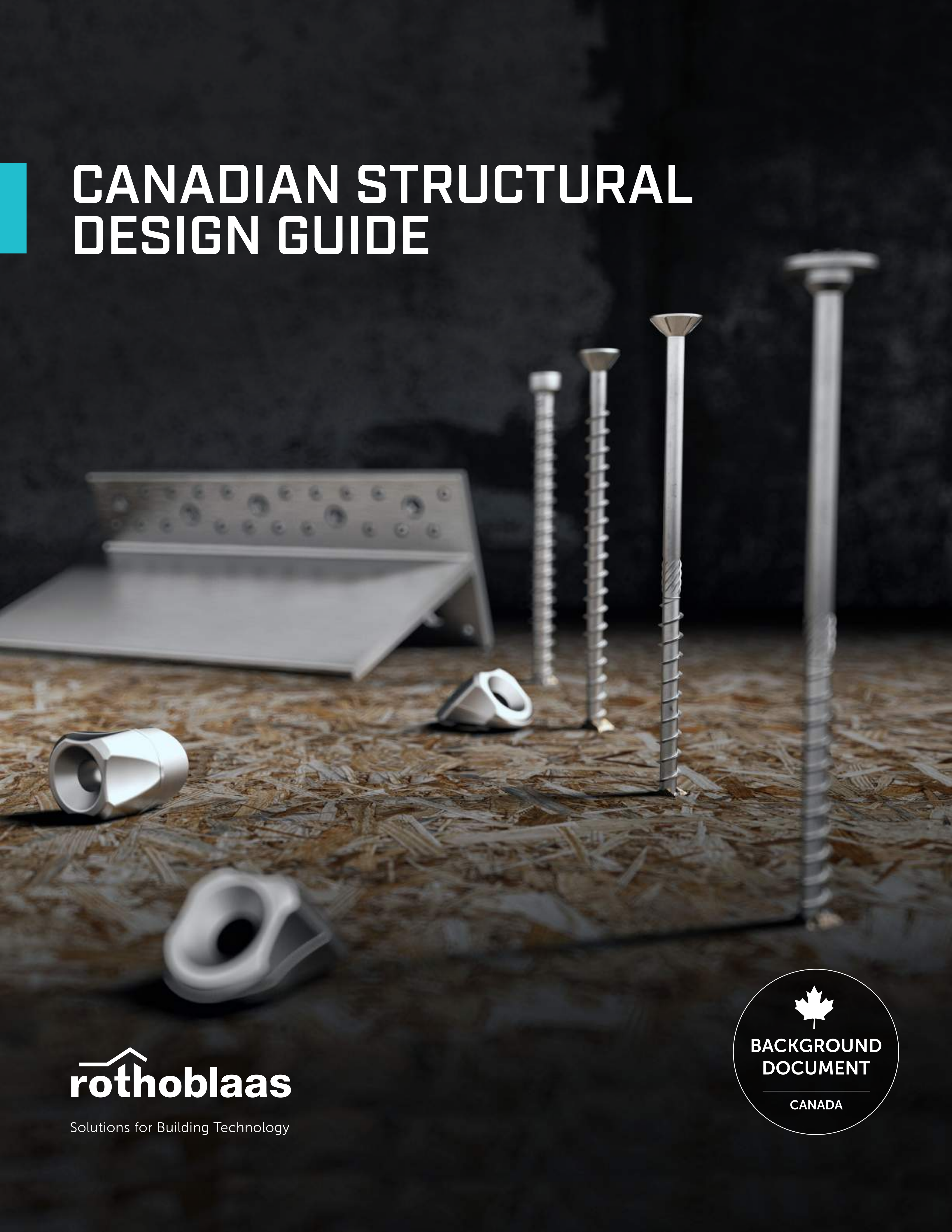
CANADIAN STRUCTURAL DESIGN GUIDE



BACKGROUND DOCUMENT

CANADA

rothoblaas

Solutions for Building Technology

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1. LIMIT STATE DESIGN - OVERVIEW

Limit state design (LSD) is a structural engineering design method in which a limit state is defined as a condition beyond which the structure is no longer considered safe or suitable for its intended use. Strength and serviceability are both limit states that require consideration. Strength limit states refer to the maximum load carrying capacity of the structure where serviceability limit states are those that restrict the normal use and occupancy of the structure such as excessive deflection or vibration.

LSD is a design format based on probabilities, in which both design loads and resistances are treated as random variables with a statistical distribution (e.g. bell curve, weibull distribution etc.). The design process aims to make the likelihood of the factored load exceeding the factored resistance (limit state) sufficiently low. This is expressed visually in Figure 1.

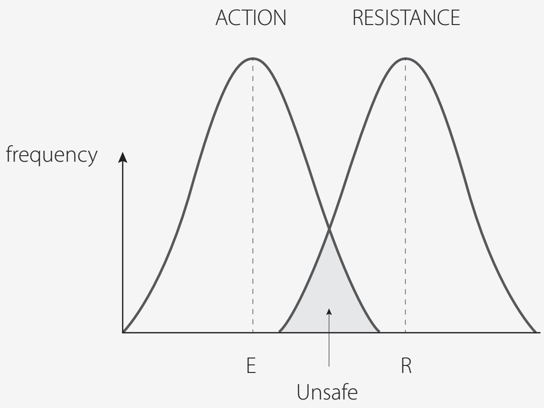


Figure 1: LSD Probabilistic Representation

The overlap of the load effect curve and the resistance curve is related to the probability of failure, and the smaller this area, the lower the probability of failure. LSD reduces the probability of failure by applying factors to both the design loads and resistances. Applicable factors are determined through statistical probability of failure. Factors are intended to account for potential uncontrollable variability in areas such as quality of construction practices and quality of construction materials.

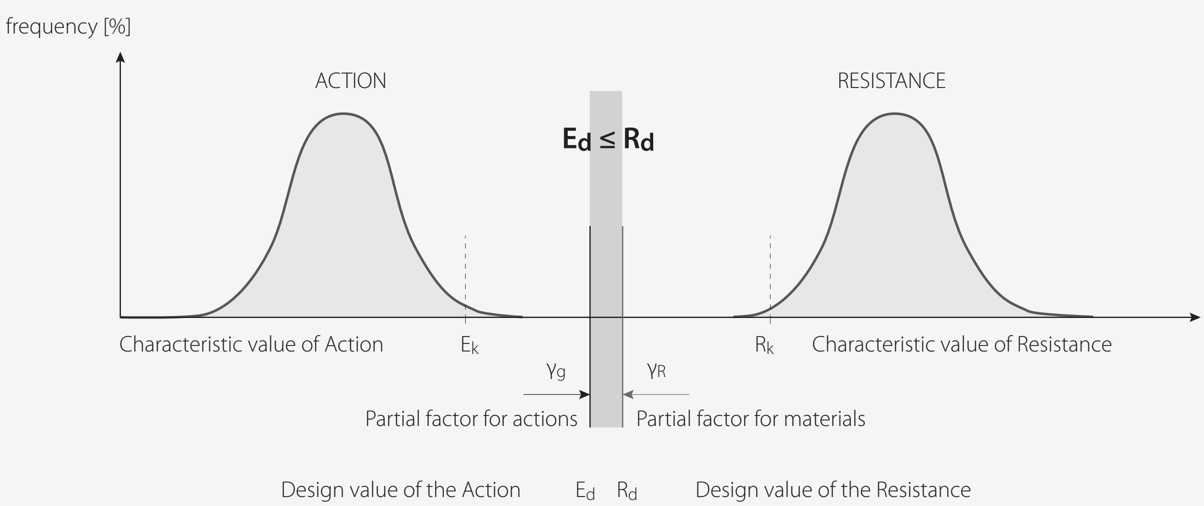


Figure 2: LSD Partial Factor Method

2. BUILDING CODE AND STANDARDS IN CANADA

2.1 GENERAL

The National Building Code of Canada (NBCC) is the model building code of Canada and is issued by the National Research Council Canada. As a model code, it has no legal status until it is adopted by a jurisdiction that regulates construction. Typically, these jurisdictions make minor adjustments specific to that jurisdiction. Part 4 of the National Building Code of Canada addresses the structural design of buildings. For the purpose of this document, all references are to the 2015 National Building Code of Canada.

The National Building Code of Canada also references the applicable design and material standards. These standards are developed and administrated by the CSA Group. This is an independent, not-for-profit, internationally-accredited standards development, testing and certification organization. These standards must be followed. If for example a building product is not covered by those standards, a report issued by an accredited organization can provide an alternate path to the use of such a product. Such a report would cover all relevant considerations related to the product, including but not limited to the materials used, production, design and construction.

2.2 LIMITS STATES DESIGN

The Canadian standard S408-11, Guidelines for the development of limit states design standards, provides the basic guidance on the limit state design principles adopted as the method for structural designs in Canada (NBCC 2015, 4.1.3).

S408-11 identifies the following limit states:
- Ultimate limit states (ULS)
- Fatigue limit state (FLS)
- Serviceability limit states (SLS)
- Structural integrity and robustness
- Fire resistance
- Durability
- Safety during construction and demolition

For the purpose of this document, only ultimate limit state and serviceability limit state are discussed.

The following formula represents the design format for **ultimate limits states (ULS)**.

Factored Resistance ≥ Effect of Factored Loads

or

$$ØR \geq \sum \alpha_i S_i$$

Where R represents the nominal resistance and Ø the resistance factor. Both values are provided in the applicable CSA Design Standards. In the case of wood, this standard is CSA O86 - Engineering Design in Wood. The loads $\sum \alpha_i S_i$ are calculated in accordance with the National Building Code of Canada (NBCC 4.1.3.2). S_i represents the specified load and α_i the applicable companion factor.

The following formula represents the design format for **serviceability limits states (SLS)**.

Serviceability Limit ≥ Effect of Service Loads

or

$$SL \geq \sum \alpha_i S_i$$

Where SL represents the serviceability limit for a given serviceability parameter. These parameters are typically deflection and vibration. Both parameters and associated limits are addressed in the National Building Code of Canada, the applicable design standards or the respective commentaries.

2.3 SPECIFIED LOADS

The specified loads are categorized in the following manner:

D = dead load due to self-weight and permanent non-structural elements
E = load due to earthquake
L = live load due to intended use and occupancy
S = load due to snow, including ice and associated rain
W = load due to wind
H = load due to lateral earth pressure, including ground water
P = permanent effects caused by prestress
T = load due to contraction and expansion caused by temperature changes, shrinkage, moisture changes, creep, movement due to differential settlement, or combinations thereof

Importance factors are applied to the specified loads for snow and rain, wind, and earthquake loads and are dependent on the type of load and type of building use and occupancy. They are different for ultimate limit states and serviceability limit states. The tables below show the various importance factors.

Table 1: Importance Factors for variable loads

Importance Category	**Snow**		**Wind**		**Earthquake**	
	ULS	SLS	ULS	SLS	ULS	SLS
Low	0.8	0.9	0.8	0.75	0.8	1.0 but varying limits based on category
Normal	1.0	0.9	1.0	0.75	1.0	
High	1.15	0.9	1.15	0.75	1.3	
Post-Disaster	1.25	0.9	1.25	0.75	1.5	

2.4 LOAD COMBINATIONS

Specified loads that are considered in the actual design are combined using a companion action format for both ultimate limit states and serviceability limits states.

Generally, the load combinations where all loads are permanent or variable are:

$$\sum \alpha_{G_i} \cdot G_i + \alpha_{Q_i} \cdot Q_1 + \sum \alpha_{CQ_i} \cdot Q_i$$

Where:

G_i = permanent load such as D, H, T or P
Q_1 = principal variable loads such as L, S or W or other load, taken in turn
Q_i = any variable load such as L, S or W
α_{G_i} = principal load factor for the permanent load, G_i
α_{Q_i} = principal load factor for the principal variable load, Q_i
α_{CQ_i} = companion load factor for other variable loads and where the second term in the equation above is the principal variable load and the last term comprises the companion (expected) variable load or loads.

2.4.1 ULTIMATE LIMIT STATES

The table below shows the various load combinations for the ultimate limit states using the load factors for the principal load and companion load as per the 2015 National Building Code of Canada (NBCC 4.1.3.2).

Table 2: load combinations for ultimate limits states

Load case	Load Combination	
	Principal Load	Companion Load
1	1.4D	-
2	(1.25D or 0.9D) + 1.5L	1.0S or 0.4W
3	(1.25D or 0.9D) + 1.5S	1.0L or 0.4W
4	(1.25D or 0.9D) + 1.4W	0.5L or 0.5S
5	1.0D + 1.0E	0.5L or 0.25S

It needs to be noted that some special considerations are given to storage loads, equipment areas, service rooms, lateral earth pressure and prestress loads. Refer to the National Building Code of Canada for details.

The resistance of the wood members and connections is adjusted based on load duration associated with the load combination and other factors impacting the resistance. See chapter 2.5 for details.

2.4.2 SERVICEABILITY ULTIMATE LIMIT STATES

The National Building Code of Canada does not specifically provide load combinations for the serviceability limits states. CSA O86 however, provides load combinations. These are summarized in Table 3.

Table 3: load combinations for serviceability limits states

Load case	Load Combination	
	Principal Load	Companion Load
1	1.0D	-
2	1.0D + 1.0L	0.5S or 0.4W
3	1.0D + 1.0S	0.5L or 0.4W
4	1.0D + 1.0W	0.5L or 0.4S

2.5 ULTIMATE LIMIT STATE RESISTANCE

2.5.1 INTRODUCTION

The calculation of resistances of wood members is following the limits states design principles. This chapter provides an overview of the process on how to obtain the design resistance, including the various adjustment factors.

2.5.2 SPECIFIED RESISTANCE

The basic approach to reliability-based design analysis used in CSA O86 - Engineering Design in Wood, is described in Foschi, Folz and Yao (1989). The Technical Committee on Engineering Design in Wood accepted the methodology and adopted the principle that specified strength properties should be scaled to a target level of the reliability index, β, when evaluated for load cases relevant to the Canadian environment. The reliability analysis method required data for the calculation of characteristic values, as well as sufficient data to establish coefficients of variation by fitting the data to Weibull 2-parameter distribution models. To represent the variability of the data, it was necessary in some cases to fit the 2-parameter Weibull model to the "lower tail" (e.g., weakest 15%) of the distribution. The load parameters identified in Foschi, Folz and Yao (1989) covered a range of Canadian loading conditions. The CSA O86 Committee based its decisions on average effects of these loading conditions.

