# Evaluation Report CCMC 13677-R
# SWG ASSY® VG Plus and SWG ASSY® 3.0 Self-Tapping Wood Screws

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## 1. Opinion

It is the opinion of the Canadian Construction Materials Centre (CCMC) that "SWG ASSY® VG Plus and SWG ASSY® 3.0 Self-Tapping Wood Screws," when used as fasteners for structural lumber connections in accordance with the conditions and limitations stated in Section 3 of this Report, complies with the National Building Code (NBC) of Canada 2015:

- Clause 1.2.1.1.(1)(a) of Division A, as an acceptable solution from Division B:
  - Article 4.3.1.1., Design Basis for Wood (CSA O86-14)

- Clause 1.2.1.1.(1)(b) of Division A, as an alternative solution that achieves at least the minimum level of performance required by Division B in the areas defined by the objectives and functional statements attributed to the following applicable acceptable solutions:
  - Article 9.23.3.1., Standard for Nails and Screws

This opinion is based on CCMC's evaluation of the technical evidence in Section 4 provided by the Report Holder.

## 2. Description

### Product Description

The products are self-tapping screws (STS) that are available in many combinations of diameters, lengths, head types, thread types (single, double or coarse threads), and as partial-thread screws or full-thread screws. This evaluation covers the following five (5) specific designations of proprietary "SWG ASSY® Self-Tapping Wood Screws" made from carbon steel (see Appendix A for a summary of the screw specifications):

1. three (3) partial-thread screws with self-tapping tip: "SWG ASSY® 3.0 SK," "SWG ASSY® 3.0 Kombi," "SWG ASSY® 3.0 Eco-fast," and
2. two (2) full-thread screws with self-drilling tip: "SWG ASSY® VG plus CYL" (cylinder head), "SWG ASSY® VG plus CSK" (countersunk head).

The "SWG ASSY® 3.0 Self-Tapping Wood Screws" are self-tapping while the "SWG ASSY® VG plus" ones have a self-drilling tip, which is also self-tapping. The partial-thread screws have a coarse thread while the full-thread screws have a single thread. Additional specifications and detailed information are available from the manufacturer's Design Guide outlined below.

### Installation Description

General Note: The use of the term 'embedment depth' throughout this Evaluation Report is equivalent to 'penetration length' of the self-tapping screw into the wood member.

### Angle of Installation

The products have been evaluated for installation at three (3) angles in relation to the timber members being fastened together: 30°, 45° and 90°.

### Spacing

The screw spacings outlined below originate from the European approval for "SWG ASSY® Self-Tapping Wood Screws" and the German standard DIN 1052.

### Installation Practice

For a successful installation, all aspects of the manufacturer's screw installation instructions must be followed, including requirements for the drill bit, drill specification, torque, screw guide for angle installations, steel plate details, etc.

## 3. Conditions and Limitations

CCMC's compliance opinion in Section 1 is bound by the "SWG ASSY® VG Plus and SWG ASSY® 3.0 Self-Tapping Wood Screws" being used in accordance with the conditions and limitations set out below.

The products are self-tapping wood screws for structural wood connections fabricated with dry lumber, intended to be used as fasteners for structural lumber connections for dry service use[1] applications only.

The following list of conditions and limitations apply to this product evaluation:

- The structural wood design, with proprietary fastener design values herein, is to be in accordance with CSA O86-14 performed by a professional engineer, with an expertise in wood design, licensed to practice within the Provincial/Territorial jurisdiction.
- The published resistances are limited to Canadian wood species/densities and proprietary structural composite lumber (SCL) tested and outlined below.
- For the withdrawal applications:
    - The lumber side plate member, being connected to the main member, must have a minimum thickness of 4d (where d is the thread outer diameter). At the admissible installation angles of 30° to 90° (angle from the horizontal (parallel to grain)), the following exceptions apply:
        (i) for the screw diameters ≥ 10 mm and installation angles other than 90° (i.e., perpendicular to grain) the minimum wood member thickness (side and main) is 8d;
        (ii) for the screw diameters = 12 mm and installation angles other than 90° (i.e., perpendicular to grain) the minimum wood member thickness (side and main) is 10d.
    - The withdrawal resistance has an upper limit set by the tensile capacity of the screws and must not be exceeded. See Table 4.1.2.1 below for the prescribed tensile capacities and limiting factored tensile values for the 6-mm, 8-mm, 10-mm and 12-mm screws.

      (Appendix E outlines permitted application cases in tabular form.)
- For lateral load resistance, the minimum wood side and main member thickness for the self-tapping screws shall be 50 mm for d < 10 mm and 100 mm for d ≥ 10 mm in order to avoid mode 1 and mode 2 failures in wood so that a ductile steel yielding mode can be achieved.
- This evaluation does not apply to connections with other materials (i.e., panel products).
- The screw angles, spacings, end/edge distances and end-grain (at angle) installations must follow the prescribed requirements and the manufacturer's recommendations.
- The Service Condition Factor for lag screws applies to these self-tapping screws and is limited to the connections fabricated with seasoned lumber and used in dry service.
- Other limitations are applicable as outlined below for specific applications.

The installation of the products must be in accordance with the manufacturer's details found in the "Design Guide for ASSY® Screws in Canada," Version 1, October, 2013.

The manufacturer, SWG/Wüerth, provides engineering and technical support through My-Ti-Con Ltd. in conjunction with the "Design Guide for ASSY® Screws in Canada" and offers the following contact number:

- MY-TI-CON: 866-899-4090 or info@my-ti-con.com

1 All lumber, wood-based panels and proprietary engineered wood products are intended for "dry service conditions." "Dry service" is defined as the in-service environment under which the average equilibrium moisture content (EMC) of lumber is 15% or less over a year and does not exceed 19% at any time. Wood contained within the interior of dry, heated or unheated buildings has generally been found to have an MC between 6% and 14% depending on season and location. During construction, all wood-based products should be protected from the weather to ensure that the 19% MC is not exceeded in accordance with the Article 9.3.2.5. of Division B of the NBC 2015.

# 4. Technical Evidence

The Report Holder has submitted technical documentation for CCMC's evaluation. Testing was conducted at laboratories recognized by CCMC. The corresponding technical evidence for this product is summarized below.

## 4.1 Material Requirements

CCMC's Technical Guide for self-tapping wood screws sets out the nature of the technical evidence required by CCMC to enable it to evaluate a product as an acceptable or alternative solution in compliance with the NBC 2015. The Report holder has submitted test results for CCMC's evaluation. Testing was conducted by an independent testing agency recognized by CCMC. The corresponding results of the tests conducted for the products are summarized in Appendix B.

### Characteristic Densities

The products' qualification test program and pre-engineered tables in the Appendices of this Report are based on the following species and respective oven-dry relative densities.

**Table 4.1.1.1 Oven-Dry Relative Densities of Timber Species**

| Timber Densities | | |
|---|---|---|
| **Visually Graded Lumber** | **Glue-Laminated Timber** | **Mean Oven-Dry Relative Density** |
| D Fir-L | D Fir-L | 0.49 |
| S-P-F | – | 0.42 |
| – | S-P-F | 0.44 |
| Hem-Fir | Hem-Fir | 0.46 |
| Northern | – | 0.35 |
| S-Y-P | – | 0.55 |
| **Structural Composite Lumber (SCL) Density** | | |
| Parallam® (PSL) | | 0.50 |

### 4.1.1 Characteristic Screw Fastener Dimensions and Strengths

### Dimensions

The detailed dimensions and thread lengths of the STS are outlined in Appendix C.

### Note:

Self-tapping screws have an "outside" screw diameter that exceeds the shank diameter. In conventional lag screws, the "outside" screw diameter is typically equal to or less than the shank diameter, unless the lag screw is a "reduced body diameter" lag screw, in which case the shank diameter is also less than the "outside" screw diameter.

