  | —    | —                |

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

<sup>1</sup>Tabulated values are for screws installed perpendicular to the face of the wood.

<sup>2</sup>Member penetration must be at least 8 times the nominal diameter.

<sup>3</sup>Reference withdrawal design values are to be multiplied by the embedded thread length in the member, not including the tip.

<sup>4</sup>Tabulated values also apply to installation at 45 degrees to the grain.

TABLE 3—REFERENCE HEAD PULL-THROUGH DESIGN VALUES ( $W_H$ )<sup>1,2</sup>

| $D_{nom}$<br>(inch) | HEAD<br>TYPE                                  | MINIMUM $t_{s,w}$<br>(inches) | $W_H$ FOR SELECTED $SG_{NDS}$ AND $SG_{eq}$ VALUES (lbf): |      |      |      |      |
|---------------------|---|-------------------------------|---|------|------|------|------|
|                     |   |                               | Sawn Lumber, Glulam and Faces of CLT Panels               |      |      |      | PSL  |
|                     |   |                               | 0.55  | 0.49 | 0.42 | 0.35 | 0.50 |
| $5/16$              | Countersunk,<br>Countersunk<br>Milling Pocket | $1\ 3/8$                      | 414   | 350  | 281  | 216  | 398  |
| $3/8$               | Countersunk,<br>Countersunk<br>Milling Pocket |                               | 474   | 408  | 334  | 266  | 491  |
| $1/2$               | Countersunk,<br>Countersunk<br>Milling Pocket |                               | 474   | 408  | 334  | 266  | 491  |

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

<sup>1</sup>Tabulated head pull-through design values,  $W_H$ , are applicable to screws installed with  $90^\circ \geq \alpha \geq 30^\circ$

<sup>2</sup>See Section 4.1.5 for pull-through design for thicker side members.

TABLE 4—REFERENCE LATERAL DESIGN VALUES (Z) FOR SINGLE SHEAR (TWO-MEMBER) WOOD-TO-WOOD CONNECTIONS DESIGNED IN ACCORDANCE WITH THE NDS<sup>1,2,3,4,5,6</sup>

| FASTENER<br>DESIGNATION <sup>1</sup> | $t_{s,w}$ (inches) | $L_{emb,l}$ (inches) | REFERENCE LATERAL DESIGN VALUE (Z) FOR SELECTED $SG_{NDS}$<br>VALUES (lbf): |                |             |          |                |             |          |                |             |
|--------------------------------------|--------------------|----------------------|---|----------------|-------------|----------|----------------|-------------|----------|----------------|-------------|
|                                      |                    |                      | 0.42  |                |             | 0.49     |                |             | 0.55     |                |             |
|                                      |                    |                      | $Z_{  }$  | $Z_{\perp/  }$ | $Z_{\perp}$ | $Z_{  }$ | $Z_{\perp/  }$ | $Z_{\perp}$ | $Z_{  }$ | $Z_{\perp/  }$ | $Z_{\perp}$ |
| $1/4"$ x $4"$                        | 2                  | $1\ 3/4$             | 123   | 123            | 123         | 142      | 142            | 142         | 158      | 158            | 158         |
| $1/4"$ x $5\ 1/2"$                   | $2\ 3/4$           | $2\ 1/2$             | 123   | 123            | 123         | 142      | 142            | 142         | 158      | 158            | 158         |
| $1/4"$ x $6\ 1/4"$                   | $3\ 1/2$           | $2\ 1/2$             | 123   | 123            | 123         | 142      | 142            | 142         | 158      | 158            | 158         |
| $5/16"$ x $4\ 3/4"$                  | 2                  | $2\ 7/16$            | 194   | 155            | 155         | 223      | 179            | 179         | 248      | 199            | 199         |
| $5/16"$ x $5\ 1/2"$                  | $2\ 3/4$           | $2\ 7/16$            | 194   | 155            | 155         | 223      | 179            | 179         | 248      | 199            | 199         |
| $5/16"$ x $6\ 1/4"$                  | $3\ 1/2$           | $2\ 7/16$            | 194   | 155            | 155         | 223      | 179            | 179         | 248      | 199            | 199         |
| $3/8"$ x $5\ 1/2"$                   | 2                  | $3\ 1/8$             | 239   | 191            | 191         | 289      | 231            | 231         | 321      | 257            | 257         |
| $3/8"$ x $5\ 1/2"$                   | $2\ 3/4$           | $2\ 3/8$             | 251   | 201            | 201         | 289      | 231            | 231         | 321      | 257            | 257         |
| $3/8"$ x $6\ 1/4"$                   | $2\ 3/4$           | $3\ 1/8$             | 251   | 201            | 201         | 289      | 231            | 231         | 321      | 257            | 257         |
| $1/2"$ x $7\ 1/8"$                   | $3\ 1/2$           | $3\ 1/8$             | 396   | 287            | 264         | 427      | 316            | 295         | 453      | 340            | 321         |
| $1/2"$ x $7\ 7/8"$                   | $3\ 1/2$           | $3\ 7/8$             | 396   | 287            | 264         | 427      | 316            | 295         | 453      | 340            | 321         |
| $1/2"$ x $7\ 7/8"$                   | 4                  | $3\ 3/8$             | 396   | 287            | 264         | 427      | 316            | 295         | 453      | 340            | 321         |