CSA O86 - Engineering Design in Wood provides specified resistances R_s for all wood products covered by the standard. As with most wood design standards following the limits states design, the starting point to obtain a material design resistance R_d is the characteristic resistance R_{05}. The characteristic resistance R_{05} represents the 5th percentile characteristic strength property. In general, the hierarchy between the various resistances can be expressed as follows:

$$R_d < R_s < R_n < R_{05}$$

Where:

R_d	= design resistance
R_s	= specified resistance
R_n	= nominal resistance
R_{05}	= characteristic resistance

As described in chapter 2.2, the design format adopted by the National Building Code of Canada has the form:

$$\textit{Factored Resistance} \geq \textit{Effect of Factored Loads}$$

The factored resistance is the product of the nominal (standardized) resistance factor, Ø , and the specified strength R_s. This is expressed as follows:

$$\varnothing \cdot R_s \geq \textit{Effect of Factored Loads}$$

The specified strength is the product of an adjustment for duration of load, A, and the nominal-short-term strength. This is expressed as follows:

$$R_s = A \cdot R_n$$

The nominal strength R_n can be related to the characteristic strength R_{05} with the use of a normalization factor B. This is expressed as follows:

$$R_n = B \cdot R_{05}$$

2.5.3 DEFINITION IN CSA O86

The definition used in CSA O86 - Engineering Design in Wood, is slightly different from the general definition above. The resistance is represented by the letter F rather than R. Further, the specified resistance is represented by f_s rather than R_s.

2.5.4 DESIGN RESISTANCES

In order to obtain the design resistance F_d the specified value f_s is multiplied by the related resistance factor Ø and all applicable modification factors K_i. These factors represent the various conditions affecting the resistance of a wood member and are outlined in CSA O86, chapter 4.3. The full equation therefore reads as follows:

$$F_d = \varnothing \cdot [\, f_s \cdot (\, K_D \cdot K_S \cdot K_T \cdot K_H \cdot K_Z \cdot K_L \,)\,]$$

These various factors are summarized in table 4.

Table 4: General Modification Factors

Symbol	Definition	Description
K_D	Load Duration Factor	The load duration factor accounts for the variable, time dependent action. K_D is 1.15 for-short term loading where the duration of the loads is not expected to last more than 7 days continuously or cumulatively throughout the life of the structure. K_D 1.0 is for loading where the duration of loads exceeds that of short-term loading but is less than long-term loading. K_D 0.65 is for long-term loading where the duration of the load is more or less permanent.
K_S	Service Condition Factor	The service condition factor accounts for varying material properties for different levels of equilibrium moisture content of the wood products.
K_T	Preservative and fire-retardant treatment factor	The preservative and fire-retardant treatment factor accounts for the change in material properties for various wood treatments.
K_H	System Factor	The system factor accounts for a potential redundancy in the structural system.
K_Z	Size Factor	The size factor accounts for the difference in material properties for various member sizes compared to the baseline values established based on a reference member size.
K_L	Lateral Stability Factor	The lateral stability factor accounts for the type of lateral support provided.

These are general modification factors. Additional modification factors may be used for specific design checks.

2.6 SERVICABILITY LIMIT STATE CRITERIA

For the purpose of this document, only the deflection criteria are discussed. For deflection, the serviceability limit states criteria are found in the design standard CSA O86 and are as follows.

Elastic Deflection:
- The elastic deflection of structural members under the load combinations for serviceability limit states shall not exceed L/180 of the span.
- For members having cambers equaling at least dead load deflection, the additional deflection due to live, snow, and wind loads shall not exceed L/180 of the span.

Permanent Deformation:
- Structural members that support long term loads in excess of 50% of the load combinations for serviceability limit states shall be designed to limit permanent deformation.
- In lieu of a more accurate evaluation of acceptable deflection limits, an upper limit of L/360 of the span shall be imposed on the elastic deflection due to long term loads.

The Wood Design Manual issued by the Canadian Wood Council provides further guidance, but these are recommendations only.

In addition, CSA O86 addresses the requirement for ponding on roof. Roof framing systems shall be investigated by rational analysis to ensure adequate performance under ponding conditions where the influence of deflections may create conditions where additional load can become concentrated and lead to structural instabilities or overloads.

3. BUILDING CODE AND STANDARDS IN EUROPE

3.1 BACKGROUND

In 1975 the Commission of the European Community decided on an action programme in order to establish a set of harmonised technical rules for the structural design of buildings and civil engineering works with the objective to replace the differing rules in the various Member States.

There is a clear and vital distinction between design codes and National Regulations/Public Authority Requirements. Harmonisation of National requirements is outside the scope of Eurocode development. It is the objective however that the Eurocodes, together with their appropriate National Annexes, should be recognised in National Regulations as one of the routes for meeting compliance.

The Eurocodes are published as a separate European Standards, each having a number of parts. By 2002, ten sections have been developed and published:

Table 5: The Structural Eurocodes

EN Number	The Structural Eurocodes
EN 1990	Eurocode 0: Basis of Structural Design
EN 1991	Eurocode 1: Actions on structures
EN 1992	Eurocode 2: Design of concrete structures
EN 1993	Eurocode 3: Design of steel structures
EN 1994	Eurocode 4: Design of composite steel and concrete structures
EN 1995	Eurocode 5: Design of timber structures
EN 1996	Eurocode 6: Design of masonry structures
EN 1997	Eurocode 7: Geotechnical design
EN 1998	Eurocode 8: Design of structures for earthquake resistance
EN 1999	Eurocode 9: Design of aluminium structures

Each of the ten Eurocodes listed in this paper are made up of separate parts, which cover the technical aspects of the structural and fire design of buildings and civil engineering structures.

The Eurocodes are a harmonised set of documents that have to be used together. Their linked relationship is shown in Figure 3

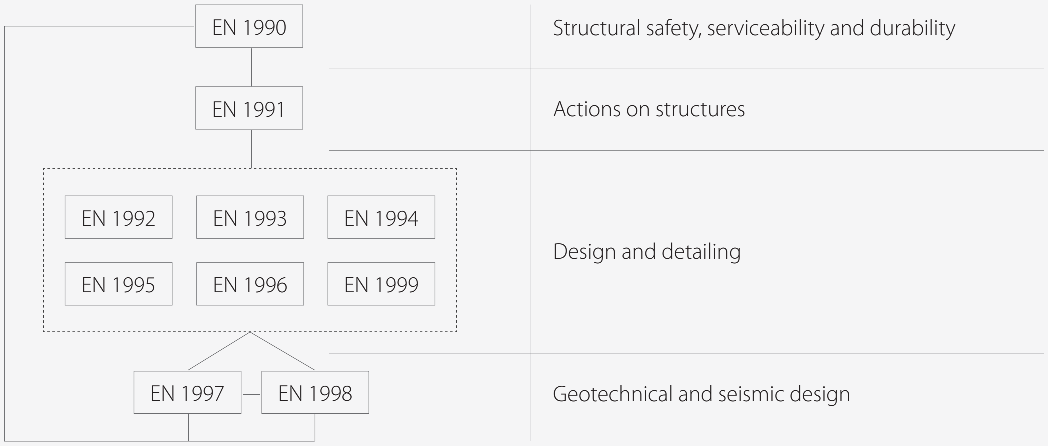


Figure 3: Linked relationship between the Eurocodes

It is the responsibility of each national standards body to implement Eurocodes as national standards.

The European Commission recognises the responsibility of regulatory authorities or national competent authorities in each EU Member State. It has safeguarded their right to determine values related to safety matters at national level through a National Annex. These safety matters include different levels of protection that may prevail at national, regional or local level.

A National Annex may only contain information on those parameters which are left open in the Eurocode for national choice (known as *Nationally Determined Parameters*), to be used for the design of buildings and civil engineering works to be constructed in the country concerned:

- values and/or classes where alternatives are given in the Eurocode (e.g. levels of safety);
- values to be used where only a symbol is given in the Eurocode (e.g. partial factors);
- country-specific data (geographical, climatic, etc.) (e.g. snow maps);
- procedures to be used where alternative procedures are given in the Eurocodes.

3.2 LIMITS STATES DESIGN

The 'Principle' requirement is that design should consider:
- Different material properties;
- Different time-dependent behaviour of materials (i.e. creep, load-duration, etc.) [Note, this is more pronounced for timber];
- Different climatic conditions (e.g. moisture variations, temperatures, relative humidity, etc.);
- Different design situations (e.g. stages of construction, change of support conditions, etc.);

There are two main parts of limit state design namely '*ULTIMATE LIMIT STATE (ULS)*' and '*SERVICEABILITY LIMIT STATE (SLS)*'.

3.3 ULTIMATE LIMIT STATES (ULS)

The following ultimate limit states (ULS) shall be verified as relevant:

I. EQU : Loss of static equilibrium of the structure or any part of it considered as a rigid body, where:
   a. minor variations in the value or the spatial distribution of actions from a single source are significant, and
   b. the strengths of construction materials or ground are generally not governing;

II. STR : Internal failure or excessive deformation of the structure or structural members, including footings, piles, basement walls, etc., where the strength of construction materials of the structure governs;

III. GEO : Failure or excessive deformation of the ground where the strengths of soil or rock are significant in providing resistance;

IV. FAT : Fatigue failure of the structure or structural members.

3.4 SERVICEABILITY LIMIT STATES (ULS)

The verification of serviceability limit states (SLS) should be based on criteria concerning the following aspects:

I. Deformations that affect:
   a. the appearance;
   b. the comfort of users;
   c. the functioning of the structure (including the functioning of machines or services) or that cause damage to finishes or non-structural members;

II. Vibrations:
   a. that cause discomfort to people;
   b. that limit the functional effectiveness of the structure;

III. Damage that is likely to adversely affect:
   a. the appearance;
   b. the durability;
   c. the functioning of the structure.

3.5 CLASSIFICATION OF ACTIONS

Actions shall be classified by their variation in time as follows:

- *permanent actions* (**G**), e.g. self-weight of structures, fixed equipment and road surfacing, and indirect actions caused by shrinkage and uneven settlements;
- *variable actions* (**Q**), e.g. imposed loads on building floors, beams and roofs, wind actions or snow loads;
- *accidental actions* (**A**), e.g. explosions, or impact from vehicles.

Certain actions, such as seismic actions and snow loads, may be considered as either accidental and/or variable actions, depending on the site location

3.6 DESIGN VALUES OF ACTIONS

In general terms the design value F_d of an action F is expressed by the following relation:

$$F_d = \gamma_f \cdot F_{rep}$$

where F_{rep} indicates the representative value of the action, and γ_f is a partial factor for the action, which provides for the possibility that the action's values may in fact present unfavourable variations from the representative values.

F_{rep} is calculated from the characteristic value F_k of the action, via expression:

$$F_{rep} = \psi \cdot F_k$$

where ψ is a reduction factor (ψ_0, ψ_1, ψ_2) equal or less than 1

3.7 LOAD COMBINATIONS

Actions are combined in various combinations. The combinations of actions given below should be used when verifying **ultimate limit states** (ULS):

- Combinations of actions for persistent or transient design situations (*fundamental combinations*):

$$\sum_{j \geq 1} \gamma_{G,j} \cdot G_{k,j} \text{ “} + \text{”} \gamma_P \cdot P \text{ “} + \text{”} \gamma_{Q,1} \cdot Q_{k,1} \text{ “} + \text{”} \sum_{i > 1} \gamma_{Q,i} \cdot \psi_{0,i} \cdot Q_{k,i}$$

This combination assumes that a number of variable actions are acting simultaneously. $Q_{k,1}$ is the dominant variable action and this is combined with the combination value of the accompanying variable actions $Q_{k,i}$.

• Combinations of actions for seismic design situations:

$$\sum_{j \geq 1} G_{k,j} \text{"} + \text{"} P \text{"} + \text{"} A_{Ed} \text{"} + \text{"} \sum_{i \geq 1} \psi_{2,i} \cdot Q_{k,i}$$

For **serviceability limit states** verification (SLS), EN 1990 requires the three combinations below to be investigated. EN 1990 gives three expressions for serviceability design: characteristic, frequent and quasi-permanent.

• The characteristic (rare) combination:

$$\sum_{j \geq 1} G_{k,j} \text{"} + \text{"} P \text{"} + \text{"} Q_{k,1} \text{"} + \text{"} \sum_{i > 1} \psi_{0,i} \cdot Q_{k,i}$$

• The frequent combination:

$$\sum_{j \geq 1} G_{k,j} \text{"} + \text{"} P \text{"} + \text{"} \psi_{1,1} \cdot Q_{k,1} \text{"} + \text{"} \sum_{i > 1} \psi_{2,i} \cdot Q_{k,i}$$

• The quasi-permanent combination:

$$\sum_{j \geq 1} G_{k,j} \text{"} + \text{"} P \text{"} + \text{"} \sum_{i \geq 1} \psi_{2,i} \cdot Q_{k,i}$$

Partial factors for actions and combinations of actions:

Table 6: Recommended values of factors for buildings

Action	Ψ_0	Ψ_1	Ψ_2
Imposed loads in buildings, category (see EN 1991-1-1)			
Category A: domestic, residential areas	0.7	0.5	0.3
Category B: office areas	0.7	0.5	0.3
Category C: congregation areas	0.7	0.7	0.6
Category D: shopping areas	0.7	0.7	0.6
Category E: storage areas	1.0	0.9	0.8
Category F: traffic area, vehicle weight ≤ 30 kN	0.7	0.7	0.6
Category G : traffic area, 30 kN < vehicle weight ≤ 160 kN	0.7	0.5	0.3
Category H : roofs	0	0	0
Snow loads on buildings (see EN 1991-1-3)*			
Finland, Iceland, Norway, Sweden			
Remainder of CEN Member States, for sites located at altitude H > 1000 m a.s.l.	0.7	0.5	0.2
Remainder of CEN Member States, for sites located at altitude H ≤ 1000 m a.s.l.	0.50	0.20	0
Wind loads on buildings (see EN 1991-1-4)	0.6	0.2	0
Temperature (non-fire) in buildings (see EN 1991-1-5)	0.6	0.5	0

NOTE: The Ψ values may be set by the National Annex.
** For countries not mentioned below, see relevant local conditions*

For buildings, the recommended partial factors for the persistent and transient situation in EN 1990 are:

Table 7: Design values of actions

		EQU - set A	STR/GEO - Set B	STR/GEO - Set C
Permanent actions	Unfavourable	$\gamma_{Gj,sup} = 1.10$	$\gamma_{Gj,sup} = 1.35$	$\gamma_{Gj,sup} = 1.00$
	Favourable	$\gamma_{Gj,inf} = 0.90$	$\gamma_{Gj,inf} = 1.00$	$\gamma_{Gj,inf} = 1.00$
Leading variable action	Unfavourable	$\gamma_{Q,1} = 1.50$	$\gamma_{Q,1} = 1.50$	$\gamma_{Q,1} = 1.30$
	Favourable	$\gamma_{Q,1} = 0$	$\gamma_{Q,1} = 0$	$\gamma_{Q,1} = 0$
Accompanying variable actions	Main (if any)	$\gamma_{Q,i} = 1.50$	$\gamma_{Q,i} = 1.50$	$\gamma_{Q,i} = 1.30$
	Others	$\gamma_{Q,i} = 0$	$\gamma_{Q,i} = 0$	$\gamma_{Q,i} = 0$

where

$\gamma_{Gj,sup}, \gamma_{Gj,inf}$ Partial factor for permanent action j in calculating upper/lower design values

γ_Q Partial factor for variable actions

In common cases the structural resistance is governed by condition STR/GEO - Set B.

