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ICC-ES Evaluation Report
ESR-3178

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DIVISION: 06 00 00—WOOD, PLASTICS AND COMPOSITES
Section: 06 05 23—Wood, Plastic and Composite Fastenings

REPORT HOLDER:

SCHRAUBENWERK GAISBACH GmbH (SWG)

EVALUATION SUBJECT:

SWG ASSYPLUS VG AND VG 4 WOOD-DRILLING SCREWS

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
$F_{yb,spec}$	=	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	=	Dowel bearing length in the main member
L_{tip}	=	Length of tip. See Tables 1A and 1B.
L_{un}	=	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.)
L_w	=	Length of screw in the wedge washer.
N_a	=	Allowable tension strength of the screw for use in ASD
N_u	=	Design tension strength of the screw for use in LRFD
R_α	=	Reduction factor for withdrawal resistance of inclined fasteners (See Section 4.1.4.)
SG_{eq}	=	Structural composite lumber equivalent specific gravity used for connection design
SG_{NDS}	=	Assigned specific gravity for the applicable species combination, glulam or other wood material in accordance with the NDS

$t_{s,w}$ = Thickness of wood side member

$t_{s,s}$ = Thickness of steel side member

t_m = Thickness of wood main member

V_a = Allowable shear strength of the screw for use in ASD

V_u = Design shear strength of the screw for use in LRFD

W = Reference unit withdrawal design value for screws installed perpendicular to face of the wood

W_H = Reference head pull-through design value

Z = Reference lateral design value

$Z_{//}$ = Reference lateral design value for screws loaded parallel to the wood grain

$Z_{\perp}$ = Reference lateral design value for screws loaded perpendicular to the wood grain

Z_{end} = Reference lateral design value for screws installed in end grain and loaded laterally.

α = Angle between the axis of the screw and the grain of the applicable wood member, degrees

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; $1^3/_{16}$ inches (30 mm) for $^5/_{16}$-inch-diameter (8 mm) screws; $1^9/_{16}$ inches (40 mm) for $^3/_8$-inch-diameter (10 mm) screws; $3^3/_{16}$ 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.

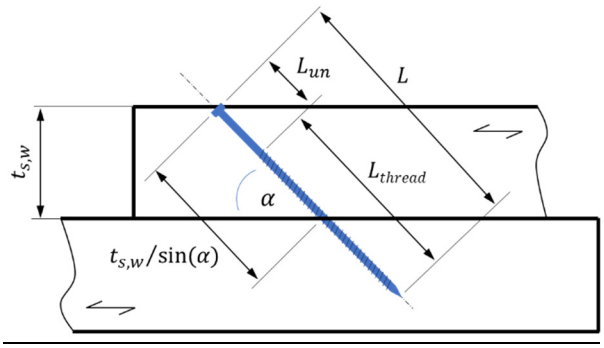
4.0 DESIGN AND INSTALLATION

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 8*D* are shown in Table 2. For inclined fastening, the applicable reduction factor from the following table must be applied:

α	R_α
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° ≥ α ≥ 30°. 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 $1^3/_4$ inches (45 mm).
3. The minimum effective screw penetration into the main member, excluding tip length, must be 6*D*.
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 $^1/_{16}$ 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:

$$L_s = L_w + t_{s,s}/\cos 45°$$

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:

$$P_a = n \cdot W'_m \cdot \cos 45°$$

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:

$$P_a = n \cdot N_a \cdot \cos 45°$$

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° 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:

$$P_a = n \cdot min\begin{bmatrix} W'_s \\ W'_m \end{bmatrix} \cdot \cos 45°$$

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

$$P_a = n \cdot N_a \cdot \cos 45°$$

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 ≤ $1^1/_2$ inches (35 mm).
3. For laterally loaded screws installed in lumber with a thickness ≤ 7D (≤ 14D for fir, Douglas fir and spruce).
4. For axially loaded screws installed in lumber with a thickness ≤ 10D and/or a width of less than 8D or $2^3/_8$ inches (60 mm), whichever is greater.
5. For $^9/_{16}$ 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
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
www.mtcsolutions.com