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

<sup>1</sup>Fastener length shown is a minimum. Tabulated values may be applied to longer fasteners, with greater penetration into the main and/or side member.

<sup>2</sup>Tabulated reference lateral design values, Z, apply to screws driven into the side grain of the main member or face of engineered wood products, such that the screws are oriented perpendicular to the grain and loaded as follows:

$Z_{||}$  : Both side and main members loaded parallel to grain.

$Z_{\perp/||}$  : Side member loaded perpendicular to grain; main member loaded parallel to grain

$Z_{\perp}$  : Both side and main members loaded perpendicular to grain.

<sup>3</sup>Reference lateral design values must be multiplied by all adjustment factors applicable to wood screws, in accordance with the NDS.

<sup>4</sup>SWG ASSYplus VG and VG 4 screws must be installed and used in dry in-service conditions, such that the wet service factor,  $C_m$ , is 1.0 in accordance with the NDS.

<sup>5</sup>The specific gravity used for design purposes must be the assigned specific gravity for sawn lumber per Table 12.3.3.A of the NDS (Table 11.3.3A of the NDS for the 2012 IBC) or the applicable Specific Gravity for Fastener Design for glulam, given in Section 5 of the NDS Supplement; or the equivalent specific gravity given in the applicable ICC-ES evaluation report on the PSL or LVL product.

<sup>6</sup>Connection configurations not addressed in the table may be designed in accordance with Section 4.1.6.

**TABLE 5—REFERENCE LATERAL DESIGN VALUES (Z) FOR SINGLE SHEAR (TWO-MEMBER) STEEL-TO-WOOD CONNECTIONS BASED ON TESTING**

| SCREW TYPE       | SCREW SIZE <sup>1</sup><br>(inches) | $t_{s,s}$ <sup>2</sup> | REFERENCE LATERAL DESIGN VALUE, (Z)<br>FOR SELECTED $SG_{NDS}$ VALUES (lbf): <sup>3,4</sup> |           |
|------------------|-------------------------------------|------------------------|---|-----------|
|                  |                                     |                        | 0.50  |           |
|                  |                                     |                        | $Z_{\perp}$   | $Z_{end}$ |
| ASSY plus VG CSK | $5/16 \times 3\ 1/8$                | 0.200 inch<br>(5 mm)   | 575   | --        |
|                  | $5/16 \times 6\ 1/4$                |                        | 575   | 555       |
|                  | $3/8 \times 4$                      |                        | 895   | --        |
|                  | $3/8 \times 7\ 7/8$                 |                        | 895   | 895       |

For **SI**: 1 inch = 25.4 mm, 1 lbf = 4.45 N, 1 ksi = 6.89 MPa.