3.8 ULTIMATE LIMIT STATE RESISTANCE

3.8.1 INTRODUCTION

Designing and the assessment of reliability of timber structural members in ultimate limit state according to contemporary European standards (Eurocode 5 EN 1995) means that each member has to satisfy the main condition in the expression:

$$S_d \leq R_d$$

where

R_d is design value of resistance of the timber structural member (load-carrying capacity)

S_d is the design value of load-effect combinations

3.8.2 DESIGN VALUES OF THE RESISTANCE

Design resistance is 'load-carrying capacity' which must be calculated by:

$$R_d = k_{mod} \cdot R_k / Y_M$$

where

R_d is design resistance (i.e. design load-carrying capacity)

R_k is characteristic value of load-carrying capacity

k_{mod} is modification factor taking into account the duration of load and moisture content

Y_M is the factor for material properties

Table 8 and Table 9 show the modification factor k_{mod} and partial factors Y_M respectively.

Table 8: Values of k_{mod}

Material	Standard	Service class	Load-duration class				
			Permanent action	Long term action	Medium term action	Short term action	Instantaneous action
Solid timber	EN 14081-1	1	0.60	0.70	0.80	0.90	1.10
		2	0.60	0.70	0.80	0.90	1.10
		3	0.50	0.55	0.65	0.70	0.90
Glued laminated timber	EN 14080	1	0.60	0.70	0.80	0.90	1.10
		2	0.60	0.70	0.80	0.90	1.10
		3	0.50	0.55	0.65	0.70	0.90
LVL	EN 14374, EN 14279	1	0.60	0.70	0.80	0.90	1.10
		2	0.60	0.70	0.80	0.90	1.10
		3	0.50	0.55	0.65	0.70	0.90
Plywood	EN 636						
	Part 1, Part 2, Part 3	1	0.60	0.70	0.80	0.90	1.10
	Part 2, Part 3	2	0.60	0.70	0.80	0.90	1.10
	Part 3	3	0.50	0.55	0.65	0.70	0.90
OSB	EN 300						
	OSB/2	1	0.30	0.45	0.65	0.85	1.10
	OSB/3, OSB/4	1	0.40	0.50	0.70	0.90	1.10
	OSB/3, OSB/4	2	0.30	0.40	0.55	0.70	0.90
Particleboard	EN 312						
	Part 4, Part 5	1	0.30	0.45	0.65	0.85	1.10
	Part 5	2	0.20	0.30	0.45	0.60	0.80
	Part 6, Part 7	1	0.40	0.50	0.70	0.90	1.10
	Part 7	2	0.30	0.40	0.55	0.70	0.90
Fibreboards hard	EN 622-2						
	HB.LA, HB.HLA 1 or 2	1	0.30	0.45	0.65	0.85	1.10
	HB.HLA 1 or 2	2	0.20	0.30	0.45	0.60	0.80
Fibreboards, medium	EN 622-3						
	MBH.LA1 or 2	1	0.20	0.40	0.60	0.80	1.10
	MBH.HLS1 or 2	1	0.20	0.40	0.60	0.80	1.10
	MBH.HLS1 or 2	2	-	-	-	0.45	0.80
Fibreboards, MDF	EN 622-5						
	MDF.LA, MDF.HLS	1	0.20	0.40	0.60	0.80	1.10
	MDF.HLS	2	-	-	-	0.45	0.80

NOTE: If a structure is loaded by loads which have different load-durations, the k_{mod} factor for the shortest load duration should be used.

Table 9: Recommended partial factors γ_M

Type of material	γ_M
Solid timber	1.3
Glued laminated timber	1.25
LVL, plywood, OSB	1.2
Particleboards	1.3
Fibreboards, hard	1.3
Fibreboards, medium	1.3
Fibreboards, MDF	1.3
Fibreboards, soft	1.3
Connections	1.3
Punched metal plate fasteners	1.25
Accidental combinations	1.0

NOTE: The recommended partial factors for material properties (γ_M) are given in table above. Information on the National choice may be found in the National Annex.

3.8.2.1 LOAD-DURATION CLASSES

Timber and wood-based products are materials that, if put under a load for a duration and with varying moisture content, their strength and stiffness performance reduce as time goes by.

The load-duration classes are characterised by the effect of a constant load acting for a certain period of time in the life of the structure. For a variable action the appropriate class shall be determined on the basis of an estimate of the typical variation of the load with time. Actions shall be assigned to one of the load-duration classes given in Table 4 for strength and stiffness calculations.

Table 10: Load-duration classes

Load-duration class	Order of accumulated duration of characteristic load	Examples of load-duration assignment
Permanent	more than 10 years	self-weight
Long-term	6 months - 10 years	storage
Medium-term	1 week - 6 months	imposed floor load, snow
Short-term	less than one week	snow, wind
Instantaneous	-	wind, accidental load, seismic

3.8.2.2 SERVICE CLASSES

Service classes are important as they represent moisture content in timber and wood-based products which affects the strength and stiffness of the materials, and thereby the structure.

Table 11: Service class

Service class	Definitions	Typical moisture content (m.c.)
1	Moisture content (m.c.) resulting from 20°C and Relative Humidity (RH) of surrounding air only exceeding 65% for a few weeks per year	Timber ≤ 12 %
2	Moisture content (m.c.) resulting from 20°C and Relative Humidity (RH) of surrounding air only exceeding 85% for a few weeks per year	Timber ≤ 20 %
3	Conditions leading to higher moisture content than 1 and 2	Timber > 20 %

NOTE : Information on the assignment of structures to service classes given above may be given in the National Annex

3.9 SERVICEABILITY LIMIT STATE CRITERIA

For the purpose of this document, only the deflection criteria are discussed. The deformation of a structure which results from the effects of actions and from moisture shall remain within appropriate limits, having regard to the possibility of damage to surfacing materials, ceilings, floors, partitions and finishes, and to the functional needs as well as any appearance requirements.

Vertical deflections are represented schematically below:

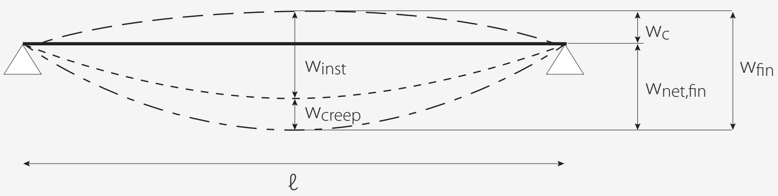


Figure 4: Vertical deflections

Where

w_c is the precamber (if applied)

w_{inst} is the instantaneous deflection. It should be calculated for the characteristic combination of actions using mean values of the appropriate moduli of elasticity, shear moduli and slip moduli

w_{creep} is the creep deflection

w_{fin} is the final deflection. It should be calculated for the quasi-permanent combination of actions

$w_{net,fin}$ is the net final deflection

The net deflection below a straight line between the supports, wnet,fin, should be taken as:

$$w_{net,fin} = w_{inst} + w_{creep} - w_c = w_{fin} - w_c$$

For structures consisting of members, components and connections with the same creep behaviour and under the assumption of a linear relationship between the actions and the corresponding deformations, the final deformation, w_{fin} , may be taken as:

$$w_{fin} = w_{fin,G} + w_{fin,Q1} + w_{fin,Qi}$$

Where

$w_{fin,G} = w_{inst,G} \cdot (1 + k_{def})$	for a permanent action, G
$w_{fin,Q1} = w_{inst,Q1} \cdot (1 + \psi_{2,1} \cdot k_{def})$	for the leading variable action, Q_1
$w_{fin,Qi} = w_{inst,Qi} \cdot (\psi_{0,i} + \psi_{2,i} \cdot k_{def})$	for accompanying variable actions, Q_i ($i > 1$)
$w_{inst,G}$, $w_{inst,Q1}$, $w_{inst,Qi}$	are the instantaneous deformations for action G, Q_1, Q_i respectively
$\psi_{2,1}$,$\psi_{2,i}$	are the factors for the quasi-permanent value of variable actions
$\psi_{0,i}$	are the factors for the combination value of variable actions
k_{def}	is given in table 8

Table 12: Values of k_{def} for timber and wood-based materials

Material	Standard	Service class		
		1	2	3
Solid timber	EN 14081-1	0.60	0.80	2.0
Glued laminated timber	EN 14080	0.60	0.80	2.0
LVL	EN 14374, EN 14279	0.60	0.80	2.0
Plywood	EN 636			
	Part 1	0.80	-	-
	Part 2	0.80	1.0	-
	Part 3	0.80	1.0	2.5
OSB	EN 300			
	OSB/2	2.25	-	-
	OSB/3, OSB/4	1.50	2.25	-
Particleboard	EN 312			
	Part 4	2.25	-	-
	Part 5	2.25	3.00	-
	Part 6	1.50	-	-
	Part 7	1.50	2.25	-
Fibreboards hard	EN 622-2			
	HB.LA	2.25	-	-
	HB.HLA 1 or 2	2.25	3.00	-
Fibreboards, medium	EN 622-3			
	MBH.LA1 or 2	3.00	-	-
	MBH.HLS1 or 2	3.00	4.00	-
Fibreboards, MDF	EN 622-5			
	MDF.LA	2.25	-	-
	MDF.HLS	2.25	3.00	-

NOTE: The **recommended** *range of limiting values of deflections for beams with span "L" is given in Table below depending upon the level of deformation deemed to be acceptable. Information on National choice may be found in the National annex.*

Table 13: Examples of limiting values for deflections of beams

	w_{inst}	$w_{net,fin}$	w_{fin}
Beam on two supports	L/300 to L/500	L/250 to L/350	L/150 to L/300
Cantilevering beams	L/150 to L/250	L/125 to L/175	L/75 to L/150

NOTE: the limits above should be considered as recommended limits

4. COMPARISON OF EUROPEAN AND CANADIAN CODES AND STANDARDS

4.1 DESIGN PRINCIPLES

As discussed in this document, both the Canadian and European Building Codes and Standards are fundamentally based on the Limits States Design Principles. The difference is in how the actual design value of the Action (load combination) and the design value of the Resistance is being determined.

4.2 DESIGN VALUE OF THE ACTION (LOAD COMBINATION)

The 2015 National Building Code of Canada and EN 1990 (EC 0) use slightly different load combinations and load factors. This chapter provides a practical overview of the differences between these combinations - from a practical design point of view.

Appendix A shows various building types, design situations, geographical locations and associated typical dead (D), live (L) snow (S), wind (W) and seismic (E) loads. Dead, live and snow, and wind loads are based on the requirements prescribed by the NBCC 2015. A comparison of the seismic design load combination is not as straight forward. It needs to be noted that the return periods used to determine the seismic hazards (spectral acceleration values) are quite different in Europe and Canada. EN 1998 is using a return period of 475 years (probability of exceedance of 10% in 50 years), whereas NBCC 2015 is using a return period of approximately 2500 years (probability of exceedance of 2% in 50 years). Also, the contributing mass (M) combinations are calculated differently. For the purpose of this comparison, we set the resulting seismic base shear to 1000 kN.

4.2.1 ULTIMATE LIMIT STATE

The loads as described above were combined using the Ultimate Limits States load combinations for EN 1990 and the NBCC 2015 respectively.

Gravity Loads
Table 14 shows the applicable loads combinations for office and residential floors.

Table 14: Example Gravity Load Combinations

Load combinations		Example Floor Loading ULS (kPa)		
		Office Floor D = 3.6 kPa L = 2.4 kPa	**Office Corridor** D = 2.6 kPa L = 4.8 kPa	**Residential Floor** D = 2.5 kPa L = 1.9 kPa
NBCC 2015	$1.25 \cdot D + 1.5 \cdot L$	8.1 kPa	10.5 kPa	6.0 kPa
EN 1990	$1.35 \cdot D + 1.5 \cdot L$	8.5 kPa	10.7 kPa	6.2 kPa

Figure 5 shows the comparison of load combinations considered.

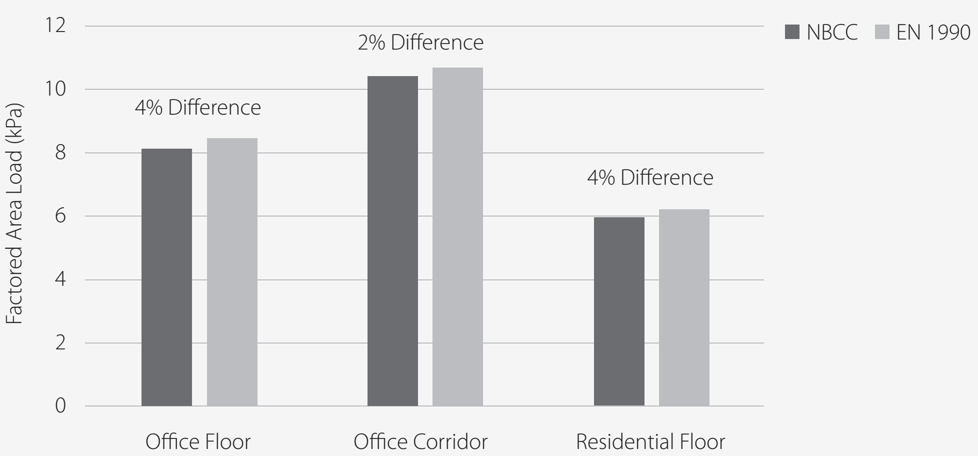


Figure 5: Comparison of NBCC 2015 and EN 1990 - Factored Floor Loads

The actual difference between the total value of the action (total design load) is minimal. For all design situations evaluated above, the load combination in accordance with EN 1990 yields the higher total applicable design load. The actual difference between the total applicable design load using the two approaches shown has a maximum difference of 4%. From a practical design standpoint, this difference between the total applicable design loads is minimal.

If a roof design is considered (flat and $\alpha = 40^\circ$), the comparison between the load combinations yields similar results with a maximum difference of 4%. Appendix A shows all geographical locations considered in the comparison as well as the results of the load combination.

If a supporting element is carrying a combination of Floor and Roof loads, the load combinations become slightly more onerous, but with similar end results. The actual difference between the total applicable design load using the two approaches is minimal.

Lateral Loads
For wind and seismic load combinations, the actual difference between the total applicable design load using the two different approaches is minimal. See Appendix A for more details.

4.2.2 SERVICEABILITY LIMIT STATE

A comparison of the serviceability requirements based on NBCC 2015, EN 1990 and the associated wood design standards CSA O86 and EN 1995 is not easily doable. Even though some of the load combinations used are similar, the material properties used to determine the deflections based on the load combinations used, as well as the actual deflection limits/recommendations associated with those load combinations are different for both the Canadian and European Codes and Standards. The European Codes provide more load combinations to be considered, with varying deflection limits. Following the Canadian codes and standards provide for less stringent requirements overall.

4.2.3 CONCLUSION

The Rothoblaas products supplied are mainly connection systems. Therefore the ultimate limit state is of more importance than the serviceability limit state in most cases. Given the results of the comparisons for the ultimate limit state above, from a **practical design standpoint** the load combinations of the National Building Code of Canada and European Standards result in very similar factored loads, particularly for gravity load combinations. It is the responsibility of the Design Engineer of Record to review and confirm the applicability of these assumptions to the specific design scenario.