## Strengths

**Table 4.1.2.1 Strength of "SWG ASSY®" Screws Made from Carbon Steel**

| Partial- (PT) or Full-Thread (FT) | "SWG ASSY®" Type STS | Outside Thread Diameter (mm) | Root Diameter[1] ($d_{min}$, mm) | Bending Yield Strength[2] (MPa) | Screw Tension Strength (kN) | | Unfactored Screw Shear Strength[2] (MPa) |
|---|---|---|---|---|---|---|---|
| | | | | | Unfactored Resistance | Factored Resistance[2] | |
| FT | VG CYL | 6 | 3.8 | 969 | 11.3 | 9.04 | 578 |
| PT | SK, Ecofast | | 3.9 | | | | |
| FT | VG CYL, VG CSK | 8 | 5 | 1015 | 18.9 | 15.12 | 641 |
| PT | SK, Ecofast, Kombi | | 5.3 | | | | |
| FT | VG CYL, VG CSK | 10 | 6.2 | 942 | 24 | 19.2 | 691 |
| PT | SK, Ecofast, Kombi | | 6.3 | | | | |
| FT | VG CSK | 12 | 7.1 | 1147 | 30 | 24 | 536 |
| PT | SK, Kombi | | 7.2 | | | | |

**Notes to Table 4.1.2.1:**

1 The root diameter values shown are average values calculated between the upper and lower tolerance levels.

2 See Appendix B for the definition of these strength values.

## 4.1.2 Spacing of "SWG ASSY®" Screws in Timber

The minimum spacing, end and edge distances of the products loaded laterally (i.e., shear) or axially (i.e., withdrawal) in timber must follow the principles of the German standards DIN 1052 and Dibt ETA-11/0190. The screw spacing and end/edge distances are summarized in Figure 1 and Table 4.1.3.1 below for information only; the designer must consult the manufacturer's Design Guide for accuracy and additional information.

**Table 4.1.3.1 Minimum Spacing, End and Edge Distances[1] for the "SWG ASSY®" Self-Tapping Wood Screws**

| Minimum Spacing or Distance | Screw Types (d = outside diameter) | | | |
|---|---|---|---|---|
| | Screws Loaded Laterally | | | Screws Loaded Axially |
| | Partial-Thread Self-Tapping | | Full-Thread Self-Drilling + Self-Tapping | Full-Thread Self-Drilling + Self-Tapping |
| | SWG ASSY® 3.0 SK, Kombi, Ecofast | | SWG ASSY® VG plus CYL, SWG ASSY® VG plus CSK | SWG ASSY® VG plus CYL, SWG ASSY® VG plus CSK |
| | Relative Density ≤ 0.42 | 0.42 < Relative Density ≤ 0.50 kg/m$^3$ | Relative Density ≤ 0.50 kg/m$^3$ | |
| Spacing parallel to grain ($S_P$) | 12d | 15d (22.5d in D-Fir) | 5d (7.5d in D-Fir) | 5d (7.5d in D-Fir) |
| Spacing perpendicular to grain ($S_Q$) | 5d | 7d | 3d | 2.5d |
| Loaded end distance ($a_L$) | 15d | 20d (30d in D-Fir) | 12d (18d in D-Fir) | 5d (7.5d in D-Fir) |
| Unloaded end distance (a) | 10d | 15d (22.5d in D-Fir) | 7d (10.5d in D-Fir) | – |
| Loaded edge distance ($e_L$) | 10d | 12d | 7d | 3d |
| Unloaded edge distance (e) | 5d | 7d | 3d | – |

**Note to Table 4.1.3.1:**

1 Minimum side plate thickness must be 4d. In addition, for screws where d > 8 mm, embedded in wood with thickness less than 5d, a minimum distance of 15d from loaded or unloaded ends applies. Timber or lumber with a thickness less than 7d or that is a species sensitive to splitting must be pre-drilled to reduce the risk of splitting. See manufacturer's recommendations for other spacing/species refinements for particular installation situations.

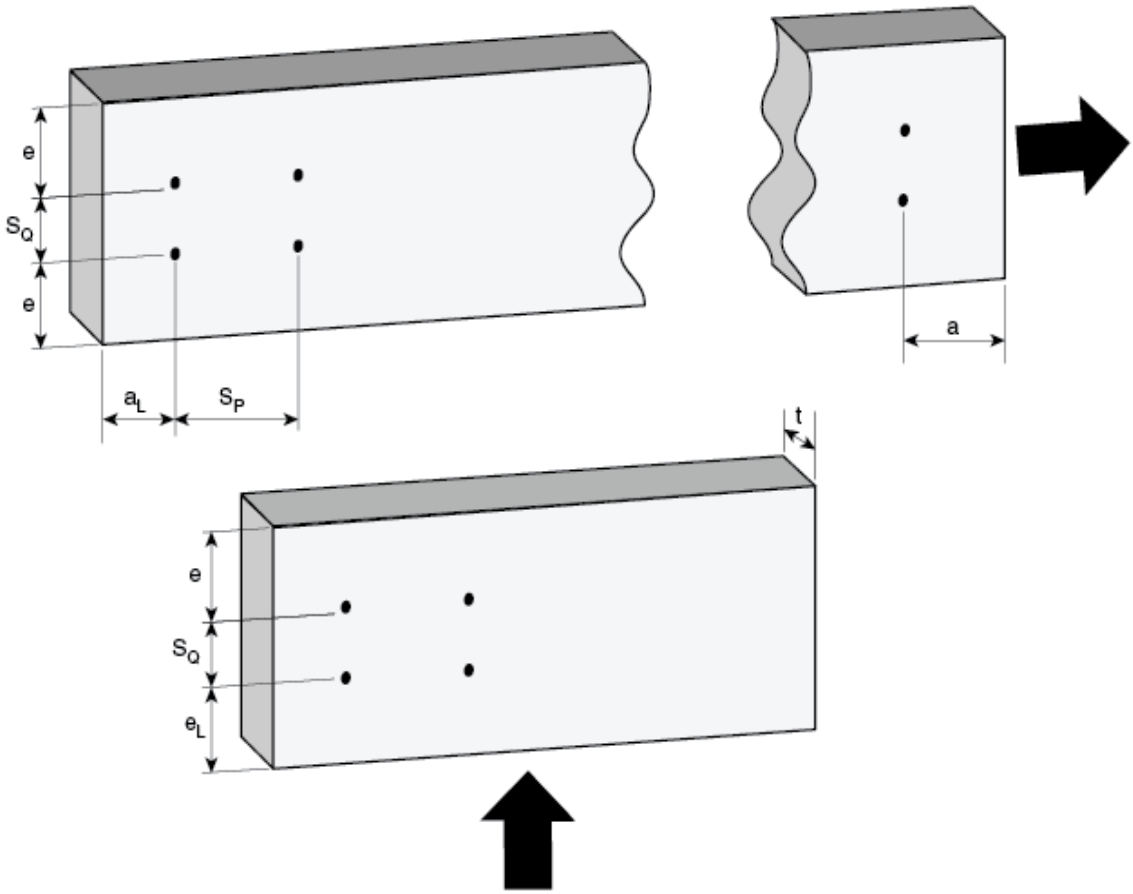


**Figure 1. Spacings, end/edge distances — see manufacturer's Design Guide for more detailed information**

- **e = unloaded edge distance**
- **$S_Q$ = spacing perpendicular to grain**
- **$S_P$ = spacing parallel to grain**
- **$a_L$ = loaded end distance**
- **$e_L$ = loaded edge distance**
- **a= unloaded end distance**
- **t = thickness of member**