<sup>1</sup>Fastener length shown is a minimum. Tabulated values may be applied to longer fasteners, with greater penetration into the main member.

<sup>2</sup>Steel plates must have a minimum specified yield strength of 37 ksi and a minimum tensile strength of 50 ksi. Holes in the steel side plates must be standard round holes with a diameter of 9 mm for the  $5/16$ -inch screws and 11 mm for the  $3/8$ -inch screws.

<sup>3</sup>Tabulated reference lateral design values, Z, apply as follows:

$Z_{\perp}$  : Screws installed into the side grain of the wood member and loaded perpendicular to grain.

$Z_{end}$  : Screws installed into end grain of the wood member and loaded laterally.

<sup>4</sup>Tabulated values apply to connections with at least two screws spaced a minimum of 5D.

**TABLE 6—RECOMMENDED DIAMETER OF PREDRILLED HOLES AND PILOT HOLES IN WOOD<sup>1</sup>**

| NOMINAL FASTENER DIAMETER<br>(inch) | RECOMMENDED PREDRILLED HOLE AND PILOT HOLE DIAMETER (inch) |
|-------------------------------------|--|
| $1/4$                               | $5/32$   |
| $5/16$                              | $3/16$   |
| $3/8$                               | $1/4$  |
| $1/2$                               | $17/64$  |
| $9/16$                              | $5/16$   |

For **SI**: 1 inch = 25.4 mm.

**TABLE 7—CONNECTION GEOMETRY REQUIREMENTS FOR FASTENERS INSTALLED PERPENDICULAR TO THE FACE OF WOOD MEMBERS AND INCLINED FASTENERS<sup>1,2,3</sup>**

| CONDITION  |  | MINIMUM DISTANCE OR SPACING<br>Self-drilled or Predrilled <sup>4</sup> |                              |
|--|--|--|------------------------------|
|  |  | $D_{nom} \leq \frac{3}{8}$ inch  | $D_{nom} > \frac{3}{8}$ inch |
| End distance<br>(see <a href="#">Figures 6</a> and <a href="#">8</a> )   | Loading toward end, $a_{end,1}$                              | 12D  | 7D                           |
|  | Loading perpendicular to grain or away from end, $a_{end,2}$ | 7D   | 4D                           |
|  | Axial loading, $a_{end,2}$                                   | 7D   | 4D                           |
|  | Inclined fastener, $a_{end,CG}$                              |  |                              |
| Edge distance<br>(see <a href="#">Figures 6</a> and <a href="#">8</a> )  | Loading toward edge, $a_{edge,1}$                            | 7D   | 4D                           |
|  | Loading parallel to grain or away from edge, $a_{edge,2}$    | 3D   | 3D                           |
|  | Axial Loading, $a_{edge,2}$                                  | 3D   | 3D                           |
|  | Inclined fastener, $a_{edge,CG}$                             |  |                              |
| Spacing between fasteners<br>parallel to grain<br>(see <a href="#">Figures 7</a> and <a href="#">8</a> )       | Loading parallel to grain, $a_1$                             | 10D  | 5D                           |
|  | Loading perpendicular to grain, $a_1$                        | 5D   | 4D                           |
|  | Axial loading, $a_1$   | 7D   | 5D                           |
|  | Inclined fastener, $a_1$                                     |  |                              |
| Spacing between fasteners,<br>perpendicular to grain<br>(see <a href="#">Figures 7</a> and <a href="#">8</a> ) | Loading parallel to grain, $a_2$                             | 4D   | 5D                           |
|  | Loading perpendicular to grain, $a_2$                        | 4D   | 5D                           |
|  | Axial loading, $a_2$   | 2.5D   | 5D                           |
|  | Inclined fastener, $a_2$                                     |  |                              |
|  | Inclined fastener, crossed screws, $a_{2,cross}$             |  |                              |

For SI: 1 inch = 25.4 mm.