4.3 DESIGN VALUE OF THE RESISTANCE

4.3.1 ULTIMATE LIMIT STATES

The National Building Code of Canada and European Standards use a different approach to determine the design value of the resistance. Characteristic and design resistances of European products can not easily be converted into equivalent specified and design resistances compliant with CSA O86. Guidance on how to relate specified strength of structural members to characteristic structural properties exist, but often some of the input data required is not easily available and from a practical standpoint it is therefore difficult to use that guidance.

In some cases, it is possible to determine the Canadian design value of the resistance by using the individual material properties of the Rothoblaas connections in combination with the design clauses contained in CSA O86-14. This would be possible for connection systems relying on nails, screws and bolts/dowels.

Where such an approach is not possible due to missing references in CSA O86-14, the designer could obtain the design value of the resistance by using the applicable k_{mod} and γ_M factors as per EN 1995. This works well for gravity and wind designs, but may be too liberal for seismic designs as the following two paragraphs explain.

In CSA O86, the design resistance for wind loads is determined using a load duration factor K_D of 1.15. Assuming a typical design situation such as a glulam perimeter column of a building, we get the following situation. Under regular gravity design (assuming typical floor and roof loads), the load duration factor K_D would be 1.0. This essentially means that the design resistance is increased by 15% going from a typical gravity design to a design accounting for wind. The same design situation under the prescription of EN 1990 and EN 1995 results in a k_{mod} factor of 0.9 and a material partial factor Y_M of 1.25 for a wind governed design. Compared to a regular gravity design using a k_{mod} factor of 0.8 and a material partial factor Y_M of 1.25, the design resistance is increased by 12% going from a typical gravity design to a design accounting for wind. This increase is in line with the 15% increase observed in CSA O86.

In CSA O86, the design resistance for seismic loads is determined using a load duration factor K_D of 1.15. Assuming a typical design situation such as a glulam column as part of a braced frame, we get the following situation. Under regular gravity design (assuming typical floor and roof loads), the load duration factor K_D would be 1.0. This essentially means that the design resistance is increased by 15% going from a typical gravity design to a design accounting for seismic. The same design situation under the prescription of EN 1990 and EN 1995 results in a k_{mod} factor of 1.1 and a material partial factor Y_M of 1.0 for a seismic governed design. Compared to a regular gravity design using a k_{mod} factor of 0.8 and a material partial factor Y_M of 1.25, the design resistance is increased by 71% going from a typical gravity design to a design accounting for seismic!

4.3.2 SERVICEABILITY LIMITS STATE

The National Building Code of Canada does not provide deflection limits. For wood designs, CSA O86 provides some deflection limits and the Wood Design Manual issued by the Canadian Wood Council provides further recommendations. European Standards do not provide deflection limits, but recommendations. The material properties used to determine the deflections based on the load combinations provided, as well as the actual deflection limits/recommendations associated with those lode combinations are different for both the Canadian Code and Standards well as European Codes.

4.3.3 WOOD DENSITIES

The Canadian, and European codes and standards use either the density or the specific gravity of the wood in connection design but these values are not interchangeable. The Canadian standard use the mean oven-dry specific gravity (CSA O86-14 Table A.12.1), whereas the European codes use the characteristic density, which represents the 5th percentile density for wood at 20° and 65% relative humidity (approximate 12% MC). In order to use Rothoblaas products and associated design values in Canada, the wood densities need to be adjusted.

5. A RATIONAL APPROACH TO THE USE OF ROTHOBLAAS PRODUCTS IN CANADA

5.1 CODES AND STANDARDS

The National Building Code of Canada defers to the applicable material specific design and production standards to regulate the applicable requirements. CSA O86-14 addresses the design of systems not currently covered in that standard in chapter 3.3.2 - New or Special Systems of Design or Construction.

"New or special systems of design or construction of wood structures or structural elements not already covered by this Standard may be used where such systems are based on analytical and engineering principles, reliable test data, or both, that demonstrate the safety and serviceability of the resulting structure for the purpose intended."

This essentially means that a product that is not covered by this standard can be used in Canada, if that product and the associated capacities are based on analytical and engineering principles and/or reliable test data.

All Rothoblaas products discussed in this document hold a European Technical Approval (ETA), which is in principal similar to a Canadian Construction Materials Centre (CCMC) report or an International Code Council (ICC) report. Over the last decade, Rothoblaas products have been used in construction projects all over the world and have demonstrated that they provide – if designed for the purpose intended - the safety and serviceability expected by the applicable codes and standards.

It is the author's opinion, that the Rothoblaas products which hold a European Technical Approval meet the intent of CSA O86-14 clause 3.3.2 and are therefore deemed acceptable for their use in Canada, if used as intended.

5.2 DESIGN VALUE OF THE ACTION (LOAD COMBINATIONS)

The specified loads, load factors and load combinations should be determined in accordance with NBCC 2015, subject to review and acceptance of this approach by the Engineer of Record.

5.3 DESIGN VALUE OF THE RESISTANCE

5.3.1 EXISTING REFERENCE TO CSA O86

The simplest way is to determine the design value of the resistance by using the individual material properties of the Rothoblaas connections in combination with the design clauses contained in CSA O86-14. This would be possible for connection systems relying on nails, screws and bolts/dowels.

Where the connections are attached to steel or concrete, the bolts and anchor bolts used shall be designed in accordance with the applicable CSA standards.

5.3.2 MISSING REFERENCE TO CSA O86

Where such an approach is not possible due to missing references in CSA O86-14, the designer may choose to obtain the design value of the resistance via a conversion from the EN 1995, using the applicable k_{mod} and Y_M factors as per EN 1995. However, this approach can result in a significant increase of the resistance under seismic conditions compared to CSA O86-14 as shown in chapter 4.3 above. The author therefore recommends to use a k_{mod} factor of 0.9 and a material partial factor Y_M related to the base material and **not** the accidental combination with $Y_M = 1.0$ for seismic load combinations (eg. $Y_M = 1.3$ for connections).

Another approach would be to determine the equivalent specified resistance of the connection system based on the principles outlined in CSA S408-11, Guidelines for the development of limit states design standards, as well as calculations in keeping with reliability-based design analysis used in CSA O86 as described in Foschi, Folz and Yao (1989) and as described in 2.5.2. In order to establish the specified strength, the following values need to be known:

- Characteristic strength property (5th percentile)
- Adjustment factor for load duration A
- Coefficient of variation V
- Normalization factor B
- Target reliability index β

In absence of that data, the use of a conversion from EN 1995 as described above is needed.

5.3.3 WOOD DENSITIES

As discussed above (4.3.3 Wood densities), the mean oven dry densities for Canadian wood species need to be converted to characteristic densities so that they are applicable to the principles used for designs in accordance with EN 1995. In order to obtain the characteristic density (5th percentile), the mean density can be multiplied with a conversion factor of 1/1.2 (according to EN 338:2009)

Table 15 shows a summary of the characteristic density and mean oven-dry relative density for typical species and materials used.

Table 15: Characteristic density and mean oven-dry relative density for typical species and materials used in Canada

Species	mean oven-dry relative density (i.e. oven dry specific gravity)	characteristic density at 12% MC (i.e. 5th percentile)
Douglas fir-Larch - D Fir-L (N) - *[sawn lumber and glulam]*	0.49	430 Kg/m^3
Hem-Fir (N) *[sawn lumber and glulam]*	0.46	405 Kg/m^3
Spruce-Pine-Fir (S-P-F) *[sawn lumber]*	0.42	370 Kg/m^3
Spruce-Lodgepole Pine-Jack Pine *[glulam]*	0.44	390 Kg/m^3
Northern Species *[lumber]*	0.35	315 Kg/m^3
Black Spruce *[glulam]*	0.56	500 Kg/m^3
Parallel strand lumber (PSL) - Parallam®	0.50	420 Kg/m^3
Laminated strand lumber (LSL)	0.50	420 Kg/m^3
Laminated veneer lumber (LVL)	0.50	420 Kg/m^3

The wood-side factored strength resistances tabulated in the following page are calculated considering the density of the wood elements equal to $\rho_k = 370$ kg/m^3 (S-P-F sawn lumber). For different wood densities (mean oven dry relative density or 5th-percentile density 12% MC wt & vol) the factored strength resistances could be modified by a corrective coefficient k_F.

Table 16: Corrective coefficient k_F for different wood densities [ρ_k or G]

Species	characteristic density at 12% MC (mean oven-dry relative density)	k_F
Douglas fir-Larch - D Fir-L (N) - [sawn lumber and glulam]	$\rho_k = 430$ kg/m^3 (G = 0.49)	1.13
Hem-Fir (N) [sawn lumber and glulam]	$\rho_k = 405$ kg/m^3 (G = 0.46)	1.07
Spruce-Lodgepole Pine-Jack Pine [glulam]	$\rho_k = 390$ kg/m^3 (G = 0.44)	1.04
Spruce-Pine-Fir (S-P-F) [sawn lumber]	$\rho_k = 370$ kg/m^3 (G = 0.42)	1.0
Northern Species [lumber]	$\rho_k = 315$ kg/m^3 (G = 0.35)	0.88
Black Spruce [glulam]	$\rho_k = 500$ kg/m^3 (G = 0.56)	1.27
Parallel strand lumber (PSL) - Parallam® Laminated strand lumber (LSL) Laminated veneer lumber (LVL)	$\rho_k = 420$ kg/m^3 (G = 0.50)	1.11

The wood-side factored strength resistances for different wood densities is calculated as: $R'_{\alpha x,d} = R_{\alpha x,d} \cdot k_f$

6. DESIGN TABLES FOR THE USE OF ROTHOBLAAS PRODUCTS IN CANADA

6.1 GENERAL

In order to simplify the design of Rothoblaas products in Canada, the author proposes to use a single Design Modification Factor DMF to convert the characteristic values into design values. This Design Modification Factor is based on K_{mod} / γ_M and the related Ultimate Limit State Load Combinations as per the 2015 National Building Code of Canada.

The approach outlined above will result in the following equation to obtain the design resistance:

$$R_d = R_{05} \cdot DMF$$

Where:

R_d = design resistance
R_{05} = characteristic resistance (adjusted for applicable density)
DMF = design modification factor based on K_{mod} for Glulam / CLT/ Solid Sawn Lumber / LVL and Plywood as per Table 8 and for γ_M as per Table 9 (γ_M = 1.3).

The application of Rothoblaas products is limited to connections for Glulam, CLT, Solid Sawn Lumber, LVL and Plywood and used in dry service conditions only (service class 1). Table 16 and table 17 show the Design Modification Factor for Glulam / CLT/ Solid Sawn Lumber / LVL and Plywood.

Table 16: Design Modification Factor for Glulam / CLT / Solid Sawn Lumber / LVL / Plywood

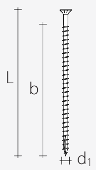
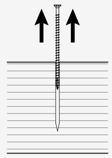
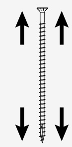
Load case	Load Combination		Design Modification Factor DMF
	Principal Load	**Companion Load**	K_{mod} / γ_M
1	1.4D	-	0.6 / 1.30 = **0.46**
2	(1.25D or 0.9D) + 1.5L	1.0S or 0.4W	0.8 / 1.30 = **0.62** (1)
3	(1.25D or 0.9D) + 1.5S	1.0L or 0.4W	0.8 / 1.30 = **0.62**
4	(1.25D or 0.9D) + 1.4W	0.5L or 0.5S	0.9 / 1.30 = **0.69**
5	1.0D + 1.0E	0.5L or 0.25S	0.9 / 1.30 = **0.69**

(1) *If Live Load L is associated with long term loads such as storage, equipment areas etc., use 0.7 / 1.30 = 0.53*

The design tables provided herein are for information purposes only and are prepared according to the methodology described above. The use of the provided tables indicates that the responsible design professional has reviewed, and judged for themselves, that the proposed methodology satisfies the requirements of clause 3.3.2 of CSA O86-14 and are therefore acceptable for use.

Carbon Steel fasteners are intended to be used in untreated wood where service conditions are specified as "dry" (KS=1.0, KT = 1.0) according to CSA O86 and for service classes 1 and 2 according to EN 1995-1 (3.8.2.2 Service classes). The design tables are derived considering permanently dry service conditions throughout the service life of the structural element (KS=1.0 - Service classes 1 and 2).

WITHDRAWAL RESISTANCE PER 10 MM OF THREAD PENETRATION [(1)]

GEOMETRY		WOOD-SIDE								STEEL-SIDE	
											
		CHARACTERISTIC VALUES		DESIGN VALUES (FACTORED RESISTANCE)						CHARACTERISTIC VALUES	
d_1		$R_{ax,k}$		$R_{ax,d}$ Load Case 1		$R_{ax,d}$ Load Case 2&3		$R_{ax,d}$ Load Case 4&5		$R_{tens,k}$	
[mm]	*[inch]*	[kN]	*[lbf]*	[kN]	*[lbf]*	[kN]	*[lbf]*	[kN]	*[lbf]*	[kN]	*[lbf]*
6	*1/4 ″*	0.93	*210*	0.43	*97*	0.57	*129*	0.65	*145*	11.3	*2,540*
7	*9/32 ″*	1.09	*245*	0.50	*113*	0.67	*151*	0.75	*170*	15.4	*3,462*
8	*5/16 ″*	1.25	*280*	0.57	*129*	0.77	*172*	0.86	*194*	20.1	*4,519*
9	*11/32 ″*	1.40	*315*	0.65	*145*	0.86	*194*	0.97	*218*	25.4	*5,710*
10	*3/8 ″*	1.56	*350*	0.72	*161*	0.96	*215*	1.08	*242*	31.4	*7,059*
11	*7/16″*	1.71	*385*	0.79	*178*	1.05	*237*	1.19	*266*	38.0	*8,543*
12	*1/2 ″*	1.87	*420*	0.86	*194*	1.15	*258*	1.29	*291*	33.9	*7,621*

NOTES

[(1)] The tensile design strength of the connector is the lower between the wood side design strength ($R_{ax,d}$) and the steel-side design strength ($R_{tens,d}$).

$$R_{ax,d} = \min \begin{cases} R_{ax,k} \cdot DMF \\ R_{tens,k} / \gamma_{M2} \end{cases}$$

In the calculations, the density of the wood elements was considered equal to ρ_k = 500 kg/m^3 (Black Spruce - Glulam).
For wood densities conversion (mean oven-dry relative density to 5th-percentile density 12% MC wt & vol) see pag. 23.
γ_{M2}: partial factor for resistance of cross-sections in tension to fracture according to EN 1993-1-1. Please see notes pag. 25.

The partial factors γ_M as defined in EN 1993-1-1 should be applied to the various characteristic values of resistance as follows:

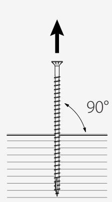
- resistance of cross-sections whatever the class is: γ_{M0} = 1,00
- resistance of members to instability assessed by member checks: γ_{M1} = 1,00
- resistance of cross-sections in tension to fracture: γ_{M2} = 1,25

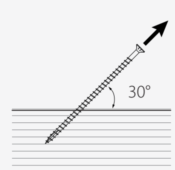
CORRECTIVE COEFFICIENT k_A FOR DIFFERENT ANGLE TO GRAIN DIRECTION α [90° TO 30°]

90 °	85 °	80 °	75 °	70 °	65 °	60 °	55 °	50 °	45 °	40 °	35 °	30 °
1.000	0.998	0.994	0.987	0.977	0.966	0.952	0.938	0.924	0.909	0.895	0.882	0.870

α: angle between the screw axis and the grain direction, with α ≥ 30°.