## 4.2 Performance Requirements

### 4.2.1 Head Pull-Through Resistance of "SWG ASSY®" Screws in Timber

The head pull-through resistance, $R_{PT}$, in the equation below is based on the characteristic value from testing and adjusted for standard term loading.

$$\mathbf{R_{PT} = Ø(r_{PT} \cdot K_d \cdot K_{SF})}$$

where:

Ø = 0.7

$r_{PT}$ = characteristic pull-through strength, adjusted to Standard Term (kN)

$K_d$ = 1.0 for standard term loading

$K_{SF}$ = 1.0 for dry service

**Table 4.2.1.1 Head Pull-Through Resistance for Partial-Thread "SWG ASSY® 3.0 STS" Screws**

| Head Pull-Through Resistance[1] [2] (kN) | | | | | | | |
|---|---|---|---|---|---|---|---|
| Diameter (mm) | Mean Oven-Dry Relative Density (kg/m3) | Partial-Thread[3] "SWG ASSY® 3.0 STS" | | | | | |
| | | SK | | Kombi | | Ecofast | |
| | | Unfactored | Factored, Ø = 0.7 | Unfactored | Factored, Ø = 0.7 | Unfactored | Factored, Ø = 0.7 |
| 6 | 0.35 | 3.84 | 2.69 | – | – | 1.64 | 1.15 |
| | 0.42 | 3.72 | 2.61 | – | – | 1.89 | 1.32 |
| | 0.49 | 5.78 | 4.04 | – | – | 3.65 | 2.56 |
| | 0.50 | 6.35 | 4.44 | – | – | 3.10 | 2.17 |
| | 0.55 | 3.96 | 2.77 | – | – | 2.81 | 1.97 |
| 8 | 0.35 | 4.12 | 2.88 | 1.88 | 1.31 | 2.14 | 1.50 |
| | 0.42 | 7.50 | 5.25 | 2.48 | 1.74 | 3.07 | 2.15 |
| | 0.49 | 9.80 | 6.86 | 3.74 | 2.62 | 3.85 | 2.69 |
| | 0.50 | 9.69 | 6.78 | 4.22 | 2.95 | 4.80 | 3.36 |
| | 0.55 | 6.55 | 4.59 | 3.26 | 2.28 | 4.76 | 3.33 |
| 10 | 0.35 | 6.67 | 4.67 | 2.60 | 1.82 | 2.70 | 1.89 |
| | 0.42 | 8.58 | 6.01 | 3.78 | 2.65 | 3.87 | 2.71 |
| | 0.49 | 8.67 | 6.07 | 5.23 | 3.66 | 6.61 | 4.63 |
| | 0.50 | 10.41 | 7.29 | 5.08 | 3.56 | 5.69 | 3.99 |
| | 0.55 | 8.31 | 5.82 | 3.86 | 2.70 | 4.43 | 3.10 |
| 12 | 0.35 | 6.81 | 4.77 | 3.33 | 2.33 | – | – |
| | 0.42 | 9.18 | 6.42 | 4.01 | 2.81 | – | – |
| | 0.49 | 11.63 | 8.14 | 5.23 | 3.66 | – | – |
| | 0.50 | 14.28 | 10.0 | 6.29 | 4.40 | – | – |
| | 0.55 | 8.43 | 5.90 | 5.23 | 3.66 | – | – |

**Notes to Table 4.2.1.1:**

1 Resistance values may be multiplied for other load durations, $K_d$.

2 The values presented in this Table correspond to the lower of the values for head pull-through resistance and factored tensile resistance stated in Table 4.1.2.1.

3 The head pull-through resistances presented apply to partial-thread screws. For full-thread screws, the designer must consider the withdrawal resistance of the screw thread embedment length in the secondary member.

## 4.2.2 Withdrawal Resistance of "SWG ASSY®" Screws in Timber

### Design Tables

A pre-calculated screw withdrawal resistance table is presented in Appendix D. The table presents the withdrawal resistance for a 20-mm-per-unit thread embedment depth for the specific angle, density and screw diameter. The pre-calculated values have been provided by the manufacturer in accordance with the design equation below. The equation has been validated following a reliability analysis as per principles of CSA O86 (see Appendix B on reliability study). These tables are presented in Appendix D for information purposes only. The designer must consult the manufacturer's official tables for design.

*Note: The tables have been prepared with a load duration value of $K_d$ = 1.0. Resistance values may be adjusted for other load durations.*

### Withdrawal Resistance Equation

The factored withdrawal resistance, $P_{rw,\alpha}$ , for installation angle (α), must be determined using the following equation[1]:

$$P_{rw,\alpha} = \varphi \frac{0.8 \cdot \delta (b \cdot 0.84 \cdot \rho)^2 \cdot d \cdot l_{ef} \cdot 10^{-6}}{\sin^2\alpha + \frac{4}{3} \cdot \cos^2\alpha} \cdot K_D \cdot K_{SF} \qquad \text{(N)}$$

where:

φ = 0.9

0.8 = adjustment to standard term loading

δ = material adjustment factor: 82 for ρ ≥ 440 kg/m$^3$; 85 for ρ < 440 kg/m$^3$

b = 1 for D-Fir-L, SPF, SYP, WRC, Hem-Fir

or

b = 0.75 for Parallam (PSL)

ρ = mean oven-dry relative density (CSA O86, Table A.10.1.) x 10$^3$ (kg/m$^3$)

0.84 = adjustment of mean oven-dry relative density to fifth percentile value

d = outside screw diameter (mm)

$l_{ef}$ = embedment depth into member (thread length-tip length (= d)) (mm)

α = screw angle

$K_D$ = load duration factor = 1.0

$K_{SF}$ = service condition factor = 1.0

1. **Note:** The prescribed screw steel tensile capacities and thus upper withdrawal capacity bounds are 11 300 N, 18 900 N, 24 000 N and 30 000 N for the 6-mm, 8-mm, 10-mm and 12-mm screws, respectively. The withdrawal resistance must not exceed the "factored" screw tensile resistance stated in Table 4.1.2.1.

## 4.2.3 Lateral Resistance of "SWG ASSY®" Screws in Timber

### Lateral Resistance

The factored lateral resistance must be calculated in accordance with CSA O86-14, "Engineering Design in Wood," Clause 12.6.6 for lag screws using shank diameter for partially-threaded screws and root diameter for fully-threaded screws. In addition, for lateral load resistance, the minimum wood side and main member thickness for the self-tapping screws shall be 50 mm for d < 10 mm and 100 mm for d ≥ 10 mm in order to avoid mode 1 and mode 2 failures in wood so that a ductile steel yielding mode can be achieved.

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**Date modified:**
2020-01-30