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

D_{nom} (inch)	HEAD STYLE	D (inch)	D_r (inch)	D_H (inch)	DRIVE TYPE AND SIZE	L[1] (inch)	L_{un} (inch)	L_{tip} (inch)	$F_{yb,spec}$[2] (psi)	ALLOWABLE FASTENER STRENGTH (ASD)		DESIGN FASTENER STRENGTH (LRFD)	
										Tension, N_a (lbf)	Shear, V_a (lbf)	Tension, N_u (lbf)	Shear, V_u (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					
						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					
						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					
						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 Across flats	AW 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.

[1]Overall fastener length is measured from top of head to bottom of tip.

[2]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} (inch)	HEAD STYLE	D (inch)	D_r (inch)	D_H (inch)	DRIVE TYPE AND SIZE	L[1] (inch)	L_{un} (inch)	L_{tip} (inch)	$F_{yb,spec}$[2] (psi)	ALLOWABLE FASTENER STRENGTH (ASD)		DESIGN FASTENER STRENGTH (LRFD)	
										Tension, N_a (lbf)	Shear, V_a (lbf)	Tension, N_u (lbf)	Shear, V_u (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 with milling 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 (no milling 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 with milling 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 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.

[1]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.

[2]Bending yield strength determined in accordance with ASTM F1575 using the root diameter.