For intermediate values of angle to grain (α) it is possible to obtain the value according to the formula: $k_A = \dfrac{1}{1{,}2 \cdot \cos^2\alpha + \sin^2\alpha}$





HBS

ETA 11/0030

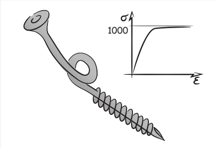
MY PROJECT SOFTWARE

Countersunk screw

Carbon steel with white galvanic zinc coating

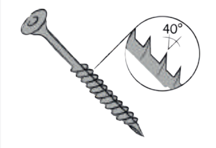
SPECIAL STEEL

Highly ductile (moves with the wood) and high-resistant steel ($f_{y,k}$ = 1000 N/mm^2)

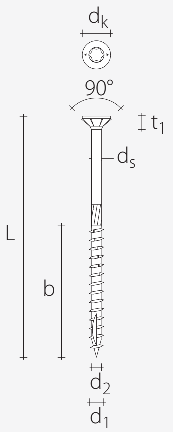


SPECIAL THREADING

Asymmetric "umbrella" threading for better wood penetration

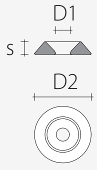


GEOMETRY AND MECHANICAL CHARACTERISTICS



HBS SCREW

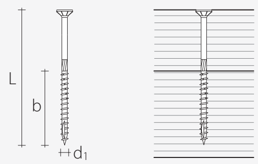
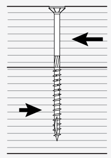
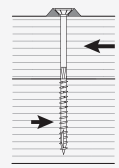
Nominal diameter	d_1	[mm]	**6**	**8**	**10**	**12**
		[inch]	***1/4″***	***5/16″***	***3/8″***	***1/2″***
Head diameter	d_k	[mm]	12.00	14.50	18.25	20.75
		[inch]	*1/4″*	*5/16″*	*3/8″*	*1/2″*
Tip diameter	d_2	[mm]	3.95	5.40	6.40	6.80
		[inch]	*5/32″*	*7/32″*	*1/4″*	*17/64″*
Shank diameter	d_s	[mm]	4.30	5.80	7.00	8.00
		[inch]	*11/64″*	*15/64″*	*9/32″*	*5/16″*
Head thickness	t_1	[mm]	4.50	4.50	5.80	7.20
		[inch]	*11/64″*	*11/64″*	*15/64″*	*9/32″*
Pre-drilling diameter	d_v	[mm]	4.00	5.00	6.00	7.00
		[inch]	*5/32″*	*13/64″*	*15/64″*	*9/32″*
Characteristic yield moment	$M_{y,k}$	[Nmm]	9,494	20,057	35,830	47,966
		[lbf.in]	*84.0*	*177.5*	*317.1*	*424.5*
Characteristic withdrawal parameter	$f_{ax,k}$	[N/mm^2]	11.7	11.7	11.7	11.7
		[psi]	*1,697*	*1,697*	*1,697*	*1,697*
Characteristic head pull-through parameter	$f_{head,k}$	[N/mm^2]	10.5	10.5	10.5	10.5
		[psi]	*1,523*	*1,523*	*1,523*	*1,523*
Characteristic tensile strength	$f_{tens,k}$	[kN]	11.3	20.1	31.4	33.9
		[lbf]	*2,540*	*4,519*	*7,059*	*7,621*
Characteristic yield strength	$f_{y,k}$	[N/mm^2]	1,000	1,000	1,000	1,000
		[psi]	*145,038*	*145,038*	*145,038*	*145,038*

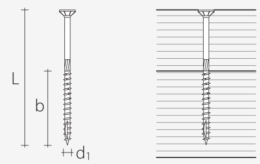
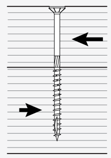
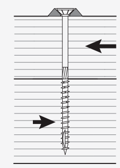


TURNED WASHER HUS

Washer			**HUS6**	**HUS8**	**HUS10**	**HUS12**
Screw			HBS Ø6	HBS Ø8	HBS Ø10	HBS Ø12
Internal diameter	**D1**	[mm]	7.50	8.50	11.00	14.00
		[inch]	*19/64″*	*21/64″*	*7/16″*	*35/64″*
External diameter	**D2**	[mm]	20.00	25.00	32.00	37.00
		[inch]	*25/32″*	*1″*	*1 1/4″*	*1 29/64″*
Thickness	**S**	[mm]	4.00	5.00	6.00	7.50
		[inch]	*5/32″*	*13/64″*	*15/64″*	*19/64″*

STATIC VALUES: SHEAR WOOD-WOOD

GEOMETRY					WOOD-WOOD								WOOD-WOOD WITH WASHER							
																				
					CHARACTERISTIC VALUES		DESIGN VALUES (FACTORED RESISTANCE)						CHARACTERISTIC VALUES		DESIGN VALUES (FACTORED RESISTANCE)					
d_1	L		b		$R_{V,k}$		$R_{V,d}$ Load Case 1		$R_{V,d}$ Load Case 2&3		$R_{V,d}$ Load Case 4&5		$R_{V,k}$		$R_{V,d}$ Load Case 1		$R_{V,d}$ Load Case 2&3		$R_{V,d}$ Load Case 4&5	
[mm]	[mm]	[inch]	[mm]	[inch]	[kN]	[lbf]	[kN]	[lbf]	[kN]	[lbf]	[kN]	[lbf]	[kN]	[lbf]	[kN]	[lbf]	[kN]	[lbf]	[kN]	[lbf]
6 1/4″ [inch]	40	1 5/8″	35	1 3/8″	0.85	191	0.39	88	0.52	118	0.59	132	0.85	191	0.39	88	0.52	118	0.59	132
	50	2″	45	1 5/8″	1.49	335	0.69	155	0.92	206	1.03	232	1.60	359	0.74	166	0.98	221	1.10	248
	60	2 3/8″	30	1 1/8″	1.72	386	0.79	178	1.06	237	1.19	267	1.87	421	0.86	194	1.15	259	1.30	291
	70	2 3/4″	40	1 5/8″	1.82	410	0.84	189	1.12	252	1.26	284	2.16	486	1.00	224	1.33	299	1.50	336
	80	3 1/8″	40	1 5/8″	2.03	456	0.94	211	1.25	281	1.40	316	2.37	532	1.09	246	1.46	328	1.64	369
	90	3 4/8″	50	2″	2.03	456	0.94	211	1.25	281	1.40	316	2.55	574	1.18	265	1.57	353	1.77	397
	100	4″	50	2″	2.03	456	0.94	211	1.25	281	1.40	316	2.55	574	1.18	265	1.57	353	1.77	397
	110	4 3/8″	60	2 3/8″	2.03	456	0.94	211	1.25	281	1.40	316	2.73	614	1.26	283	1.68	378	1.89	425
	120	4 3/4″	60	2 3/8″	2.03	456	0.94	211	1.25	281	1.40	316	2.73	614	1.26	283	1.68	378	1.89	425
	130	5 1/8″	60	2 3/8″	2.03	456	0.94	211	1.25	281	1.40	316	2.73	614	1.26	283	1.68	378	1.89	425
	140	5 1/2″	75	2 3/4″	2.03	456	0.94	211	1.25	281	1.40	316	2.73	614	1.26	283	1.68	378	1.89	425
	150	6″	75	2 3/4″	2.03	456	0.94	211	1.25	281	1.40	316	2.73	614	1.26	283	1.68	378	1.89	425
	160	6 1/4″	75	2 3/4″	2.03	456	0.94	211	1.25	281	1.40	316	2.73	614	1.26	283	1.68	378	1.89	425
	180	7 1/8″	75	2 3/4″	2.03	456	0.94	211	1.25	281	1.40	316	2.73	614	1.26	283	1.68	378	1.89	425
	200	7 7/8″	75	2 3/4″	2.03	456	0.94	211	1.25	281	1.40	316	2.73	614	1.26	283	1.68	378	1.89	425
	220	8 5/8″	75	2 3/4″	2.03	456	0.94	211	1.25	281	1.40	316	2.73	614	1.26	283	1.68	378	1.89	425
	240	9 1/2″	75	2 3/4″	2.03	456	0.94	211	1.25	281	1.40	316	2.73	614	1.26	283	1.68	378	1.89	425
	260	10 1/4″	75	2 3/4″	2.03	456	0.94	211	1.25	281	1.40	316	2.73	614	1.26	283	1.68	378	1.89	425
	280	11″	75	2 3/4″	2.03	456	0.94	211	1.25	281	1.40	316	2.73	614	1.26	283	1.68	378	1.89	425
	300	11 7/8″	75	2 3/4″	2.03	456	0.94	211	1.25	281	1.40	316	2.73	614	1.26	283	1.68	378	1.89	425
8 5/16″ [inch]	80	3 1/8″	52	2″	2.52	566	1.16	261	1.55	348	1.74	392	3.21	722	1.48	333	1.98	444	2.22	500
	100	4″	52	2″	3.18	715	1.47	330	1.96	440	2.20	495	3.88	871	1.79	402	2.39	536	2.68	603
	120	4 3/4″	60	2 3/8″	3.20	720	1.48	332	1.97	443	2.22	499	4.09	921	1.89	425	2.52	566	2.83	637
	140	5 1/2″	60	2 3/8″	3.20	720	1.48	332	1.97	443	2.22	499	4.09	921	1.89	425	2.52	566	2.83	637
	160	6 1/4″	80	3 1/8″	3.20	720	1.48	332	1.97	443	2.22	499	4.34	976	2.00	451	2.67	601	3.01	676
	180	7 1/8″	80	3 1/8″	3.20	720	1.48	332	1.97	443	2.22	499	4.34	976	2.00	451	2.67	601	3.01	676
	200	7 7/8″	80	3 1/8″	3.20	720	1.48	332	1.97	443	2.22	499	4.34	976	2.00	451	2.67	601	3.01	676
	220	8 5/8″	80	3 1/8″	3.20	720	1.48	332	1.97	443	2.22	499	4.34	976	2.00	451	2.67	601	3.01	676
	240	9 1/2″	80	3 1/8″	3.20	720	1.48	332	1.97	443	2.22	499	4.34	976	2.00	451	2.67	601	3.01	676
	260	10 1/4″	80	3 1/8″	3.20	720	1.48	332	1.97	443	2.22	499	4.34	976	2.00	451	2.67	601	3.01	676
	280	11″	80	3 1/8″	3.20	720	1.48	332	1.97	443	2.22	499	4.34	976	2.00	451	2.67	601	3.01	676
	300	11 7/8″	100	4″	3.20	720	1.48	332	1.97	443	2.22	499	4.34	976	2.00	451	2.67	601	3.01	676
	320	12 5/8″	100	4″	3.20	720	1.48	332	1.97	443	2.22	499	4.34	976	2.00	451	2.67	601	3.01	676
	340	13 3/8″	100	4″	3.20	720	1.48	332	1.97	443	2.22	499	4.34	976	2.00	451	2.67	601	3.01	676
	360	14 1/4″	100	4″	3.20	720	1.48	332	1.97	443	2.22	499	4.34	976	2.00	451	2.67	601	3.01	676
	380	15″	100	4″	3.20	720	1.48	332	1.97	443	2.22	499	4.34	976	2.00	451	2.67	601	3.01	676
	400	15 3/4″	100	4″	3.20	720	1.48	332	1.97	443	2.22	499	4.34	976	2.00	451	2.67	601	3.01	676
	440	17 1/4″	100	4″	3.20	720	1.48	332	1.97	443	2.22	499	4.34	976	2.00	451	2.67	601	3.01	676
	500	19 3/4″	100	4″	3.20	720	1.48	332	1.97	443	2.22	499	4.34	976	2.00	451	2.67	601	3.01	676