<sup>1</sup>End 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.

<sup>2</sup>Wood 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.

<sup>3</sup>For CLT products, parallel and perpendicular-to-grain descriptions apply to the grain orientation at the shear plane for lateral loading and to the face grain orientation for withdrawal loading.

<sup>4</sup>For the purpose of determining connection geometry requirements, the screws are considered to drill their own "predrilled" hole.

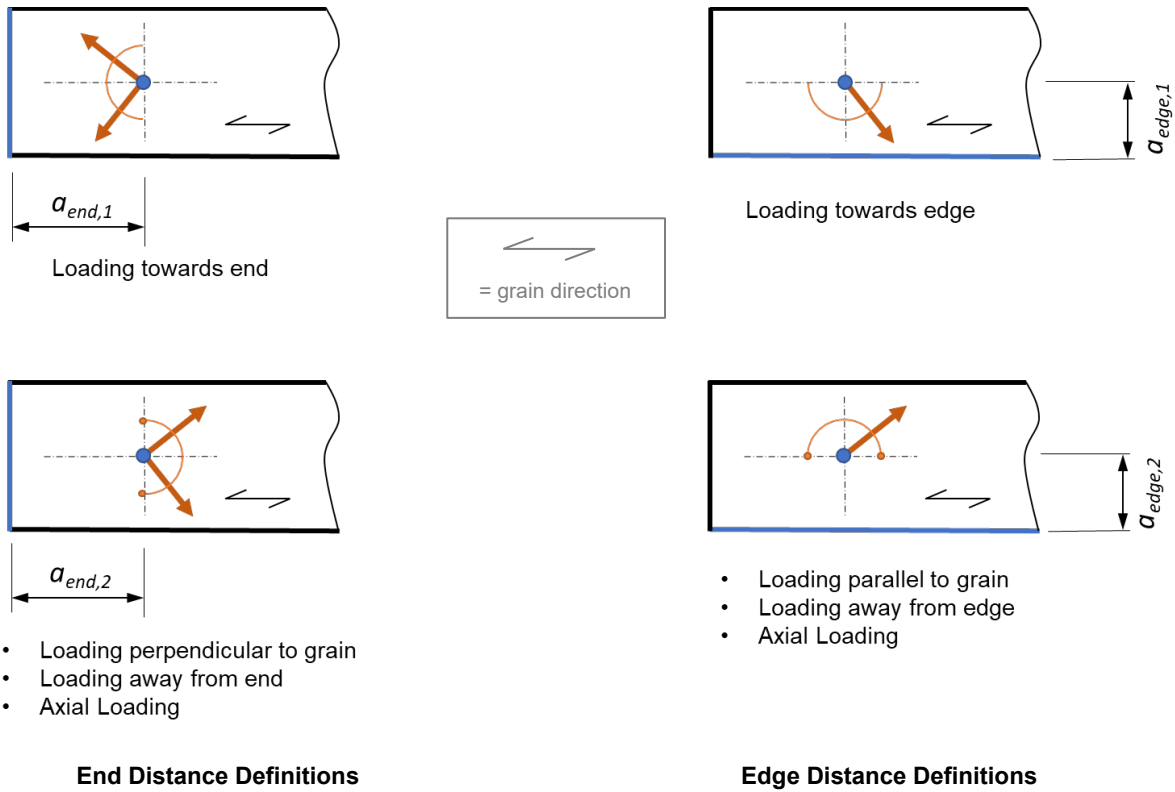