# Appendix A - Self-Tapping Screws - Specification Summary

**Table A1 Self-Tapping Screws - Specification Summary**

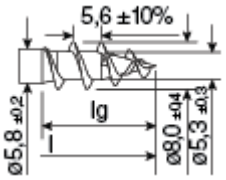
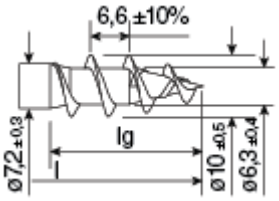
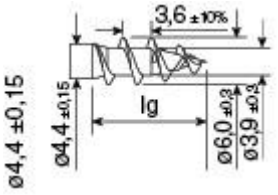
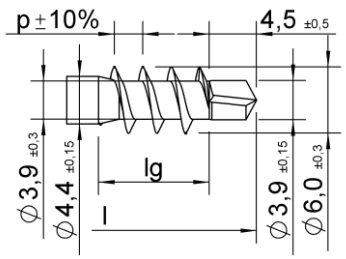
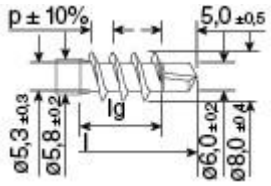
| Series | Name | Head Type | Outside Diameter (Ø) (mm) | Screw Length varies by (Ø) (mm) | Thread Length | Thread Type | Shank Cutter |
|---|---|---|---|---|---|---|---|
| **Partial Thread STS - SWG ASSY® 3.0** | **SWG ASSY 3.0 SK** | Large Washer Head | 6,8,10,12 | 60-1000 | varies | • course thread<br>• Self-Tapping Tip (e.g. 8-mm Ø)<br>  <br>SWG ASSY 3.0 SK detail | yes |
| | |  <br>SWG ASSY 3.0 SK image | | | | | |
| | **SWG ASSY 3.0 Kombi** | Hex Head | 8,10,12 | 60-600 | varies | • course thread<br>• Self-Tapping Tip (e.g. 10-mm Ø)<br>  <br>SWG ASSY 3.0 Kombi detail | yes |
| | |  <br>SWG ASSY 3.0 Kombi image | | | | | |
| | **SWG ASSY 3.0 Ecofast** | Countersunk Head | 6,8,10 | 60-400 | varies | • course thread<br>• Self-Tapping Tip (e.g. 6-mm Ø)<br>  <br>SWG ASSY 3.0 Ecofast detail | yes |
| | |  <br>SWG ASSY 3.0 Ecofast image | | | | | |

**Table A1 Self-Tapping Screws - Specification Summary (cont.)**

| Series | Name | Head Type | Outside Diameter (Ø) (mm) | Screw Length varies by (Ø) (mm) | Thread Length | Thread Type | Shank Cutter |
|---|---|---|---|---|---|---|---|
| Full-Thread STS – ASSY VG plus | SWG ASSY VG plus Cyl. | Cylindrical Head | 6,8,10 | 70-800 | Full Thread | • single thread<br>• Self-Drilling Tip (eg. 6-mm Ø)<br>  <br><br>SWG ASSY VG plus Cyl. detail | n/a |
| | |  <br>SWG ASSY VG plus Cyl. image | | | | | |
| | SWG ASSY VG plus CSK | Countersunk Head | 8,10,12 | 80-800 | Full Thread | • single thread<br>• Self-Drilling Tip (e.g. 8-mm Ø)<br>  <br><br>SWG ASSY VG plus CSK detail | n/a |
| | |  <br>SWG ASSY VG plus CSK image | | | | | |

# Appendix B - Summary of Testing and Design Value Derivation

**Table B1 Summary of Testing and Design Value Derivation**

| Property | Test Information |
|---|---|
| **Partial (coarse) Thread vs. Full (single) Thread Screws** | |
| Thread type - Withdrawal Resistance | Testing was done to compare the withdrawal resistance of the 6-mm- and 10-mm-diameter full-thread vs. partial-thread screws which differ in thread pitch. Twenty-eight (28) statistical samples were tested in two species of wood: DF and western red cedar. The screws have similar withdrawal resistance with the partially threaded screws having slightly higher values. The test program below was conducted on the full-thread screws and design values are considered applicable to the partial thread screws. |
| **Full Thread - ASSY® VG plus CYL (cylinder head), ASSY® VG plus CSK (countersunk head)** | |
| **Fastener metal tests** | |
| Bending Yield Strength | Ten (10) screws, each of four diameters, were tested (6 mm, 8 mm, 10 mm, 12 mm) in bending. The published bending yield strength is the minimum of: (i) the bending yield stress from the moment/section modulus, and (ii) the average of the sum of the yield strength and ultimate strength (dowel/bolt yield strength, CSA O86, Article 10.4.4.3.3.3.(b)) |
| Tension | Steel tensile values were made available by the manufacturer and withdrawal tests that failed in tension formed the data set. The manufacturer's minimum ultimate tensile stress governs. The factored tensile stress is multiplied with $\Phi$= 0.8 from CSA S16 for steel. |
| Shear | Ten (10) screws, each of four diameters, were tested (6 mm, 8 mm, 10 mm, 12 mm) in accordance with AISI-TS-4-02. The unfactored shear stress is the characteristic ultimate screw shear stress value (i.e. fifth percentile, 75% confidence). |
| **Screw Resistances** | |
| Withdrawal resistance | Twenty-eight (28) screws of each combination were tested: four screw diameters (d) were tested (d= 6 mm, 8 mm, 10 mm, 12 mm), four embedment depths (4d, 8d, 12d, 16d), five wood species (DF, SP glulam, western red cedar, SYP and Parallam (PSL)), and three angles to the grain (90°, 45° and 30°), for a total of 5880 withdrawal tests.<br>The data was used to verify and validate the two European equations for self-tapping screws installed at an angle. The Eurocode 5 (Equation 2) and the DIN 1052:2008-12 (Equation 1) were compared w.r.t. establishing the characteristic withdrawal value. The DIN equation was the most precise with a nonconformance of only 0.3%. The equation was further adjusted for duration of load and is presented in Section 4.2.2 above. |
| Pull-through resistance | Twenty-eight (28) of each combination were tested: four screw diameters (d = 6 mm, 8 mm, 10 mm, 12 mm), three types of heads (countersunk, washer and hex), and two types of thread, for a total of 1680 screw head pull-through tests. |
| Lateral resistance | As per CSA O86-14, Section 12.6.6 for lag screw design using shank diameter for partially-threaded screws and root diameter for fully-threaded screws. |

**Table B1 Summary of Testing and Design Value Derivation (cont.)**

| Property | Test Information |
|---|---|
| Reliability: withdrawal resistance | In addition to the extensive database, a random process model was developed to represent stochastic withdrawal resistance considering the wood substrate, installation angles, embedment depths and screw diameters.<br>A formal reliability analysis was conducted using the "First Order Second Moment Method." Two modes of failure were considered: screw withdrawal and screw breakage. A performance factor of 0.9 was confirmed for an average beta of ≥ 3.47 with a minimum greater than 2.5. The lower bound beta was consistent with the performance level of dimension lumber having a minimum beta = 2.5. |
| Reliability: pull-through resistance | In addition to the extensive database, a random process model was developed for simulation of the pull-through resistance considering the variety of wood densities and screw properties.<br>A formal reliability analysis was conducted using the "First Order Second Moment Method." For the head pull through resistance with a performance factor of 0.7, the average beta was ≥ 3.41 with a minimum greater than 3.1. This reliability level is consistent with the safety level for combined screw pull-through resistance and screw breakage failure. |
| Spacing | The recommended screw spacings have been adopted from the latest DIN standard published in Germany with proprietary spacings specified for ASSY screws in their product evaluation, Dibt ETA-11/0190. |