GEOMETRY					WOOD-WOOD								WOOD-WOOD WITH WASHER							
																				
					CHARACTERISTIC VALUES		DESIGN VALUES (FACTORED RESISTANCE)						CHARACTERISTIC VALUES		DESIGN VALUES (FACTORED RESISTANCE)					
d_1	L		b		$R_{V,k}$		$R_{V,d}$ Load Case 1		$R_{V,d}$ Load Case 2&3		$R_{V,d}$ Load Case 4&5		$R_{V,k}$		$R_{V,d}$ Load Case 1		$R_{V,d}$ Load Case 2&3		$R_{V,d}$ Load Case 4&5	
[mm]	[mm]	*[inch]*	[mm]	*[inch]*	[kN]	*[lbf]*	[kN]	*[lbf]*	[kN]	*[lbf]*	[kN]	*[lbf]*	[kN]	*[lbf]*	[kN]	*[lbf]*	[kN]	*[lbf]*	[kN]	*[lbf]*
	80	*3 1/8″*	52	*2″*	3.53	*794*	1.63	*367*	2.17	*489*	2.45	*550*	4.21	*946*	1.94	*437*	2.59	*582*	2.91	*655*
	100	*4″*	52	*2″*	4.07	*914*	1.88	*422*	2.50	*563*	2.82	*633*	4.74	*1,066*	2.19	*492*	2.92	*656*	3.28	*738*
	120	*4 3/4″*	60	*2 3/8″*	4.69	*1,055*	2.17	*487*	2.89	*649*	3.25	*730*	5.61	*1,262*	2.59	*582*	3.45	*777*	3.89	*874*
	140	*5 1/2″*	60	*2 3/8″*	4.71	*1,058*	2.17	*488*	2.90	*651*	3.26	*732*	5.63	*1,265*	2.60	*584*	3.46	*778*	3.90	*876*
	160	*6 1/4″*	80	*3 1/8″*	4.71	*1,059*	2.17	*489*	2.90	*652*	3.26	*733*	6.24	*1,403*	2.88	*648*	3.84	*864*	4.32	*972*
	180	*7 1/8″*	80	*3 1/8″*	4.71	*1,059*	2.17	*489*	2.90	*652*	3.26	*733*	6.24	*1,403*	2.88	*648*	3.84	*864*	4.32	*972*
10 *3/8″ [inch]*	**200**	*7 7/8″*	80	*3 1/8″*	4.71	*1,059*	2.17	*489*	2.90	*652*	3.26	*733*	6.24	*1,403*	2.88	*648*	3.84	*864*	4.32	*972*
	220	*8 5/8″*	80	*3 1/8″*	4.71	*1,059*	2.17	*489*	2.90	*652*	3.26	*733*	6.24	*1,403*	2.88	*648*	3.84	*864*	4.32	*972*
	240	*9 1/2″*	80	*3 1/8″*	4.71	*1,059*	2.17	*489*	2.90	*652*	3.26	*733*	6.24	*1,403*	2.88	*648*	3.84	*864*	4.32	*972*
	260	*10 1/4″*	80	*3 1/8″*	4.71	*1,059*	2.17	*489*	2.90	*652*	3.26	*733*	6.24	*1,403*	2.88	*648*	3.84	*864*	4.32	*972*
	280	*11″*	80	*3 1/8″*	4.71	*1,059*	2.17	*489*	2.90	*652*	3.26	*733*	6.24	*1,403*	2.88	*648*	3.84	*864*	4.32	*972*
	300	*11 7/8″*	100	*4″*	4.71	*1,059*	2.17	*489*	2.90	*652*	3.26	*733*	6.61	*1,485*	3.05	*685*	4.07	*914*	4.57	*1,028*
	320	*12 5/8″*	100	*4″*	4.71	*1,059*	2.17	*489*	2.90	*652*	3.26	*733*	6.61	*1,485*	3.05	*685*	4.07	*914*	4.57	*1,028*
	340	*13 3/8″*	100	*4″*	4.71	*1,059*	2.17	*489*	2.90	*652*	3.26	*733*	6.61	*1,485*	3.05	*685*	4.07	*914*	4.57	*1,028*
	360	*14 1/4″*	100	*4″*	4.71	*1,059*	2.17	*489*	2.90	*652*	3.26	*733*	6.61	*1,485*	3.05	*685*	4.07	*914*	4.57	*1,028*
	380	*15″*	100	*4″*	4.71	*1,059*	2.17	*489*	2.90	*652*	3.26	*733*	6.61	*1,485*	3.05	*685*	4.07	*914*	4.57	*1,028*
	400	*15 3/4″*	100	*4″*	4.71	*1,059*	2.17	*489*	2.90	*652*	3.26	*733*	6.61	*1,485*	3.05	*685*	4.07	*914*	4.57	*1,028*
	160	*6 1/4″*	80	*3 1/8″*	5.86	*1,318*	2.71	*608*	3.61	*811*	4.06	*913*	7.62	*1,712*	3.52	*790*	4.69	*1,054*	5.27	*1,186*
	200	*7 7/8″*	80	*3 1/8″*	5.86	*1,318*	2.71	*608*	3.61	*811*	4.06	*913*	7.62	*1,712*	3.52	*790*	4.69	*1,054*	5.27	*1,186*
	240	*9 1/2″*	80	*3 1/8″*	5.86	*1,318*	2.71	*608*	3.61	*811*	4.06	*913*	7.62	*1,712*	3.52	*790*	4.69	*1,054*	5.27	*1,186*
	280	*11″*	80	*3 1/8″*	5.86	*1,318*	2.71	*608*	3.61	*811*	4.06	*913*	7.62	*1,712*	3.52	*790*	4.69	*1,054*	5.27	*1,186*
	320	*12 5/8″*	120	*4 3/4″*	5.86	*1,318*	2.71	*608*	3.61	*811*	4.06	*913*	8.44	*1,897*	3.89	*876*	5.19	*1,167*	5.84	*1,313*
12 *1/2″ [inch]*	**360**	*14 1/4″*	120	*4 3/4″*	5.86	*1,318*	2.71	*608*	3.61	*811*	4.06	*913*	8.44	*1,897*	3.89	*876*	5.19	*1,167*	5.84	*1,313*
	400	*15 3/4″*	120	*4 3/4″*	5.86	*1,318*	2.71	*608*	3.61	*811*	4.06	*913*	8.44	*1,897*	3.89	*876*	5.19	*1,167*	5.84	*1,313*
	440	*17 1/4″*	120	*4 3/4″*	5.86	*1,318*	2.71	*608*	3.61	*811*	4.06	*913*	8.44	*1,897*	3.89	*876*	5.19	*1,167*	5.84	*1,313*
	480	*19″*	120	*4 3/4″*	5.86	*1,318*	2.71	*608*	3.61	*811*	4.06	*913*	8.44	*1,897*	3.89	*876*	5.19	*1,167*	5.84	*1,313*
	520	*20 1/2″*	120	*4 3/4″*	5.86	*1,318*	2.71	*608*	3.61	*811*	4.06	*913*	8.44	*1,897*	3.89	*876*	5.19	*1,167*	5.84	*1,313*
	560	*22″*	120	*4 3/4″*	5.86	*1,318*	2.71	*608*	3.61	*811*	4.06	*913*	8.44	*1,897*	3.89	*876*	5.19	*1,167*	5.84	*1,313*
	600	*23 5/8″*	120	*4 3/4″*	5.86	*1,318*	2.71	*608*	3.61	*811*	4.06	*913*	8.44	*1,897*	3.89	*876*	5.19	*1,167*	5.84	*1,313*

GENERAL PRINCIPLES

- Characteristic values comply with the EN 1995:2008 standard in accordance with ETA-11/0030.
- According to EN 1995:2008 for shear characteristic values the contribution from the rope effect ($F_{ax,Rk}$ / 4) is considered. This is resulting in higher shear resistances compared to shear resistances calculated in accordance with CSA O86-14.
- Design values for wood-side are obtained from the following characteristic values:

$$R_d = R_k \cdot DMF$$

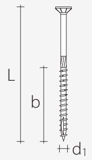
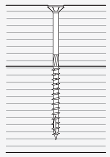
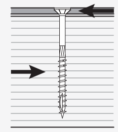
DMF: design modification factor based on k_{mod} as per Table 8 and for γ_M as per Table 9 (γ_M = 1.3). See pag. 24.

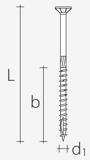
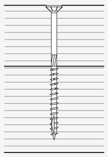
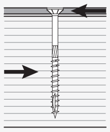
Load case	Load Combination		Design Modification Factor DMF
	Principal Load	Companion Load	
1	1.4D	-	**0.46**
2	(1.25D or 0.9D) + 1.5L	1.0S or 0.4W	**0.62** (1)
3	(1.25D or 0.9D) + 1.5S	1.0L or 0.4W	**0.62**
4	(1.25D or 0.9D) + 1.4W	0.5L or 0.5S	**0.69**
5	1.0D + 1.0E	0.5L or 0.25S	**0.69**

(1) *If Live Load L is associated with long term loads such as storage, equipment areas etc., use 0,54*

- For the mechanical resistance values and the geometry of the screws, reference was made to ETA-11/0030.
- In the calculations, the density of the wood elements was considered equal to ρ_k = 370 kg/m^3 (S-P-F sawn lumber). For wood densities conversion (mean oven-dry relative density to 5th-percentile density 12% MC wt & vol) see pag. 23. Characteristic resistances can also be considered as valid for higher densities, for the purposes of safety.
- Values were calculated considering the threaded part as being completely inserted into the wood.
- Sizing and verification of the wooden elements and steel plates must be done separately.
- The shear characteristic resistances are calculated for screws inserted without pre-bored holes. In the case of screws inserted with pre-bored holes, greater resistance values can be obtained.
- For different calculation methods, the myProject software is available free of charge (www.rothoblaas.com).
- The characteristic resistances were calculated using solid wood or glulam. In the case of joints with CLT elements, the resistance values may be different and should be calculated on the basis of the characteristics of the panel and the connection configuration.

STATIC VALUES: SHEAR STEEL-WOOD

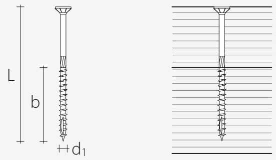
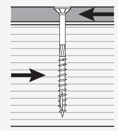
GEOMETRY					THIN STEEL-WOOD PLATE [(1)]								
 													
						CHARACTERISTIC VALUES		DESIGN VALUES (FACTORED RESISTANCE)					
d_1	L		b			$R_{V,k}$		$R_{V,d}$ Load Case 1		$R_{V,d}$ Load Case 2&3		$R_{V,d}$ Load Case 4&5	
[mm]	[mm]	*[inch]*	[mm]	*[inch]*		[kN]	*[lbf]*	[kN]	*[lbf]*	[kN]	*[lbf]*	[kN]	*[lbf]*
6 *1/4 ″ [inch]*	40	*1 5/8 ″*	35	*1 3/8 ″*	$S_{PLATE} \leq 3$ mm *[1/8 ″ inch]*	1.57	*354*	0.73	*163*	0.97	*218*	1.09	*245*
	50	*2 ″*	45	*1 5/8 ″*		2.00	*449*	0.92	*207*	1.23	*277*	1.38	*311*
	60	*2 3/8 ″*	30	*1 1/8 ″*		2.18	*491*	1.01	*227*	1.34	*302*	1.51	*340*
	70	*2 3/4 ″*	40	*1 5/8 ″*		2.37	*532*	1.09	*246*	1.46	*328*	1.64	*369*
	80	*3 1/8 ″*	40	*1 5/8 ″*		2.37	*532*	1.09	*246*	1.46	*328*	1.64	*369*
	90	*3 4/8 ″*	50	*2 ″*		2.55	*574*	1.18	*265*	1.57	*353*	1.77	*397*
	100	*4 ″*	50	*2 ″*		2.55	*574*	1.18	*265*	1.57	*353*	1.77	*397*
	110	*4 3/8 ″*	60	*2 3/8 ″*		2.74	*615*	1.26	*284*	1.68	*378*	1.89	*426*
	120	*4 3/4 ″*	60	*2 3/8 ″*		2.74	*615*	1.26	*284*	1.68	*378*	1.89	*426*
	130	*5 1/8 ″*	60	*2 3/8 ″*		2.74	*615*	1.26	*284*	1.68	*378*	1.89	*426*
	140	*5 1/2 ″*	75	*2 3/4 ″*		3.01	*677*	1.39	*312*	1.85	*416*	2.08	*469*
	150	*6 ″*	75	*2 3/4 ″*		3.01	*677*	1.39	*312*	1.85	*416*	2.08	*469*
	160	*6 1/4 ″*	75	*2 3/4 ″*		3.01	*677*	1.39	*312*	1.85	*416*	2.08	*469*
	180	*7 1/8 ″*	75	*2 3/4 ″*		3.01	*677*	1.39	*312*	1.85	*416*	2.08	*469*
	200	*7 7/8 ″*	75	*2 3/4 ″*		3.01	*677*	1.39	*312*	1.85	*416*	2.08	*469*
	220	*8 5/8 ″*	75	*2 3/4 ″*		3.01	*677*	1.39	*312*	1.85	*416*	2.08	*469*
	240	*9 1/2 ″*	75	*2 3/4 ″*		3.01	*677*	1.39	*312*	1.85	*416*	2.08	*469*
	260	*10 1/4 ″*	75	*2 3/4 ″*		3.01	*677*	1.39	*312*	1.85	*416*	2.08	*469*
	280	*11″*	75	*2 3/4 ″*		3.01	*677*	1.39	*312*	1.85	*416*	2.08	*469*
	300	*11 7/8 ″*	75	*2 3/4 ″*		3.01	*677*	1.39	*312*	1.85	*416*	2.08	*469*
8 *5/16 ″ [inch]*	80	*3 1/8 ″*	52	*2 ″*	$S_{PLATE} \leq 4$ mm *[5/32 ″ inch]*	3.90	*877*	1.80	*405*	2.40	*539*	2.70	*607*
	100	*4 ″*	52	*2 ″*		3.90	*877*	1.80	*405*	2.40	*539*	2.70	*607*
	120	*4 3/4 ″*	60	*2 3/8 ″*		4.09	*921*	1.89	*425*	2.52	*566*	2.83	*637*
	140	*5 1/2 ″*	60	*2 3/8 ″*		4.09	*921*	1.89	*425*	2.52	*566*	2.83	*637*
	160	*6 1/4 ″*	80	*3 1/8 ″*		4.58	*1,031*	2.12	*476*	2.82	*634*	3.17	*713*
	180	*7 1/8 ″*	80	*3 1/8 ″*		4.58	*1,031*	2.12	*476*	2.82	*634*	3.17	*713*
	200	*7 7/8 ″*	80	*3 1/8 ″*		4.58	*1,031*	2.12	*476*	2.82	*634*	3.17	*713*
	220	*8 5/8 ″*	80	*3 1/8 ″*		4.58	*1,031*	2.12	*476*	2.82	*634*	3.17	*713*
	240	*9 1/2 ″*	80	*3 1/8 ″*		4.58	*1,031*	2.12	*476*	2.82	*634*	3.17	*713*
	260	*10 1/4 ″*	80	*3 1/8 ″*		4.58	*1,031*	2.12	*476*	2.82	*634*	3.17	*713*
	280	*11″*	80	*3 1/8 ″*		4.58	*1,031*	2.12	*476*	2.82	*634*	3.17	*713*
	300	*11 7/8 ″*	100	*4 ″*		5.07	*1,141*	2.34	*526*	3.12	*702*	3.51	*790*
	320	*12 5/8 ″*	100	*4 ″*		5.07	*1,141*	2.34	*526*	3.12	*702*	3.51	*790*
	340	*13 3/8 ″*	100	*4 ″*		5.07	*1,141*	2.34	*526*	3.12	*702*	3.51	*790*
	360	*14 1/4 ″*	100	*4 ″*		5.07	*1,141*	2.34	*526*	3.12	*702*	3.51	*790*
	380	*15″*	100	*4 ″*		5.07	*1,141*	2.34	*526*	3.12	*702*	3.51	*790*
	400	*15 3/4 ″*	100	*4 ″*		5.07	*1,141*	2.34	*526*	3.12	*702*	3.51	*790*
	440	*17 1/4 ″*	100	*4 ″*		5.07	*1,141*	2.34	*526*	3.12	*702*	3.51	*790*
	500	*19 3/4 ″*	100	*4 ″*		5.07	*1,141*	2.34	*526*	3.12	*702*	3.51	*790*

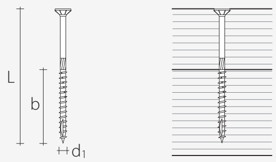
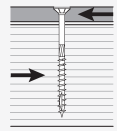
GEOMETRY						THIN STEEL-WOOD PLATE (1)							
 													