FIGURE 6—END AND EDGE DISTANCE DEFINITIONS FOR SCREWS INSTALLED PERPENDICULAR TO GRAIN

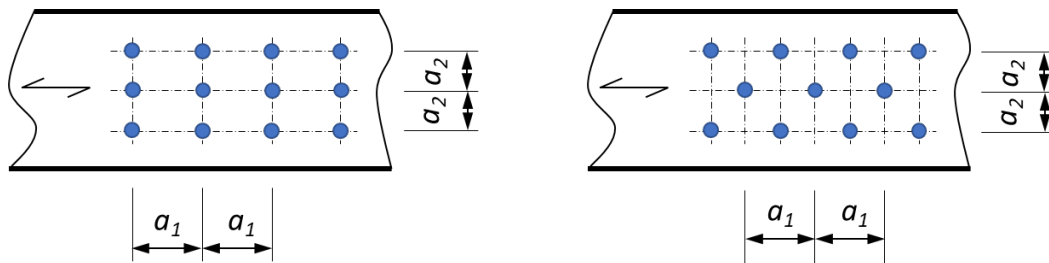


FIGURE 7—SPACING DEFINITIONS FOR SCREWS INSTALLED PERPENDICULAR TO GRAIN

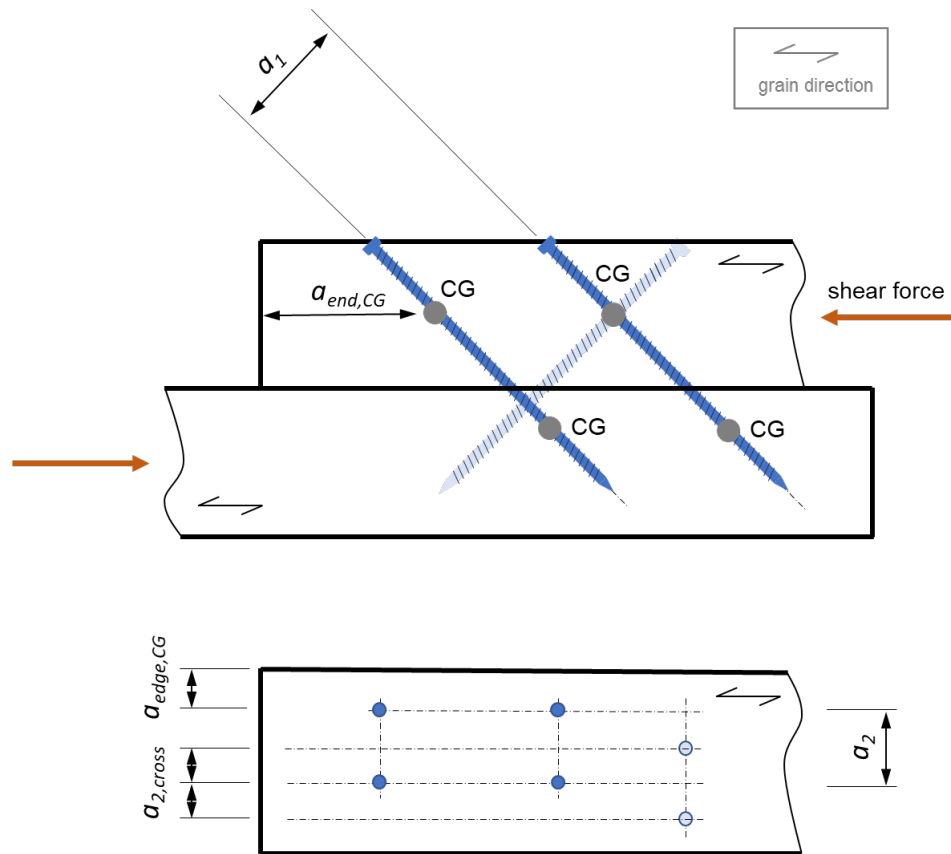


FIGURE 8—SPACING DEFINITIONS FOR INCLINED AND CROSSED SCREWS



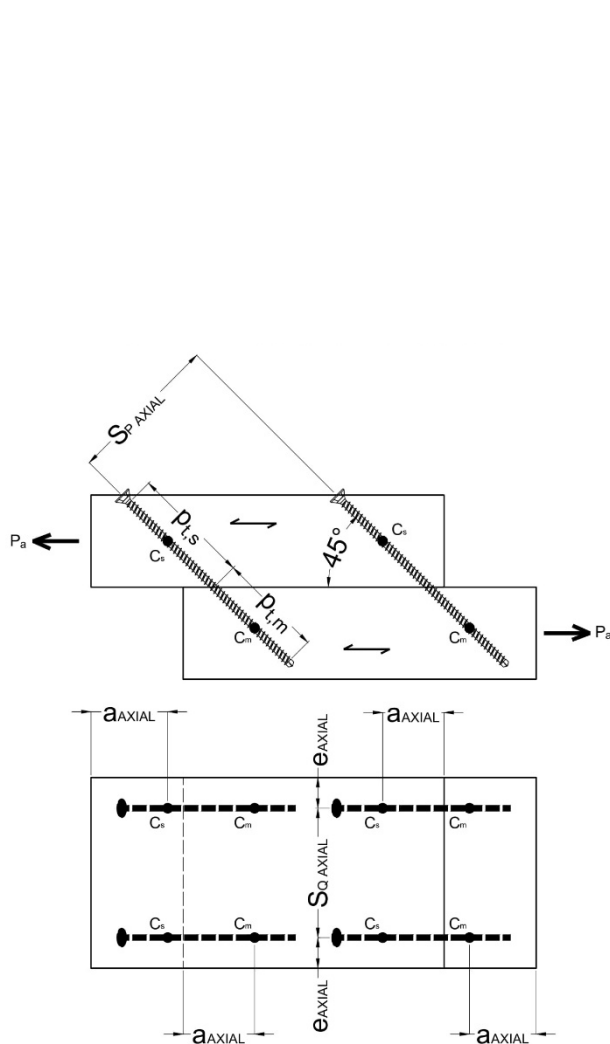
TABLE 8—CONNECTION GEOMETRY REQUIREMENTS FOR CONNECTIONS DESCRIBED IN SECTION 4.1.11<sup>1,2</sup>

| CONDITION  | MINIMUM DIMENSION<br>(in terms of nominal screw diameter, D) |
|--|--|
| End distance, $a_{AXIAL}$ <sup>3</sup>             | 5D (7.5D in D-Fir)   |
| Edge distance, $e_{AXIAL}$                         | 3D   |
| Spacing between fasteners in a row, $S_{P\ AXIAL}$ | 5D (7.5D in D-Fir)   |
| Spacing between rows of fasteners, $S_{Q\ AXIAL}$  | 2.5D   |

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

<sup>2</sup> See Figures 9 and 10.

<sup>3</sup> End distance must also be sufficient to ensure that the screw is fully embedded in the wood member.



Note:  $C_m$  = Center of gravity of the threaded portion of the screw in the main member;  $C_s$  = Center of gravity of the threaded portion of the screw in the side member.