## Appendix C - Detailed Screw Dimensions

**Table C1 SWG ASSY® Kombi" - metric specs[1]**

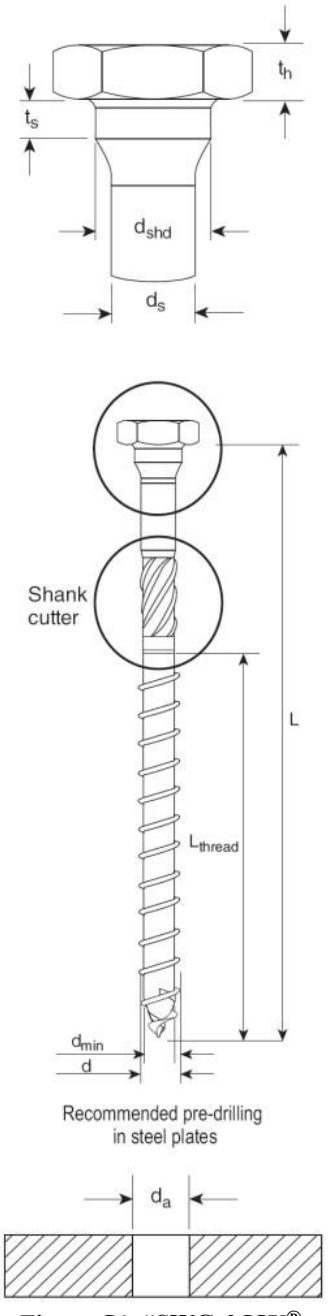
| d | L | $L_{thread}$ | $L_{tip}$[2] | $d_{head}$ | $d_{min}$ | $d_s$ | $d_a$ | $d_{shd}$ | $t_h$ | $t_s$ | Bit | Figure |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | mm | | | | | | | | | | | |
| 8 | 60 | 40 | 8 | 12 | 5.3 | 5.8 | 9 | 7.8 | 4.5 | 3.5 | AW 40 or 12 mm socket |  |
| | 80 | 50 | | | | | | | | | | |
| | 100 | 60 | | | | | | | | | | |
| | 120 to 200 in 20 mm increments | 80 | | | | | | | | | | |
| | 220 to 300 in 20 mm increments | 100 | | | | | | | | | | |
| 10 | 140 | 80 | 10 | 15 | 6.3 | 7.2 | 11 | 9.8 | 5 | 3.75 | AW 40 or 15 mm socket | |
| | 160 to 300 in 20 mm increments | 100 | | | | | | | | | | |
| | 320 to 400 in 20 mm increments | 120 | | | | | | | | | | |
| | 440 to 520 in 40 mm increments | 120 | | | | | | | | | | |
| 12 | 100 | 60 | 12 | 17 | 7.2 | 8.2 | 13 | 11.8 | 5.5 | 4 | AW 40 or 17 mm socket | |
| | 120 | 80 | | | | | | | | | | |
| | 140 | 80 | | | | | | | | | | |
| | 160 to 200 in 20 mm increments | 100 | | | | | | | | | | |
| | 220 to 360 in 20 mm increments | 120 | | | | | | | | | | |
| | 380 to 600 in 20 mm increments | 145 | | | | | | | | | | |



**Figure C1. "SWG ASSY® Kombi" - metric specs**

### Notes to Table C1:

1 Note: values listed in the table above are average measurements.

2 $L_{tip}$ = length of un-threaded portion on screw tip.

**Table C2 "SWG ASSY® Ecofast" - metric specs[1]**

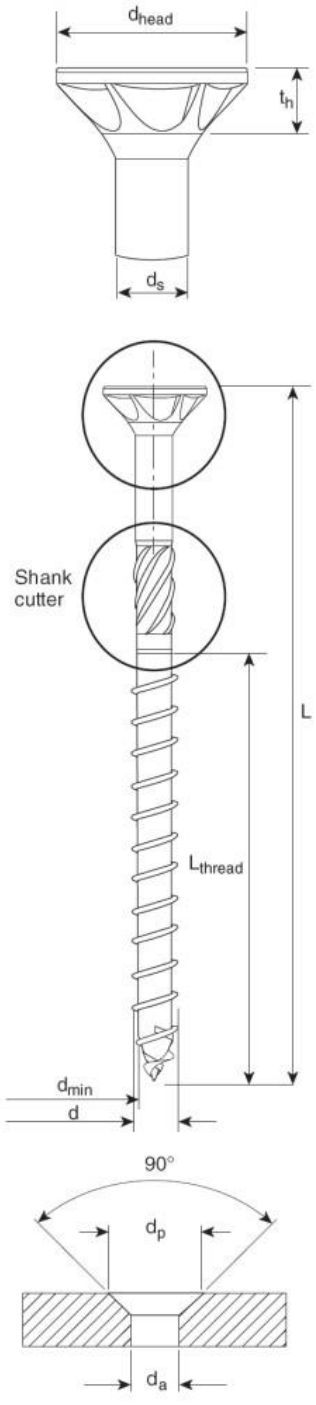
| d | L | $L_{thread}$ | $L_{tip}$[2] | $d_{head}$ | $d_{min}$ | $d_s$ | $d_a$ | $t_h$ | $d_p$ | Bit | Figure |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | mm | | | | | | | | | | |
| 6 | 60 | 37 | 6 | 12 | 4 | 4.4 | 7 | 4.2 | 14.5 | AW 30 |  |
| | 70 | 42 | | | | | | | | | |
| | 80 | 50 | | | | | | | | | |
| | 90 | 50 | | | | | | | | | |
| | 100 | 60 | | | | | | | | | |
| | 120 to 300 in 20 mm increments | 70 | | | | | | | | | |
| 8 | 60 | 50 | 8 | 14.7 | 5 | 5.8 | 9 | 4.6 | 19 | AW 40 | |
| | 80 | 50 | | | | | | | | | |
| | 90 | 60 | | | | | | | | | |
| | 100 | 60 | | | | | | | | | |
| | 120 to 200 in 20 mm increments | 80 | | | | | | | | | |
| | 220 to 400 in 20 mm increments | 100 | | | | | | | | | |
| 10 | 80 | 50 | 10 | 18 | 6.3 | 7.2 | 11 | 5.5 | 23 | AW 50 | |
| | 100 | 60 | | | | | | | | | |
| | 120 to 140 | 80 | | | | | | | | | |
| | 160 to 300 in 20 mm increments | 100 | | | | | | | | | |
| | 320 to 400 in 20 mm increments | 120 | | | | | | | | | |



**Figure C2. "SWG ASSY® Ecofast" - metric specs**

**Notes to Table C2:**

1 Note: values listed in the table above are average measurements.

2 $L_{tip}$ = length of un-threaded portion on screw tip.

**Table C3 "SWG ASSY® SK" - metric specs**[1]

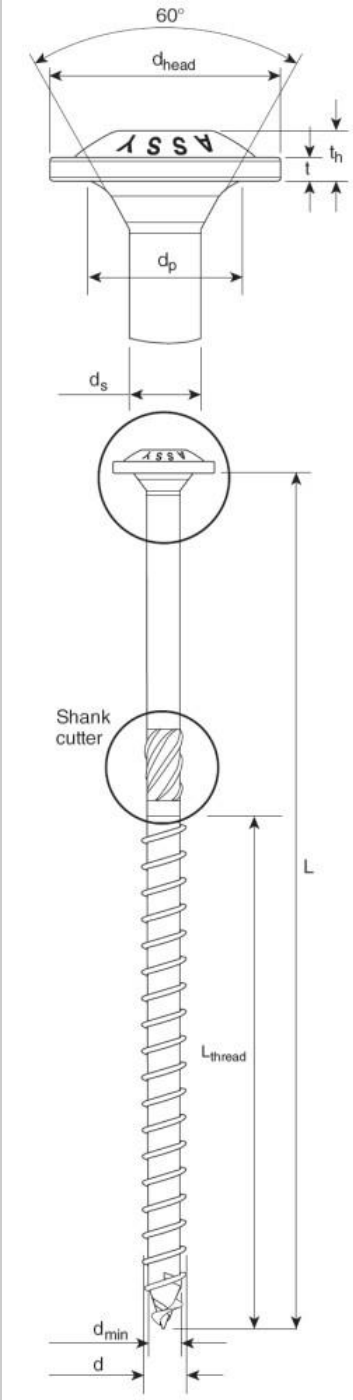
| d | L | $L_{thread}$ | $L_{tip}$[2] | $d_{head}$ | $d_{min}$ | $d_s$ | $d_p$ | t | $t_h$ | Bit | Figure |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | mm | | | | | | | | | | |
| 6 | 60 | 37 | 6 | 14 | 3.9 | 4.4 | 8 | 1.2 | 3 | AW 30 |  |
| | 70 | 42 | | | | | | | | | |
| | 80 | 50 | | | | | | | | | |
| | 90 | 50 | | | | | | | | | |
| | 100 | 60 | | | | | | | | | |
| | 100 to 300 in 20 mm increments | 70 | | | | | | | | | |
| 8 | 60 | 50 | 8 | 22 | 5.3 | 5.8 | 10 | 1.8 | 3.8 | AW 40 | |
| | 80 | 50 | | | | | | | | | |
| | 100 | 60 | | | | | | | | | |
| | 120 to 200 in 20 mm increments | 80 | | | | | | | | | |
| | 220 to 480 in 20 mm increments | 100 | | | | | | | | | |
| 10 | 140 | 80 | 10 | 25 | 6.3 | 7.2 | 13.5 | 2.2 | 4.6 | AW 50 | |
| | 160 to 300 in 20 mm increments | 100 | | | | | | | | | |
| | 320 to 460 in 20 mm increments | 120 | | | | | | | | | |
| 12 | 200 | 100 | 12 | 29 | 7.2 | 8.2 | 14 | 2.6 | 5 | AW 50 | |
| | 220 to 340 in 20 mm increments | 120 | | | | | | | | | |
| | 380 to 520 in 40 mm increments | 145 | | | | | | | | | |
| | 900 | 120 | | | | | | | | | |
| | 1000 | 120 | | | | | | | | | |