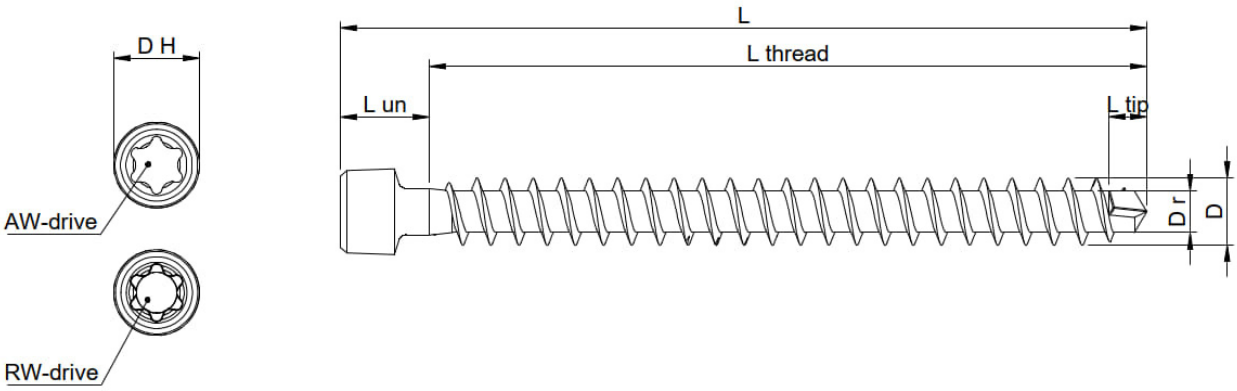


FIGURE 1 --- ASSYplus VG and ASSYplus VG 4 SCREW WITH CYLINDRICAL HEAD

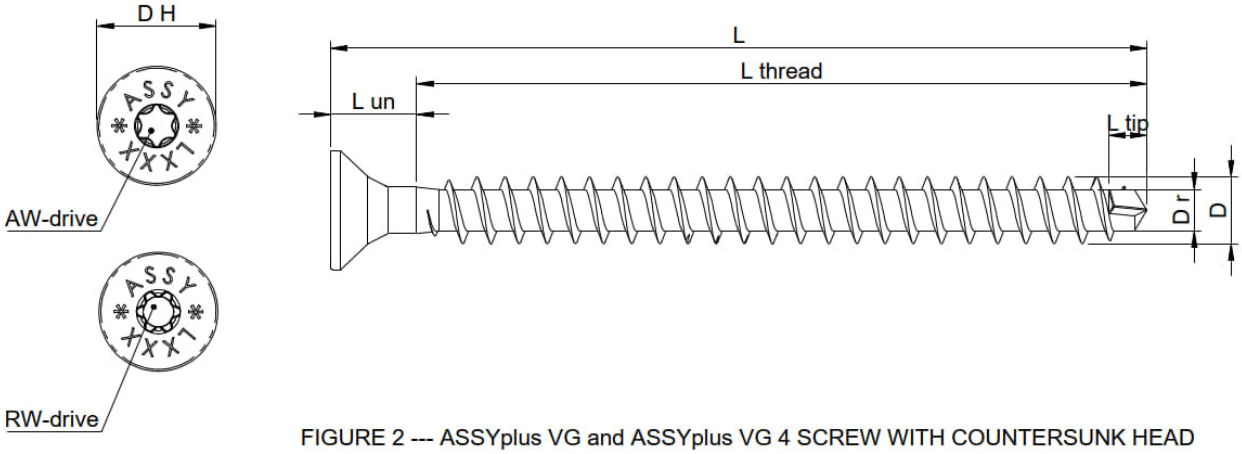


FIGURE 2 --- ASSYplus VG and ASSYplus VG 4 SCREW WITH COUNTERSUNK HEAD

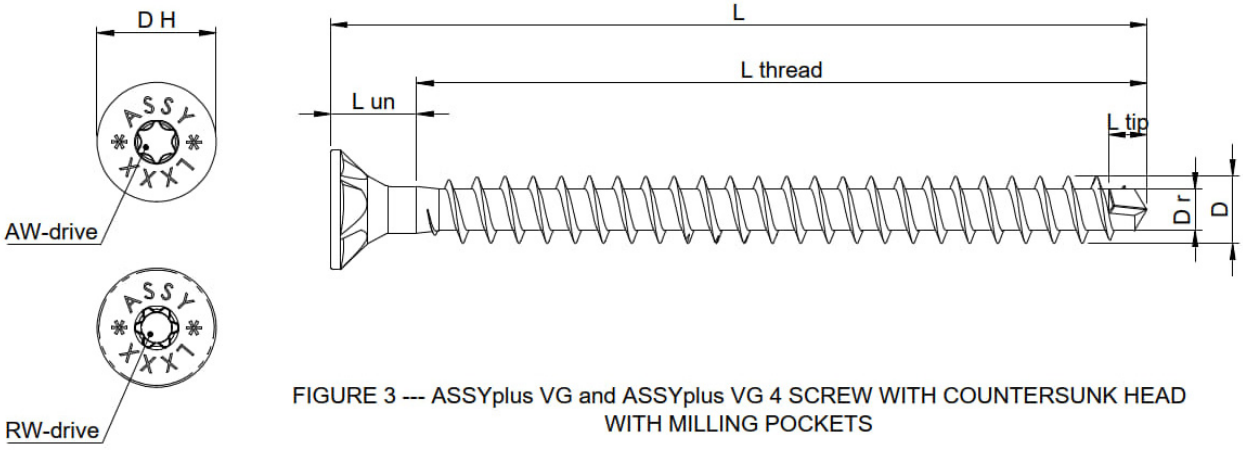


FIGURE 3 --- ASSYplus VG and ASSYplus VG 4 SCREW WITH COUNTERSUNK HEAD WITH MILLING POCKETS

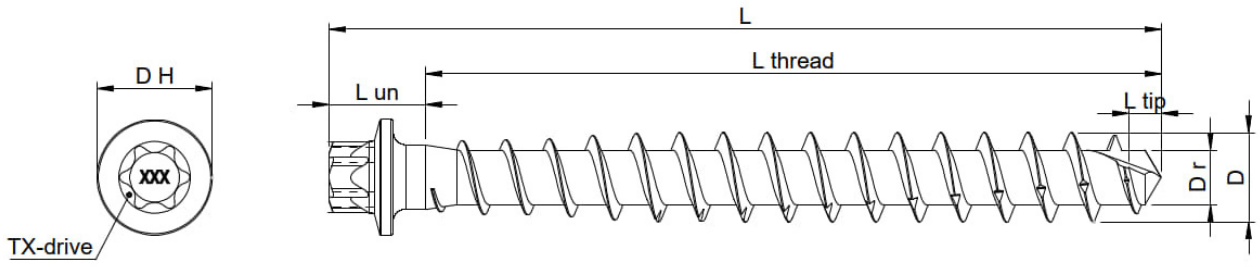


FIGURE 4 - ASSYPLUS VG AND ASSYPLUS VG 4 SCREW WITH REVERSE HEAD

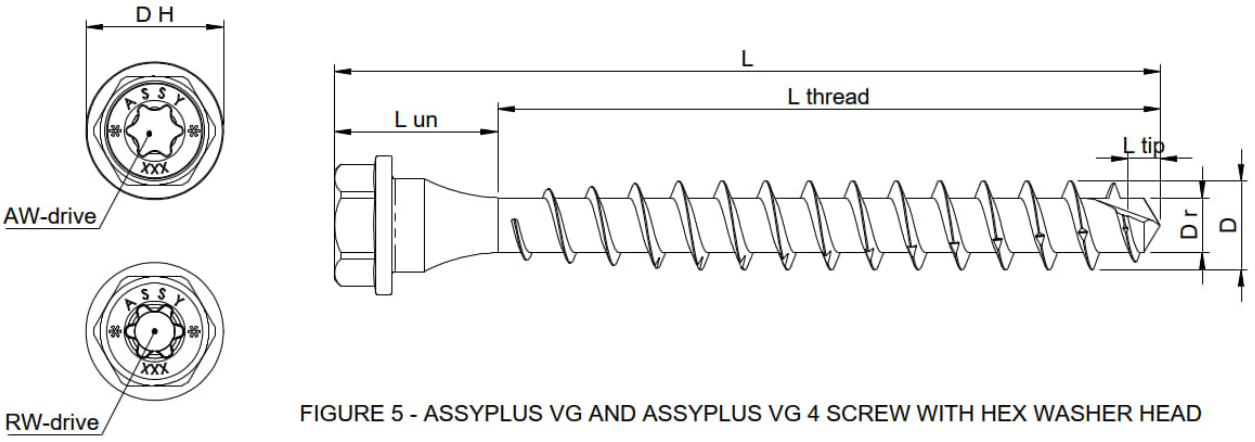


FIGURE 5 - ASSYPLUS VG AND ASSYPLUS VG 4 SCREW WITH HEX WASHER HEAD

TABLE 2—REFERENCE WITHDRAWAL DESIGN VALUES (W)[1,2,3]

D_{nom} (inch)	$L_{emb,w}$	W FOR SELECTED SG_{NDS} AND SG_{eq} VALUES (lbf/in):				
		Faces of Sawn Lumber, Glulam and CLT Panels				PSL[4]
		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.

[1]Tabulated values are for screws installed perpendicular to the face of the wood.
[2]Member penetration must be at least 8 times the nominal diameter.
[3]Reference withdrawal design values are to be multiplied by the embedded thread length in the member, not including the tip.
[4]Tabulated values also apply to installation at 45 degrees to the grain.

TABLE 3—REFERENCE HEAD PULL-THROUGH DESIGN VALUES (W_H)[1,2]

D_{nom} (inch)	HEAD TYPE	MINIMUM $t_{s,w}$ (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, Countersunk Milling Pocket	1 3/8	414	350	281	216	398
3/8	Countersunk, Countersunk Milling Pocket		474	408	334	266	491
1/2	Countersunk, Countersunk Milling Pocket		474	408	334	266	491

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

[1]Tabulated head pull-through design values, W_H, are applicable to screws installed with 90° ≥ α ≥ 30°
[2]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[1,2,3,4,5,6]

FASTENER DESIGNATION[1]	$t_{s,w}$ (inches)	$L_{emb,t}$ (inches)	REFERENCE LATERAL DESIGN VALUE (Z) FOR SELECTED SG_{NDS} VALUES (lbf):								
			0.42			0.49			0.55		
			$Z_{\parallel}$	$Z_{\perp/\parallel}$	$Z_{\perp}$	$Z_{\parallel}$	$Z_{\perp/\parallel}$	$Z_{\perp}$	$Z_{\parallel}$	$Z_{\perp/\parallel}$	$Z_{\perp}$
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.