FIGURE 9—CONNECTION GEOMETRY FOR INCLINED SCREWS IN TWO-MEMBER WOOD-TO-WOOD CONNECTION

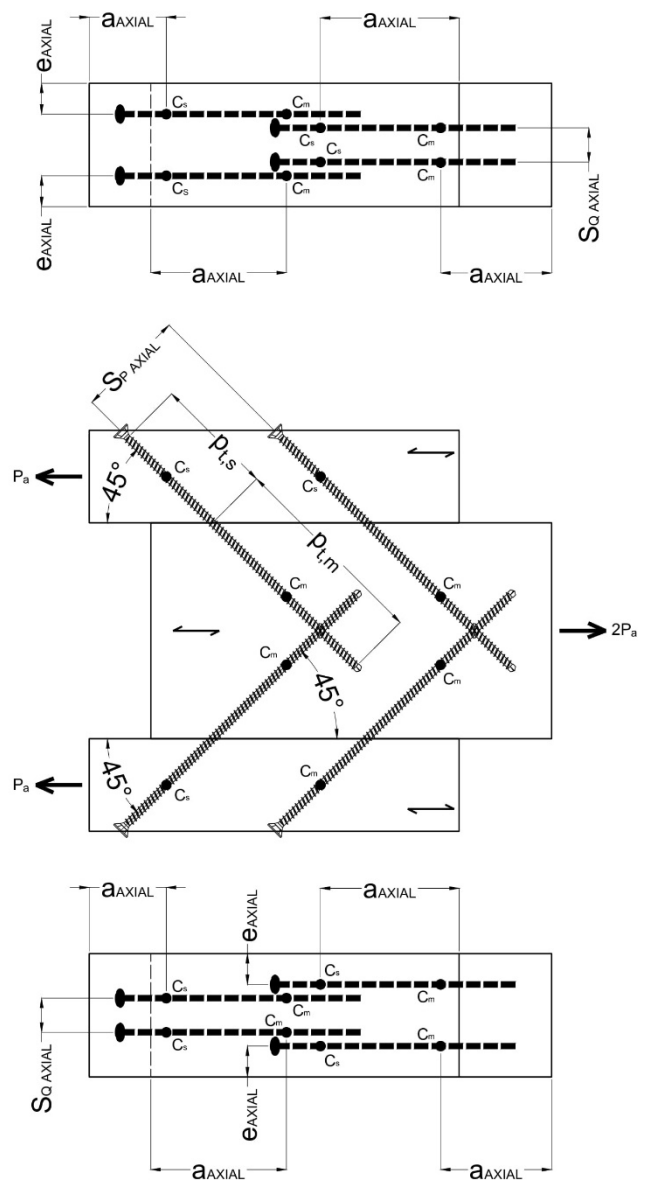
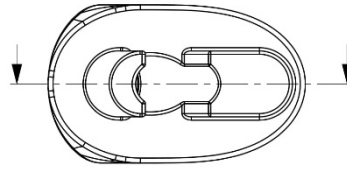
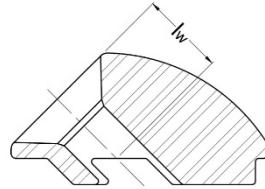


FIGURE 10—CONNECTION GEOMETRY FOR INCLINED SCREWS IN THREE-MEMBER WOOD-TO-WOOD CONNECTION



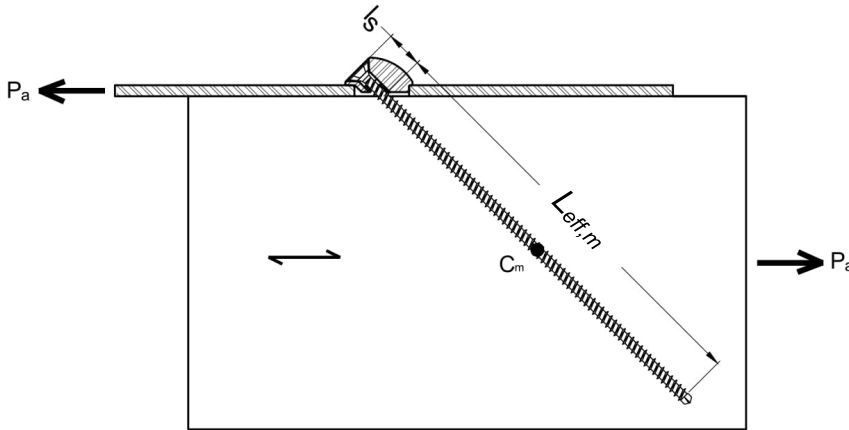
Bottom View



Cross Section

| NOMINAL SCREW DIAMETER (inch) | DIMENSION $l_w$ (inch) |
|-------------------------------|------------------------|
| $\frac{5}{16}$                | 0.500                  |
| $\frac{3}{8}$                 | 0.724                  |
| $\frac{1}{2}$                 | 0.780                  |

FIGURE 11—STEEL WEDGE WASHER



Note: Minimum dimensions for end distance, edge distance and spacing of the screws in the wood member are as shown in [Figure 9](#).

FIGURE 12—CONNECTION GEOMETRY FOR INCLINED SCREWS USED IN STEEL-TO-WOOD CONNECTIONS WITH WEDGE WASHERS