**Figure C3. "SWG ASSY® SK" - metric specs**

**Notes to Table C3:**

1 Note: values listed in the table above are average measurements.

2 $L_{tip}$ = length of un-threaded portion on screw tip.

**Table C4 "SWG ASSY® VG plus Cyl." - metric specs[1]**

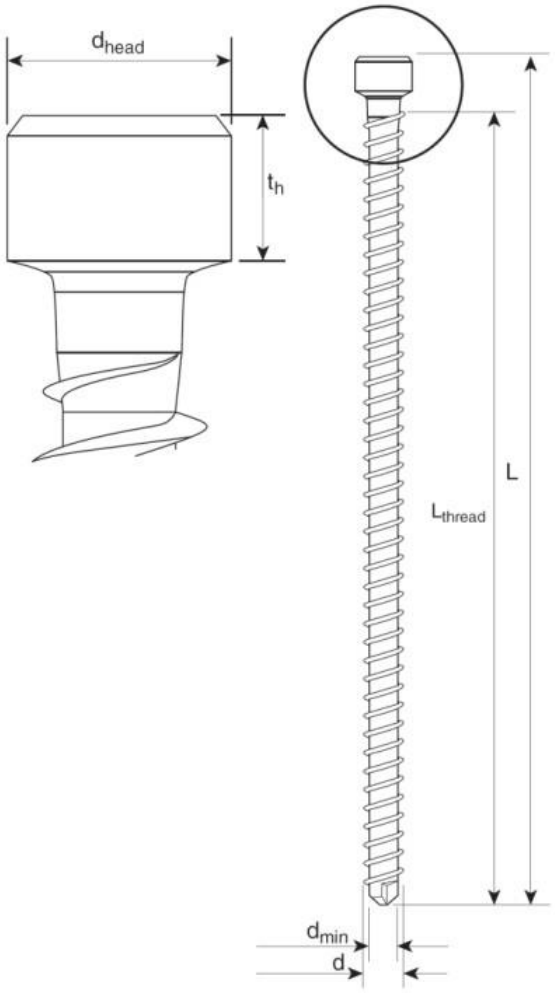
| d | L | $L_{thread}$ | $L_{tip}$[2] | $d_{head}$ | $d_{min}$ | $t_h$ | Bit | Figure |
|---|---|---|---|---|---|---|---|---|
| | mm | | | | | | | |
| 6 | 80 | 73 | 6 | 8 | 3.8 | 4.7 | AW 30 |  |
| | 100 | 93 | | | | | | |
| | 120 | 113 | | | | | | |
| | 140 | 133 | | | | | | |
| | 160 | 153 | | | | | | |
| | 180 | 173 | | | | | | |
| | 200 | 193 | | | | | | |
| 8 | 160 | 144 | 8 | 10 | 5 | 7.5 | AW 40 | |
| | 180 | 164 | | | | | | |
| | 200 | 184 | | | | | | |
| | 220 | 204 | | | | | | |
| | 240 | 224 | | | | | | |
| | 260 | 244 | | | | | | |
| | 280 | 264 | | | | | | |
| | 300 | 284 | | | | | | |
| | 330 | 311 | | | | | | |
| | 360 | 344 | | | | | | |
| | 380 | 364 | | | | | | |
| | 430 | 414 | | | | | | |
| | 480 | 464 | | | | | | |
| | 530 | 514 | | | | | | |
| | 580 | 564 | | | | | | |



**Figure C4. "SWG ASSY® VG plus Cyl." - metric specs**

**Table C4 "SWG ASSY® VG plus Cyl." - metric specs[1] (cont.)**

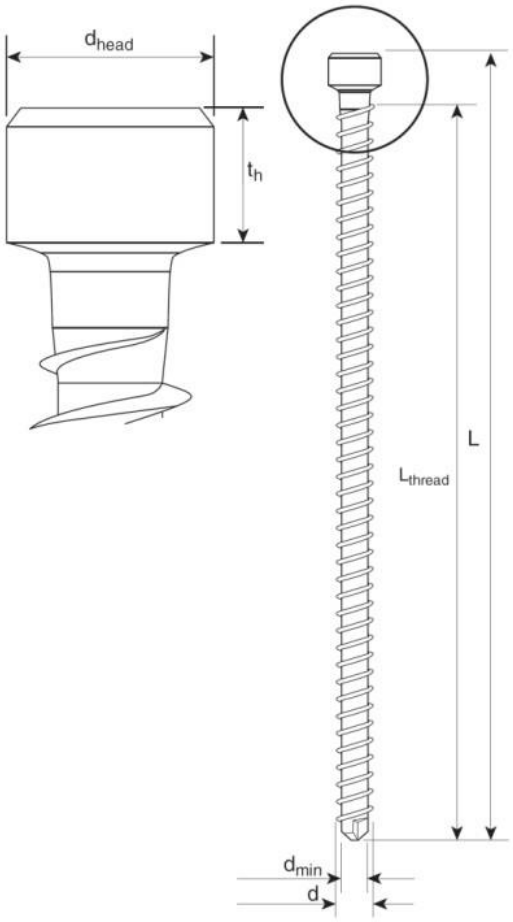
| d | L | $L_{thread}$ | $L_{tip}$[2] | $d_{head}$ | $d_{min}$ | $t_h$ | Bit | Figure |
|---|---|---|---|---|---|---|---|---|
| | mm | | | | | | | |
| 10 | 120 | 105 | 10 | 13.4 | 6.2 | 8 | AW 50 |  |
| | 140 | 125 | | | | | | |
| | 160 | 145 | | | | | | |
| | 180 | 165 | | | | | | |
| | 200 | 185 | | | | | | |
| | 220 | 205 | | | | | | |
| | 240 | 225 | | | | | | |
| | 260 | 245 | | | | | | |
| | 280 | 265 | | | | | | |
| | 300 | 280 | | | | | | |
| | 320 | 305 | | | | | | |
| | 340 | 325 | | | | | | |
| | 360 | 345 | | | | | | |
| | 380 | 365 | | | | | | |
| | 400 | 380 | | | | | | |
| | 430 | 415 | | | | | | |
| | 480 | 456 | | | | | | |
| | 530 | 506 | | | | | | |
| | 580 | 556 | | | | | | |
| | 650 | 626 | | | | | | |
| | 700 | 680 | | | | | | |
| | 750 | 726 | | | | | | |
| | 800 | 780 | | | | | | |



**Figure C4. "SWG ASSY® VG plus Cyl." - metric specs**

**Notes to Table C4:**

1 Note: values listed in the table above are average measurements.

2 $L_{tip}$ = length of un-threaded portion on screw tip.