[1]Fastener length shown is a minimum. Tabulated values may be applied to longer fasteners, with greater penetration into the main and/or side member.
[2]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:
$Z_{\parallel}$: Both side and main members loaded parallel to grain.
$Z_{\perp/\parallel}$: Side member loaded perpendicular to grain; main member loaded parallel to grain
$Z_{\perp}$: Both side and main members loaded perpendicular to grain.
[3]Reference lateral design values must be multiplied by all adjustment factors applicable to wood screws, in accordance with the NDS.
[4]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.
[5]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.
[6]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[1] (inches)	$t_{s,s}$ [2]	REFERENCE LATERAL DESIGN VALUE, (*Z*) FOR SELECTED SG_{NDS} VALUES (lbf):[3,4]	
			0.50	
			$Z_{\perp}$	Z_{end}
ASSY plus VG CSK	$^5/_{16}$ x $3^1/_8$	0.200 inch (5 mm)	575	--
	$^5/_{16}$ x $6^1/_4$		575	555
	$^3/_8$ x 4		895	--
	$^3/_8$ x $7^7/_8$		895	895

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

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

[2]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.

[3]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.

[4]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[1]

NOMINAL FASTENER DIAMETER (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[1,2,3]

CONDITION		MINIMUM DISTANCE OR SPACING Self-drilled or Predrilled[4]	
		$D_{nom} \leq {}^3/_8$ inch	$D_{nom} > {}^3/_8$ inch
End distance (see Figures 6 and 8)	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 (see Figures 6 and 8)	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 parallel to grain (see Figures 7 and 8)	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, perpendicular to grain (see Figures 7 and 8)	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, $a_{2,cross}$	1.5D	1.5D

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

[1]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.

[2]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.

[3]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.

4For the purpose of determining connection geometry requirements, the screws are considered to drill their own “predrilled” hole.