						CHARACTERISTIC VALUES		DESIGN VALUES (FACTORED RESISTANCE)					
d_1	L		b			$R_{V,k}$		$R_{V,d}$ Load Case 1		$R_{V,d}$ Load Case 2&3		$R_{V,d}$ Load Case 4&5	
[mm]	[mm]	*[inch]*	[mm]	*[inch]*		[kN]	*[lbf]*	[kN]	*[lbf]*	[kN]	*[lbf]*	[kN]	*[lbf]*
10 *3/8″ [inch]*	80	*3 1/8″*	52	*2″*	$S_{PLATE} \le 5$ mm *[16/64″ inch]*	4.56	*1,026*	2.11	*473*	2.81	*631*	3.16	*710*
	100	*4″*	52	*2″*		5.39	*1,211*	2.49	*559*	3.31	*745*	3.73	*838*
	120	*4 3/4″*	60	*2 3/8″*		5.63	*1,266*	2.60	*584*	3.47	*779*	3.90	*876*
	140	*5 1/2″*	60	*2 3/8″*		5.63	*1,266*	2.60	*584*	3.47	*779*	3.90	*876*
	160	*6 1/4″*	80	*3 1/8″*		6.24	*1,403*	2.88	*648*	3.84	*864*	4.32	*972*
	180	*7 1/8″*	80	*3 1/8″*		6.24	*1,403*	2.88	*648*	3.84	*864*	4.32	*972*
	200	*7 7/8″*	80	*3 1/8″*		6.24	*1,403*	2.88	*648*	3.84	*864*	4.32	*972*
	220	*8 5/8″*	80	*3 1/8″*		6.24	*1,403*	2.88	*648*	3.84	*864*	4.32	*972*
	240	*9 1/2″*	80	*3 1/8″*		6.24	*1,403*	2.88	*648*	3.84	*864*	4.32	*972*
	260	*10 1/4″*	80	*3 1/8″*		6.24	*1,403*	2.88	*648*	3.84	*864*	4.32	*972*
	280	*11″*	80	*3 1/8″*		6.24	*1,403*	2.88	*648*	3.84	*864*	4.32	*972*
	300	*11 7/8″*	100	*4″*		6.85	*1,541*	3.16	*711*	4.22	*948*	4.75	*1,067*
	320	*12 5/8″*	100	*4″*		6.85	*1,541*	3.16	*711*	4.22	*948*	4.75	*1,067*
	340	*13 3/8″*	100	*4″*		6.85	*1,541*	3.16	*711*	4.22	*948*	4.75	*1,067*
	360	*14 1/4″*	100	*4″*		6.85	*1,541*	3.16	*711*	4.22	*948*	4.75	*1,067*
	380	*15″*	100	*4″*		6.85	*1,541*	3.16	*711*	4.22	*948*	4.75	*1,067*
	400	*15 3/4″*	100	*4″*		6.85	*1,541*	3.16	*711*	4.22	*948*	4.75	*1,067*
12 *1/2″ [inch]*	160	*6 1/4″*	80	*3 1/8″*	$S_{PLATE} \le 6$ mm *[1/4″ inch]*	7.62	*1,712*	3.52	*790*	4.69	*1,054*	5.27	*1,186*
	200	*7 7/8″*	80	*3 1/8″*		7.62	*1,712*	3.52	*790*	4.69	*1,054*	5.27	*1,186*
	240	*9 1/2″*	80	*3 1/8″*		7.62	*1,712*	3.52	*790*	4.69	*1,054*	5.27	*1,186*
	280	*11″*	80	*3 1/8″*		7.62	*1,712*	3.52	*790*	4.69	*1,054*	5.27	*1,186*
	320	*12 5/8″*	120	*4 3/4″*		9.09	*2,042*	4.19	*943*	5.59	*1,257*	6.29	*1,414*
	360	*14 1/4″*	120	*4 3/4″*		9.09	*2,042*	4.19	*943*	5.59	*1,257*	6.29	*1,414*
	400	*15 3/4″*	120	*4 3/4″*		9.09	*2,042*	4.19	*943*	5.59	*1,257*	6.29	*1,414*
	440	*17 1/4″*	120	*4 3/4″*		9.09	*2,042*	4.19	*943*	5.59	*1,257*	6.29	*1,414*
	480	*19″*	120	*4 3/4″*		9.09	*2,042*	4.19	*943*	5.59	*1,257*	6.29	*1,414*
	520	*20 1/2″*	120	*4 3/4″*		9.09	*2,042*	4.19	*943*	5.59	*1,257*	6.29	*1,414*
	560	*22″*	120	*4 3/4″*		9.09	*2,042*	4.19	*943*	5.59	*1,257*	6.29	*1,414*
	600	*23 5/8″*	120	*4 3/4″*		9.09	*2,042*	4.19	*943*	5.59	*1,257*	6.29	*1,414*

NOTES

(1) The shear characteristics resistances are calculated considering the case of a thin plate ($S_{PLATE} \le 0,5\ d_1$).
(2) The shear characteristic resistances are calculated considering the case of a thick plate ($S_{PLATE} \ge d_1$).
(3) The axial thread-extraction resistance was calculated considering a 90° angle between the grain and the connector and for a fixing length of b.
(4) The axial resistance to head penetration, with and without a washer, was calculated using wood elements.
In the case of steel-wood connections, generally the steel tensile strength is binding with respect to head separation or penetration.

STATIC VALUES: SHEAR STEEL-WOOD

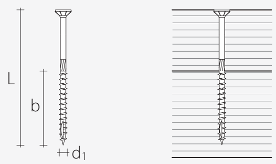
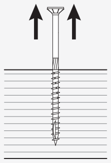
GEOMETRY					THICK STEEL-WOOD PLATE (2)								
													
						CHARACTERISTIC VALUES		DESIGN VALUES (FACTORED RESISTANCE)					
d_1	L		b			$R_{V,k}$		$R_{V,d}$ Load Case 1		$R_{V,d}$ Load Case 2&3		$R_{V,d}$ Load Case 4&5	
[mm]	[mm]	*[inch]*	[mm]	*[inch]*		[kN]	*[lbf]*	[kN]	*[lbf]*	[kN]	*[lbf]*	[kN]	*[lbf]*
6 1/4″ [inch]	40	1 5/8″	35	1 3/8″	$S_{PLATE} \leq$ 6 mm [1/4″ inch]	2.52	567	1.16	262	1.55	349	1.75	392
	50	2″	45	1 5/8″		3.06	688	1.41	318	1.88	424	2.12	477
	60	2 3/8″	30	1 1/8″		2.86	643	1.32	297	1.76	396	1.98	445
	70	2 3/4″	40	1 5/8″		3.04	685	1.41	316	1.87	421	2.11	474
	80	3 1/8″	40	1 5/8″		3.04	685	1.41	316	1.87	421	2.11	474
	90	3 4/8″	50	2″		3.23	726	1.49	335	1.99	447	2.24	502
	100	4″	50	2″		3.23	726	1.49	335	1.99	447	2.24	502
	110	4 3/8″	60	2 3/8″		3.41	767	1.57	354	2.10	472	2.36	531
	120	4 3/4″	60	2 3/8″		3.41	767	1.57	354	2.10	472	2.36	531
	130	5 1/8″	60	2 3/8″		3.41	767	1.57	354	2.10	472	2.36	531
	140	5 1/2″	75	2 3/4″		3.69	829	1.70	383	2.27	510	2.55	574
	150	6″	75	2 3/4″		3.69	829	1.70	383	2.27	510	2.55	574
	160	6 1/4″	75	2 3/4″		3.69	829	1.70	383	2.27	510	2.55	574
	180	7 1/8″	75	2 3/4″		3.69	829	1.70	383	2.27	510	2.55	574
	200	7 7/8″	75	2 3/4″		3.69	829	1.70	383	2.27	510	2.55	574
	220	8 5/8″	75	2 3/4″		3.69	829	1.70	383	2.27	510	2.55	574
	240	9 1/2″	75	2 3/4″		3.69	829	1.70	383	2.27	510	2.55	574
	260	10 1/4″	75	2 3/4″		3.69	829	1.70	383	2.27	510	2.55	574
	280	11″	75	2 3/4″		3.69	829	1.70	383	2.27	510	2.55	574
	300	10 7/8″	75	2 3/4″		3.69	829	1.70	383	2.27	510	2.55	574
8 5/16″ [inch]	80	3 1/8″	52	2″	$S_{PLATE} \leq$ 8 mm [5/16″ inch]	4.99	1,121	2.30	517	3.07	690	3.45	776
	100	4″	52	2″		4.99	1,121	2.30	517	3.07	690	3.45	776
	120	4 3/4″	60	2 3/8″		5.18	1,165	2.39	538	3.19	717	3.59	807
	140	5 1/2″	60	2 3/8″		5.18	1,165	2.39	538	3.19	717	3.59	807
	160	6 1/4″	80	3 1/8″		5.67	1,275	2.62	589	3.49	785	3.93	883
	180	7 1/8″	80	3 1/8″		5.67	1,275	2.62	589	3.49	785	3.93	883
	200	7 7/8″	80	3 1/8″		5.67	1,275	2.62	589	3.49	785	3.93	883
	220	8 5/8″	80	3 1/8″		5.67	1,275	2.62	589	3.49	785	3.93	883
	240	9 1/2″	80	3 1/8″		5.67	1,275	2.62	589	3.49	785	3.93	883
	260	10 1/4″	80	3 1/8″		5.67	1,275	2.62	589	3.49	785	3.93	883
	280	11″	80	3 1/8″		5.67	1,275	2.62	589	3.49	785	3.93	883
	300	11 7/8″	100	4″		6.16	1,385	2.84	639	3.79	852	4.27	959
	320	12 5/8″	100	4″		6.16	1,385	2.84	639	3.79	852	4.27	959
	340	13 3/8″	100	4″		6.16	1,385	2.84	639	3.79	852	4.27	959
	360	14 1/4″	100	4″		6.16	1,385	2.84	639	3.79	852	4.27	959
	380	15″	100	4″		6.16	1,385	2.84	639	3.79	852	4.27	959
	400	15 3/4″	100	4″		6.16	1,385	2.84	639	3.79	852	4.27	959
	440	17 1/4″	100	4″		6.16	1,385	2.84	639	3.79	852	4.27	959
	500	19 3/4″	100	4″		6.16	1,385	2.84	639	3.79	852	4.27	959

GEOMETRY					THICK STEEL-WOOD PLATE (2)								
													
						CHARACTERISTIC VALUES		DESIGN VALUES (FACTORED RESISTANCE)					
d_1	L		b			$R_{V,k}$		$R_{V,d}$ Load Case 1		$R_{V,d}$ Load Case 2&3		$R_{V,d}$ Load Case 4&5	
[mm]	[mm]	*[inch]*	[mm]	*[inch]*		[kN]	*[lbf]*	[kN]	*[lbf]*	[kN]	*[lbf]*	[kN]	*[lbf]*
10 *3/8″ [inch]*	80	*3 1/8″*	52	*2″*	$S_{PLATE} \leq$ 10 mm *[3/8″ inch]*	6.71	*1,508*	3.10	*696*	4.13	*928*	4.64	*1,044*
	100	*4″*	52	*2″*		6.96	*1,564*	3.21	*722*	4.28	*963*	4.82	*1,083*
	120	*4 3/4″*	60	*2 3/8″*		7.20	*1,619*	3.32	*747*	4.43	*997*	4.99	*1,121*
	140	*5 1/2″*	60	*2 3/8″*		7.20	*1,619*	3.32	*747*	4.43	*997*	4.99	*1,121*
	160	*6 1/4″*	80	*3 1/8″*		7.81	*1,757*	3.61	*811*	4.81	*1,081*	5.41	*1,216*
	180	*7 1/8″*	80	*3 1/8″*		7.81	*1,757*	3.61	*811*	4.81	*1,081*	5.41	*1,216*
	200	*7 7/8″*	80	*3 1/8″*		7.81	*1,757*	3.61	*811*	4.81	*1,081*	5.41	*1,216*
	220	*8 5/8″*	80	*3 1/8″*		7.81	*1,757*	3.61	*811*	4.81	*1,081*	5.41	*1,216*
	240	*9 1/2″*	80	*3 1/8″*		7.81	*1,757*	3.61	*811*	4.81	*1,081*	5.41	*1,216*
	260	*10 1/4″*	80	*3 1/8″*		7.81	*1,757*	3.61	*811*	4.81	*1,081*	5.41	*1,216*
	280	*11″*	80	*3 1/8″*		7.81	*1,757*	3.61	*811*	4.81	*1,081*	5.41	*1,216*
	300	*11 7/8″*	100	*4″*		8.43	*1,894*	3.89	*874*	5.19	*1,166*	5.83	*1,311*
	320	*12 5/8″*	100	*4″*		8.43	*1,894*	3.89	*874*	5.19	*1,166*	5.83	*1,311*
	340	*13 3/8″*	100	*4″*		8.43	*1,894*	3.89	*874*	5.19	*1,166*	5.83	*1,311*
	360	*14 1/4″*	100	*4″*		8.43	*1,894*	3.89	*874*	5.19	*1,166*	5.83	*1,311*
	380	*15″*	100	*4″*		8.43	*1,894*	3.89	*874*	5.19	*1,166*	5.83	*1,311*
	400	*15 3/4″*	100	*4″*		8.43	*1,894*	3.89	*874*	5.19	*1,166*	5.83	*1,311*
12 *1/2″ [inch]*	160	*6 1/4″*	80	*3 1/8″*	$S_{PLATE} \leq$ 12 mm *[1/2″ inch]*	9.56	*2,148*	4.41	*992*	5.88	*1,322*	6.62	*1,487*
	200	*7 7/8″*	80	*3 1/8″*		9.56	*2,148*	4.41	*992*	5.88	*1,322*	6.62	*1,487*
	240	*9 1/2″*	80	*3 1/8″*		9.56	*2,148*	4.41	*992*	5.88	*1,322*	6.62	*1,487*
	280	*11″*	80	*3 1/8″*		9.56	*2,148*	4.41	*992*	5.88	*1,322*	6.62	*1,487*
	320	*12 5/8″*	120	*4 3/4″*		11.02	*2,478*	5.09	*1,144*	6.78	*1,525*	7.63	*1,716*
	360	*14 1/4″*	120	*4 3/4″*		11.02	*2,478*	5.09	*1,144*	6.78	*1,525*	7.63	*1,716*
	400	*15 3/4″*	120	*4 3/4″*		11.02	*2,478*	5.09	*1,144*	6.78	*1,525*	7.63	*1,716*
	440	*17 1/4″*	120	*4 3/4″*		11.02	*2,478*	5.09	*1,144*	6.78	*1,525*	7.63	*1,716*
	480	*19″*	120	*4 3/4″*		11.02	*2,478*	5.09	*1,144*	6.78	*1,525*	7.63	*1,716*
	520	*20 1/2″*	120	*4 3/4″*		11.02	*2,478*	5.09	*1,144*	6.78	*1,525*	7.63	*1,716*
	560	*22″*	120	*4 3/4″*		11.02	*2,478*	5.09	*1,144*	6.78	*1,525*	7.63	*1,716*
	600	*23 5/8″*	120	*4 3/4″*		11.02	*2,478*	5.09	*1,144*	6.78	*1,525*	7.63	*1,716*

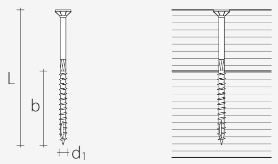
NOTES

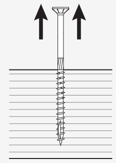
(1) The shear characteristics resistances are calculated considering the case of a thin plate ($S_{PLATE} \leq 0,5\ d_1$).
(2) The shear characteristic resistances are calculated considering the case of a thick plate ($S_{PLATE} \geq d_1$).
(3) The axial thread-extraction resistance was calculated considering a 90° angle between the grain and the connector and for a fixing length of b.
(4) The axial resistance to head penetration, with and without a washer, was calculated using wood elements.
In the case of steel-wood connections, generally the steel tensile strength is binding with respect to head separation or penetration.