**Table C5 "SWG ASSY® VG plus CSK" - metric specs[1]**

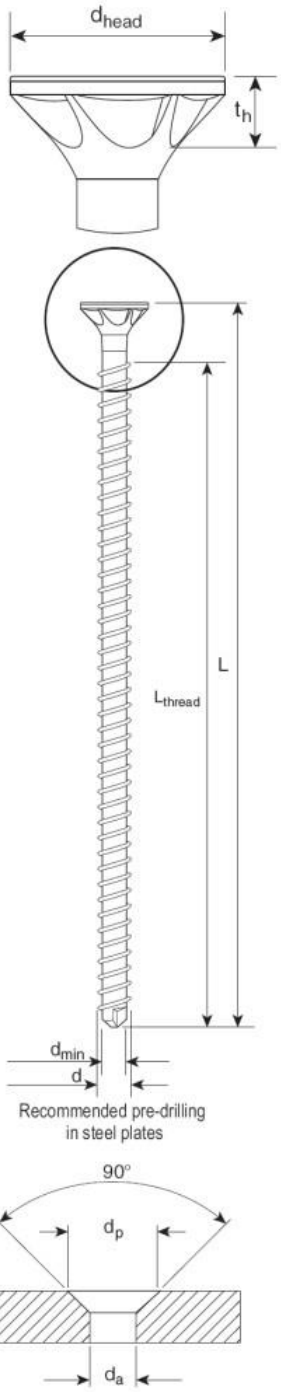
| d | L | $L_{thread}$ | $L_{tip}$[2] | $d_{head}$ | $d_{min}$ | $d_a$ | $t_h$ | $d_p$ | Bit | Figure |
|---|---|---|---|---|---|---|---|---|---|---|
| | mm | | | | | | | | | |
| 8 | 80 | 61 | 8 | 14.8 | 5 | 9 | 4.6 | 19 | AW 40 |  |
| | 120 | 103 | | | | | | | | |
| | 140 | 123 | | | | | | | | |
| | 160 | 143 | | | | | | | | |
| | 180 | 163 | | | | | | | | |
| | 200 | 183 | | | | | | | | |
| | 220 | 203 | | | | | | | | |
| | 240 | 223 | | | | | | | | |
| | 260 | 243 | | | | | | | | |
| | 280 | 263 | | | | | | | | |
| | 300 | 283 | | | | | | | | |
| 10 | 100 | 77 | 10 | 19.6 | 6.2 | 11 | 6.5 | 24 | AW 50 | |
| | 140 | 125 | | | | | | | | |
| | 160 | 145 | | | | | | | | |
| | 180 | 165 | | | | | | | | |
| | 200 | 185 | | | | | | | | |
| | 220 | 205 | | | | | | | | |
| | 240 | 225 | | | | | | | | |
| | 260 | 245 | | | | | | | | |
| | 280 | 265 | | | | | | | | |
| | 300 | 280 | | | | | | | | |
| | 320 | 305 | | | | | | | | |
| | 340 | 325 | | | | | | | | |
| | 360 | 345 | | | | | | | | |
| | 380 | 365 | | | | | | | | |
| | 400 | 385 | | | | | | | | |
| | 430 | 415 | | | | | | | | |
| | 480 | 465 | | | | | | | | |
| | 530 | 512 | | | | | | | | |
| | 580 | 562 | | | | | | | | |
| | 650 | 632 | | | | | | | | |
| | 700 | 682 | | | | | | | | |
| | 750 | 732 | | | | | | | | |
| | 800 | 782 | | | | | | | | |



**Figure C5. "SWG ASSY® VG plus CSK" - metric specs**

**Table C5 "SWG ASSY® VG plus CSK" - metric specs[1] (cont.)**

| d | L | $L_{thread}$ | $L_{tip}$[2] | $d_{head}$ | $d_{min}$ | $d_a$ | $t_h$ | $d_p$ | Bit | Figure |
|---|---|---|---|---|---|---|---|---|---|---|
| | mm | | | | | | | | | |
| 12 | 120 | 105 | 12 | 22.1 | 7.1 | 13 | 6.7 | 26 | AW 50 | |
| | 140 | 125 | | | | | | | | |
| | 160 | 145 | | | | | | | | |
| | 180 | 165 | | | | | | | | |
| | 200 | 185 | | | | | | | | |
| | 220 | 205 | | | | | | | | |
| | 240 | 225 | | | | | | | | |
| | 260 | 245 | | | | | | | | |
| | 280 | 265 | | | | | | | | |
| | 300 | 285 | | | | | | | | |
| | 380 | 365 | | | | | | | | |
| | 480 | 465 | | | | | | | | |
| | 600 | 585 | | | | | | | | |

**Notes to Table C5:**

1 Note: values listed in the table above are average measurements.

2 $L_{tip}$ = length of un-threaded portion on screw tip.

# Appendix D - Factored Withdrawal Resistances

**Table D1 Factored Withdrawal Resistance per 20-mm thread embedment depth[1]**

| Factored withdrawal resistance $P_{rw,\alpha}$ in kN per 20 mm (¾″) of thread penetration | | | | | | | | | Factored tensile resistance in kN |
|---|---|---|---|---|---|---|---|---|---|
| α | d | ρ = 0.35 | ρ = 0.42 | ρ = 0.44 | ρ = 0.46 | ρ = 0.49 | ρ = 0.5 PSL | ρ = 0.55 | |
| 90° | 6 | 0.63 | 0.91 | 0.97 | 1.06 | 1.20 | 0.70 | 1.51 | 9.04 |
| | 8 | 0.85 | 1.22 | 1.29 | 1.41 | 1.60 | 0.94 | 2.02 | 15.12 |
| | 10 | 1.06 | 1.52 | 1.61 | 1.76 | 2.00 | 1.17 | 2.52 | 19.2 |
| | 12 | 1.27 | 1.83 | 1.94 | 2.12 | 2.40 | 1.41 | 3.02 | 24 |
| 45° | 6 | 0.54 | 0.78 | 0.83 | 0.91 | 1.03 | 0.60 | 1.30 | 9.04 |
| | 8 | 0.73 | 1.04 | 1.11 | 1.21 | 1.37 | 0.80 | 1.73 | 15.12 |
| | 10 | 0.91 | 1.31 | 1.38 | 1.51 | 1.71 | 1.00 | 2.16 | 19.2 |
| | 12 | 1.09 | 1.57 | 1.66 | 1.81 | 2.06 | 1.21 | 2.59 | 24 |
| 30° | 6 | 0.51 | 0.73 | 0.77 | 0.85 | 0.96 | 0.56 | 1.21 | 9.04 |
| | 8 | 0.68 | 0.98 | 1.03 | 1.13 | 1.28 | 0.75 | 1.61 | 15.12 |
| | 10 | 0.85 | 1.22 | 1.29 | 1.41 | 1.60 | 0.94 | 2.02 | 19.2 |
| | 12 | 1.02 | 1.46 | 1.55 | 1.69 | 1.92 | 1.12 | 2.42 | 24 |

**Note to Table D1:**

1 The designer must verify that the factored withdrawal resistance does not exceed the factored tensile resistance.
The designer must verify the actual thread length of the screw.
The effective thread embedment depth is, d = thread length - tip length.
For conditions other that $K_D$ = 1 the designer must apply adjustment factors to values in table above.