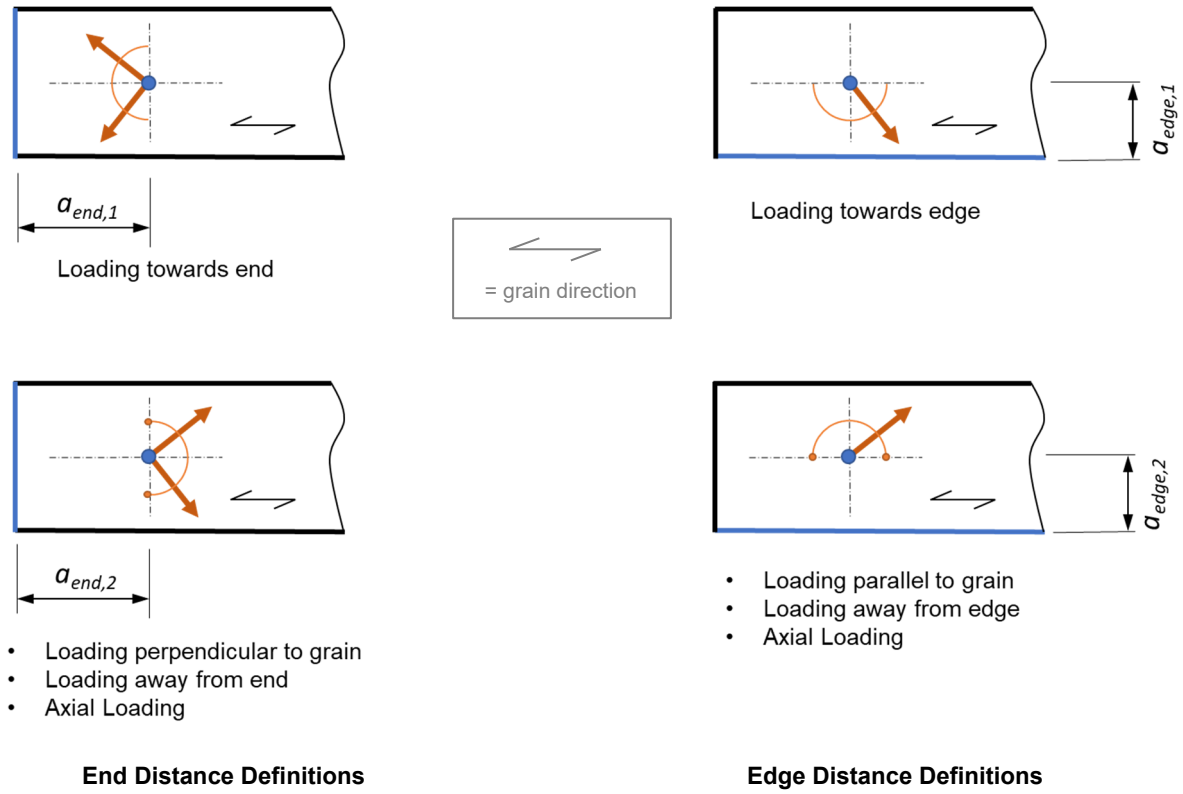


FIGURE 6—END AND EDGE DISTANCE DEFINITIONS FOR SCREWS INSTALLED PERPENDICULAR TO GRAIN

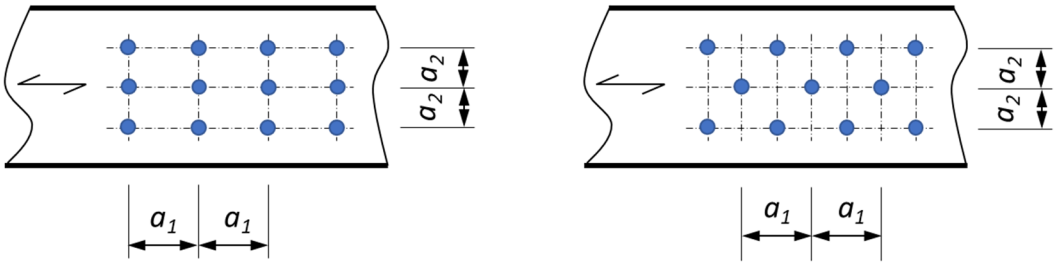


FIGURE 7—SPACING DEFINITIONS FOR SCREWS INSTALLED PERPENDICULAR TO GRAIN

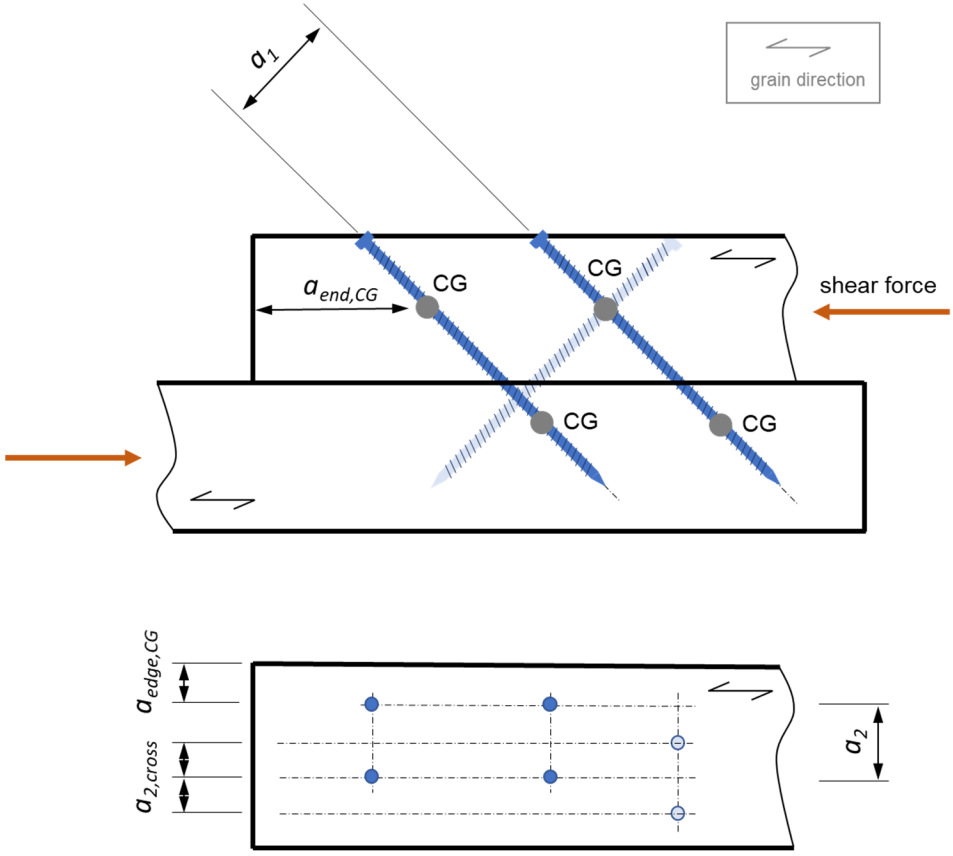
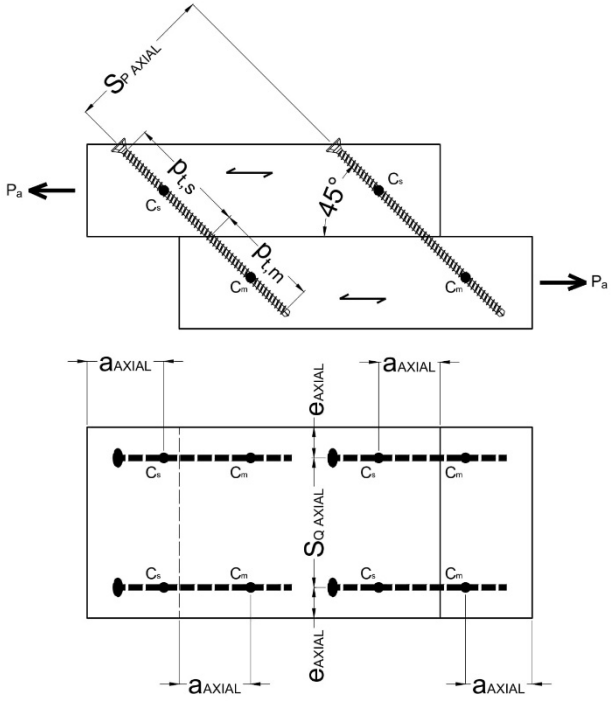


FIGURE 8—SPACING DEFINITIONS FOR INCLINED AND CROSSED SCREWS

TABLE 8—CONNECTION GEOMETRY REQUIREMENTS FOR CONNECTIONS DESCRIBED IN SECTION 4.1.11[1,2]

CONDITION	MINIMUM DIMENSION (in terms of nominal screw diameter, D)
End distance, a_{AXIAL} [3]	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

[1] 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.
[2]See Figures 9 and 10.
[3]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