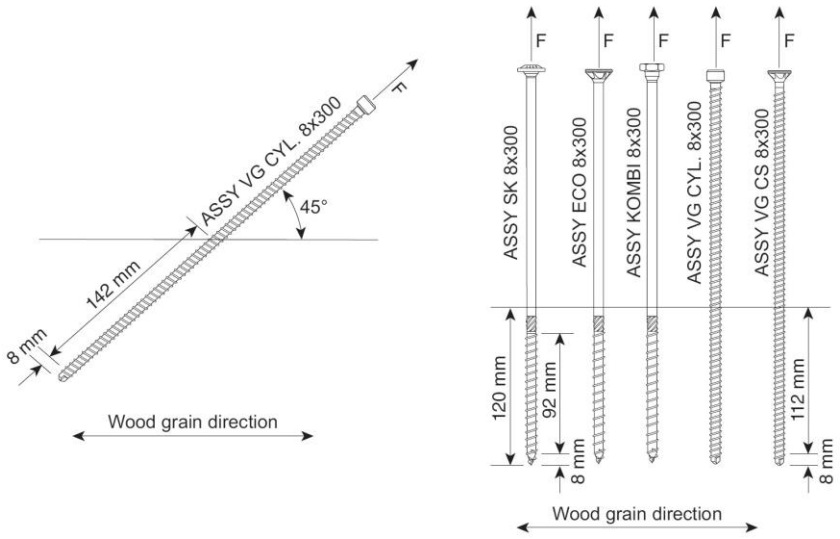



**Figure D1. Factored withdrawal resistance**

## Appendix E – Application Cases Permitted

**Table E1. The list of permitted application cases**

| Wood Species | Screw Diameter (mm) | Installation angle (°) | Effective embedment depth (mm) | | | |
|---|---|---|---|---|---|---|
| | | | 4d | 8d | 12d | 16d |
| DF | 6 | 90 | ✓ | ✓ | ✓ | ✓ |
| DF | 8 | 90 | ✓ | ✓ | ✓ | ✓ |
| DF | 10 | 90 | ✓ | ✓ | ✓ | ✓ |
| DF | 12 | 90 | ✓ | ✓ | ✓ | ✓ |
| DF | 6 | 45 | ✓ | ✓ | ✓ | ✓ |
| DF | 8 | 45 | ✓ | ✓ | ✓ | ✓ |
| DF | 10 | 45 | X | ✓ | ✓ | ✓ |
| DF | 12 | 45 | X | X | ✓ | ✓ |
| DF | 6 | 30 | ✓ | ✓ | ✓ | ✓ |
| DF | 8 | 30 | ✓ | ✓ | ✓ | ✓ |
| DF | 10 | 30 | X | ✓ | ✓ | ✓ |
| DF | 12 | 30 | X | X | ✓ | ✓ |

| Wood Species | Screw Diameter (mm) | Installation angle (°) | Effective embedment depth (mm) | | | |
|---|---|---|---|---|---|---|
| | | | 4d | 8d | 12d | 16d |
| SP | 6 | 90 | ✓ | ✓ | ✓ | ✓ |
| SP | 8 | 90 | ✓ | ✓ | ✓ | ✓ |
| SP | 10 | 90 | ✓ | ✓ | ✓ | ✓ |
| SP | 12 | 90 | ✓ | ✓ | ✓ | ✓ |
| SP | 6 | 45 | ✓ | ✓ | ✓ | ✓ |
| SP | 8 | 45 | ✓ | ✓ | ✓ | ✓ |
| SP | 10 | 45 | X | ✓ | ✓ | ✓ |
| SP | 12 | 45 | X | X | ✓ | ✓ |
| SP | 6 | 30 | ✓ | ✓ | ✓ | ✓ |
| SP | 8 | 30 | ✓ | ✓ | ✓ | ✓ |
| SP | 10 | 30 | X | ✓ | ✓ | ✓ |
| SP | 12 | 30 | X | X | ✓ | ✓ |

| Wood Species | Screw Diameter (mm) | Installation angle (°) | Effective embedment depth (mm) | | | |
|---|---|---|---|---|---|---|
| | | | 4d | 8d | 12d | 16d |
| PSL | 6 | 90 | ✓ | ✓ | ✓ | ✓ |
| PSL | 8 | 90 | ✓ | ✓ | ✓ | ✓ |
| PSL | 10 | 90 | ✓ | ✓ | ✓ | ✓ |
| PSL | 12 | 90 | ✓ | ✓ | ✓ | ✓ |
| PSL | 6 | 45 | ✓ | ✓ | ✓ | ✓ |
| PSL | 8 | 45 | ✓ | ✓ | ✓ | ✓ |
| PSL | 10 | 45 | X | ✓ | ✓ | ✓ |
| PSL | 12 | 45 | X | X | ✓ | ✓ |
| PSL | 6 | 30 | ✓ | ✓ | ✓ | ✓ |
| PSL | 8 | 30 | ✓ | ✓ | ✓ | ✓ |
| PSL | 10 | 30 | X | ✓ | ✓ | ✓ |
| PSL | 12 | 30 | X | X | ✓ | ✓ |

Note:✓-allowed; X-not allowed.
DF- Douglas-fir; SP- Spruce Pine; PSL- Parallel Strand Lumber; WRC- Western Red Cedar; SYP- Southern Yellow Pine

**Table E1. The list of application cases (cont'd)**

| Wood Species | Screw Diameter (mm) | Installation angle (°) | Effective embedment depth (mm) | | | |
|---|---|---|---|---|---|---|
| | | | 4d | 8d | 12d | 16d |
| WRC | 6 | 90 | ✓ | ✓ | ✓ | ✓ |
| WRC | 8 | 90 | ✓ | ✓ | ✓ | ✓ |
| WRC | 10 | 90 | ✓ | ✓ | ✓ | ✓ |
| WRC | 12 | 90 | ✓ | ✓ | ✓ | ✓ |
| WRC | 6 | 45 | ✓ | ✓ | ✓ | ✓ |
| WRC | 8 | 45 | ✓ | ✓ | ✓ | ✓ |
| WRC | 10 | 45 | X | ✓ | ✓ | ✓ |
| WRC | 12 | 45 | X | X | ✓ | ✓ |
| WRC | 6 | 30 | ✓ | ✓ | ✓ | ✓ |
| WRC | 8 | 30 | ✓ | ✓ | ✓ | ✓ |
| WRC | 10 | 30 | X | ✓ | ✓ | ✓ |
| WRC | 12 | 30 | X | X | ✓ | ✓ |

| Wood Species | Screw Diameter (mm) | Installation angle (°) | Effective embedment depth (mm) | | | |
|---|---|---|---|---|---|---|
| | | | 4d | 8d | 12d | 16d |
| SYP | 6 | 90 | ✓ | ✓ | ✓ | ✓ |
| SYP | 8 | 90 | ✓ | ✓ | ✓ | ✓ |
| SYP | 10 | 90 | ✓ | ✓ | ✓ | ✓ |
| SYP | 12 | 90 | ✓ | ✓ | ✓ | ✓ |
| SYP | 6 | 45 | ✓ | ✓ | ✓ | ✓ |
| SYP | 8 | 45 | ✓ | ✓ | ✓ | ✓ |
| SYP | 10 | 45 | X | ✓ | ✓ | ✓ |
| SYP | 12 | 45 | X | X | ✓ | ✓ |
| SYP | 6 | 30 | ✓ | ✓ | ✓ | ✓ |
| SYP | 8 | 30 | ✓ | ✓ | ✓ | ✓ |
| SYP | 10 | 30 | X | ✓ | ✓ | ✓ |
| SYP | 12 | 30 | X | X | ✓ | ✓ |

Note:✓-allowed; X-not allowed.
DF- Douglas-fir; SP- Spruce Pine; PSL- Parallel Strand Lumber; WRC- Western Red Cedar; SYP- Southern Yellow Pine