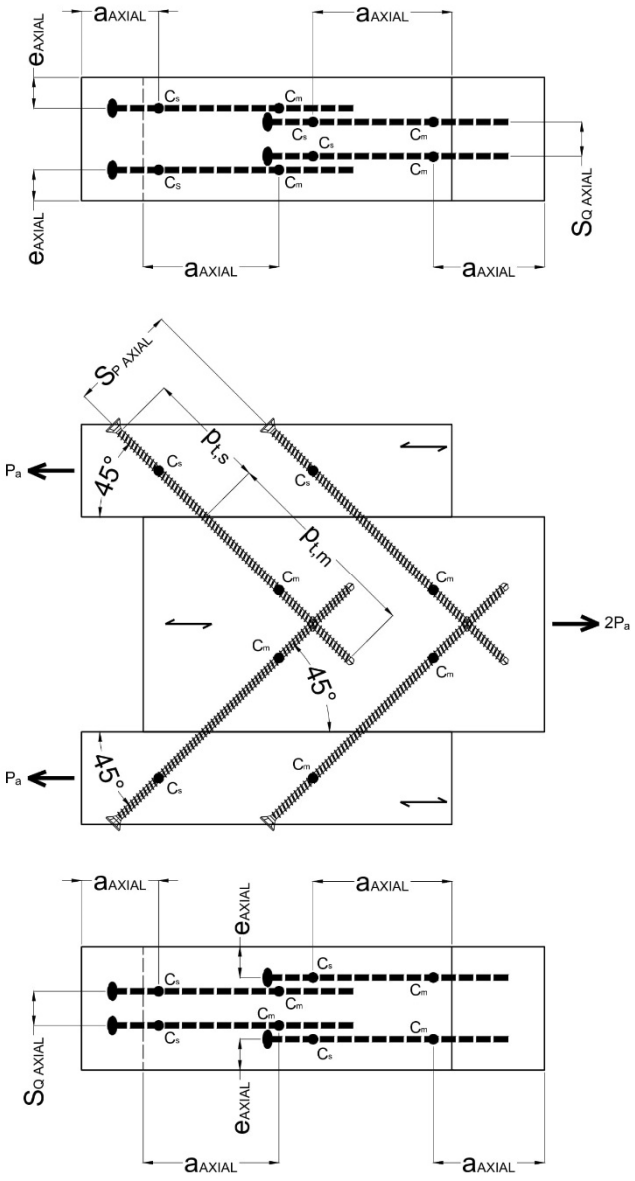
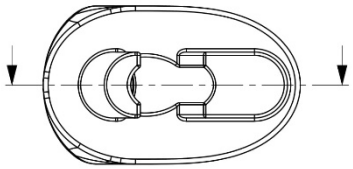
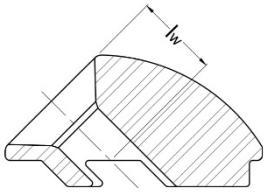


FIGURE 10—CONNECTION GEOMETRY FOR INCLINED SCREWS IN THREE-MEMBER WOOD-TO-WOOD CONNECTION



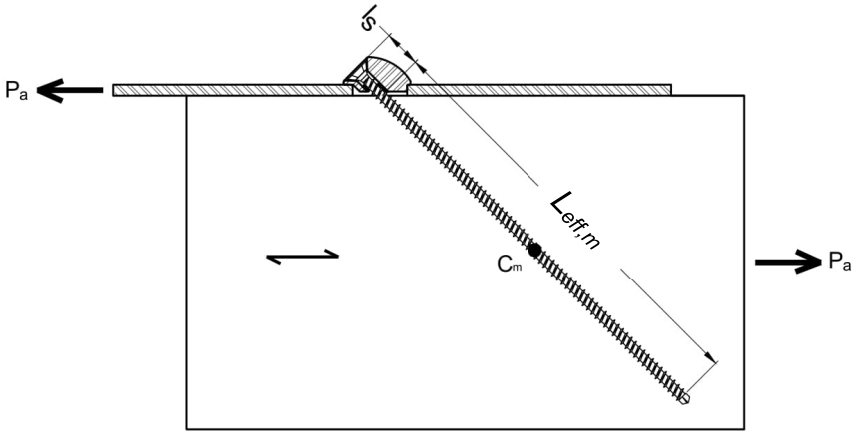
Bottom View



Cross Section

NOMINAL SCREW DIAMETER (inch)	DIMENSION l_w (inch)
$^5/_{16}$	0.500
$^3/_8$	0.724
$^1/_2$	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