STATIC VALUES: TRACTION THREAD WITHDRAWAL

GEOMETRY					THREAD WITHDRAWAL (3)							
												
					CHARACTERISTIC VALUES		DESIGN VALUES (FACTORED RESISTANCE)					
d_1	L		b		$R_{ax,k}$		$R_{ax,d}$ Load Case 1		$R_{ax,d}$ Load Case 2&3		$R_{ax,d}$ Load Case 4&5	
[mm]	[mm]	[inch]	[mm]	[inch]	[kN]	[lbf]	[kN]	[lbf]	[kN]	[lbf]	[kN]	[lbf]
6 1/4″ [inch]	40	1 5/8″	35	1 3/8″	2.57	577	1.19	267	1.58	355	1.78	400
	50	2″	45	1 5/8″	3.30	742	1.52	343	2.03	457	2.29	514
	60	2 3/8″	30	1 1/8″	2.20	495	1.02	228	1.35	305	1.52	343
	70	2 3/4″	40	1 5/8″	2.94	660	1.35	305	1.81	406	2.03	457
	80	3 1/8″	40	1 5/8″	2.94	660	1.35	305	1.81	406	2.03	457
	90	3 4/8″	50	2″	3.67	825	1.69	381	2.26	508	2.54	571
	100	4″	50	2″	3.67	825	1.69	381	2.26	508	2.54	571
	110	4 3/8″	60	2 3/8″	4.40	990	2.03	457	2.71	609	3.05	685
	120	4 3/4″	60	2 3/8″	4.40	990	2.03	457	2.71	609	3.05	685
	130	5 1/8″	60	2 3/8″	4.40	990	2.03	457	2.71	609	3.05	685
	140	5 1/2″	75	2 3/4″	5.50	1,237	2.54	571	3.39	761	3.81	857
	150	6″	75	2 3/4″	5.50	1,237	2.54	571	3.39	761	3.81	857
	160	6 1/4″	75	2 3/4″	5.50	1,237	2.54	571	3.39	761	3.81	857
	180	7 1/8″	75	2 3/4″	5.50	1,237	2.54	571	3.39	761	3.81	857
	200	7 7/8″	75	2 3/4″	5.50	1,237	2.54	571	3.39	761	3.81	857
	220	8 5/8″	75	2 3/4″	5.50	1,237	2.54	571	3.39	761	3.81	857
	240	9 1/2″	75	2 3/4″	5.50	1,237	2.54	571	3.39	761	3.81	857
	260	10 1/4″	75	2 3/4″	5.50	1,237	2.54	571	3.39	761	3.81	857
	280	11″	75	2 3/4″	5.50	1,237	2.54	571	3.39	761	3.81	857
	300	11 7/8″	75	2 3/4″	5.50	1,237	2.54	571	3.39	761	3.81	857
8 5/16″ [inch]	80	3 1/8″	52	2″	5.09	1,144	2.35	528	3.13	704	3.52	792
	100	4″	52	2″	5.09	1,144	2.35	528	3.13	704	3.52	792
	120	4 3/4″	60	2 3/8″	5.87	1,320	2.71	609	3.61	812	4.06	914
	140	5 1/2″	60	2 3/8″	5.87	1,320	2.71	609	3.61	812	4.06	914
	160	6 1/4″	80	3 1/8″	7.83	1,760	3.61	812	4.82	1,083	5.42	1,218
	180	7 1/8″	80	3 1/8″	7.83	1,760	3.61	812	4.82	1,083	5.42	1,218
	200	7 7/8″	80	3 1/8″	7.83	1,760	3.61	812	4.82	1,083	5.42	1,218
	220	8 5/8″	80	3 1/8″	7.83	1,760	3.61	812	4.82	1,083	5.42	1,218
	240	9 1/2″	80	3 1/8″	7.83	1,760	3.61	812	4.82	1,083	5.42	1,218
	260	10 1/4″	80	3 1/8″	7.83	1,760	3.61	812	4.82	1,083	5.42	1,218
	280	11″	80	3 1/8″	7.83	1,760	3.61	812	4.82	1,083	5.42	1,218
	300	11 7/8″	100	4″	9.79	2,200	4.52	1,015	6.02	1,354	6.77	1,523
	320	12 5/8″	100	4″	9.79	2,200	4.52	1,015	6.02	1,354	6.77	1,523
	340	13 3/8″	100	4″	9.79	2,200	4.52	1,015	6.02	1,354	6.77	1,523
	360	14 1/4″	100	4″	9.79	2,200	4.52	1,015	6.02	1,354	6.77	1,523
	380	15″	100	4″	9.79	2,200	4.52	1,015	6.02	1,354	6.77	1,523
	400	15 3/4″	100	4″	9.79	2,200	4.52	1,015	6.02	1,354	6.77	1,523
	440	17 1/4″	100	4″	9.79	2,200	4.52	1,015	6.02	1,354	6.77	1,523
	500	19 3/4″	100	4″	9.79	2,200	4.52	1,015	6.02	1,354	6.77	1,523

GEOMETRY					THREAD WITHDRAWAL [(3)]							
					CHARACTERISTIC VALUES		DESIGN VALUES (FACTORED RESISTANCE)					
d_1	L		b		$R_{ax,k}$		$R_{ax,d}$ Load Case 1		$R_{ax,d}$ Load Case 2&3		$R_{ax,d}$ Load Case 4&5	
[mm]	[mm]	*[inch]*	[mm]	*[inch]*	[kN]	*[lbf]*	[kN]	*[lbf]*	[kN]	*[lbf]*	[kN]	*[lbf]*
10 *3/8″ [inch]*	80	*3 1/8″*	52	*2″*	6.36	*1,430*	2.94	*660*	3.91	*880*	4.40	*990*
	100	*4″*	52	*2″*	6.36	*1,430*	2.94	*660*	3.91	*880*	4.40	*990*
	120	*4 3/4″*	60	*2 3/8″*	7.34	*1,650*	3.39	*761*	4.52	*1,015*	5.08	*1,142*
	140	*5 1/2″*	60	*2 3/8″*	7.34	*1,650*	3.39	*761*	4.52	*1,015*	5.08	*1,142*
	160	*6 1/4″*	80	*3 1/8″*	9.79	*2,200*	4.52	*1,015*	6.02	*1,354*	6.77	*1,523*
	180	*7 1/8″*	80	*3 1/8″*	9.79	*2,200*	4.52	*1,015*	6.02	*1,354*	6.77	*1,523*
	200	*7 7/8″*	80	*3 1/8″*	9.79	*2,200*	4.52	*1,015*	6.02	*1,354*	6.77	*1,523*
	220	*8 5/8″*	80	*3 1/8″*	9.79	*2,200*	4.52	*1,015*	6.02	*1,354*	6.77	*1,523*
	240	*9 1/2″*	80	*3 1/8″*	9.79	*2,200*	4.52	*1,015*	6.02	*1,354*	6.77	*1,523*
	260	*10 1/4″*	80	*3 1/8″*	9.79	*2,200*	4.52	*1,015*	6.02	*1,354*	6.77	*1,523*
	280	*11″*	80	*3 1/8″*	9.79	*2,200*	4.52	*1,015*	6.02	*1,354*	6.77	*1,523*
	300	*11 7/8″*	100	*4″*	12.23	*2,750*	5.65	*1,269*	7.53	*1,692*	8.47	*1,904*
	320	*12 5/8″*	100	*4″*	12.23	*2,750*	5.65	*1,269*	7.53	*1,692*	8.47	*1,904*
	340	*13 3/8″*	100	*4″*	12.23	*2,750*	5.65	*1,269*	7.53	*1,692*	8.47	*1,904*
	360	*14 1/4″*	100	*4″*	12.23	*2,750*	5.65	*1,269*	7.53	*1,692*	8.47	*1,904*
	380	*15″*	100	*4″*	12.23	*2,750*	5.65	*1,269*	7.53	*1,692*	8.47	*1,904*
	400	*15 3/4″*	100	*4″*	12.23	*2,750*	5.65	*1,269*	7.53	*1,692*	8.47	*1,904*
12 *1/2″ [inch]*	160	*6 1/4″*	80	*3 1/8″*	11.74	*2,640*	5.42	*1,218*	7.23	*1,625*	8.13	*1,828*
	200	*7 7/8″*	80	*3 1/8″*	11.74	*2,640*	5.42	*1,218*	7.23	*1,625*	8.13	*1,828*
	240	*9 1/2″*	80	*3 1/8″*	11.74	*2,640*	5.42	*1,218*	7.23	*1,625*	8.13	*1,828*
	280	*11″*	80	*3 1/8″*	11.74	*2,640*	5.42	*1,218*	7.23	*1,625*	8.13	*1,828*
	320	*12 5/8″*	120	*4 3/4″*	17.61	*3,960*	8.13	*1,828*	10.84	*2,437*	12.19	*2,741*
	360	*14 1/4″*	120	*4 3/4″*	17.61	*3,960*	8.13	*1,828*	10.84	*2,437*	12.19	*2,741*
	400	*15 3/4″*	120	*4 3/4″*	17.61	*3,960*	8.13	*1,828*	10.84	*2,437*	12.19	*2,741*
	440	*17 1/4″*	120	*4 3/4″*	17.61	*3,960*	8.13	*1,828*	10.84	*2,437*	12.19	*2,741*
	480	*19″*	120	*4 3/4″*	17.61	*3,960*	8.13	*1,828*	10.84	*2,437*	12.19	*2,741*
	520	*20 1/2″*	120	*4 3/4″*	17.61	*3,960*	8.13	*1,828*	10.84	*2,437*	12.19	*2,741*
	560	*22″*	120	*4 3/4″*	17.61	*3,960*	8.13	*1,828*	10.84	*2,437*	12.19	*2,741*
	600	*23 5/8″*	120	*4 3/4″*	17.61	*3,960*	8.13	*1,828*	10.84	*2,437*	12.19	*2,741*





GENERAL PRINCIPLES

- Characteristic values comply with the EN 1995:2008 standard in accordance with ETA-11/0030.
- According to EN 1995:2008 for shear characteristic values the contribution from the rope effect ($F_{ax,Rk}$ / 4) is considered. This is resulting in higher shear resistances compared to shear resistances calculated in accordance with CSA O86-14.
- Design values for wood-side are obtained from the following characteristic values:

$$R_d = R_k \cdot DMF$$

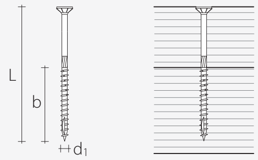
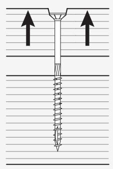
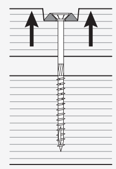
DMF: design modification factor based on k_{mod} as per Table 8 and for γ_M as per Table 9 (γ_M = 1.3). See page 24.

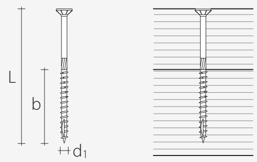
Load case	Load Combination		Design Modification Factor DMF
	Principal Load	Companion Load	
1	1.4D	-	**0.46**
2	(1.25D or 0.9D) + 1.5L	1.0S or 0.4W	**0.62** [(1)]
3	(1.25D or 0.9D) + 1.5S	1.0L or 0.4W	**0.62**
4	(1.25D or 0.9D) + 1.4W	0.5L or 0.5S	**0.69**
5	1.0D + 1.0E	0.5L or 0.25S	**0.69**

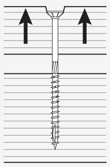
[(1)] *If Live Load L is associated with long term loads such as storage, equipment areas etc., use 0,54*

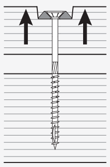
- For the mechanical resistance values and the geometry of the screws, reference was made to ETA-11/0030.
- In the calculations, the density of the wood elements was considered equal to ρ_k = 370 kg/m^3 (S-P-F sawn lumber). For wood densities conversion (mean oven-dry relative density to 5th-percentile density 12% MC wt & vol) see pag. 23. Characteristic resistances can also be considered as valid for higher densities, for the purposes of safety.
- Values were calculated considering the threaded part as being completely inserted into the wood.
- Sizing and verification of the wooden elements and steel plates must be done separately.
- The shear characteristic resistances are calculated for screws inserted without pre-bored holes. In the case of screws inserted with pre-bored holes, greater resistance values can be obtained.
- For different calculation methods, the myProject software is available free of charge (www.rothoblaas.com).
- The characteristic resistances were calculated using solid wood or glulam. In the case of joints with CLT elements, the resistance values may be different and should be calculated on the basis of the characteristics of the panel and the connection configuration.

STATIC VALUES: TRACTION HEAD PENETRATION

GEOMETRY					HEAD PENETRATION [(4)]								HEAD PENETRATION WITH WASHER [(4)]							
																				
					CHARACTERISTIC VALUES		DESIGN VALUES (FACTORED RESISTANCE)						CHARACTERISTIC VALUES		DESIGN VALUES (FACTORED RESISTANCE)					
d_1	L		b		$R_{head,k}$		$R_{head,d}$ Load Case 1		$R_{head,d}$ Load Case 2&3		$R_{head,d}$ Load Case 4&5		$R_{head,k}$		$R_{head,d}$ Load Case 1		$R_{head,d}$ Load Case 2&3		$R_{head,d}$ Load Case 4&5	
[mm]	[mm]	*[inch]*	[mm]	*[inch]*	[kN]	*[lbf]*	[kN]	*[lbf]*	[kN]	*[lbf]*	[kN]	*[lbf]*	[kN]	*[lbf]*	[kN]	*[lbf]*	[kN]	*[lbf]*	[kN]	*[lbf]*
6 *1/4″ [inch]*	40	*1 5/8″*	35	*1 3/8″*	1.58	*355*	0.73	*164*	0.97	*219*	1.09	*246*	4.39	*987*	2.03	*456*	2.70	*607*	3.04	*683*
	60	*2 3/8″*	30	*1 1/8″*	1.58	*355*	0.73	*164*	0.97	*219*	1.09	*246*	4.39	*987*	2.03	*456*	2.70	*607*	3.04	*683*
	70	*2 3/4″*	40	*1 5/8″*	1.58	*355*	0.73	*164*	0.97	*219*	1.09	*246*	4.39	*987*	2.03	*456*	2.70	*607*	3.04	*683*
	80	*3 1/8″*	40	*1 5/8″*	1.58	*355*	0.73	*164*	0.97	*219*	1.09	*246*	4.39	*987*	2.03	*456*	2.70	*607*	3.04	*683*
	90	*3 4/8″*	50	*2″*	1.58	*355*	0.73	*164*	0.97	*219*	1.09	*246*	4.39	*987*	2.03	*456*	2.70	*607*	3.04	*683*
	100	*4″*	50	*2″*	1.58	*355*	0.73	*164*	0.97	*219*	1.09	*246*	4.39	*987*	2.03	*456*	2.70	*607*	3.04	*683*
	110	*4 3/8″*	60	*2 3/8″*	1.58	*355*	0.73	*164*	0.97	*219*	1.09	*246*	4.39	*987*	2.03	*456*	2.70	*607*	3.04	*683*
	120	*4 3/4″*	60	*2 3/8″*	1.58	*355*	0.73	*164*	0.97	*219*	1.09	*246*	4.39	*987*	2.03	*456*	2.70	*607*	3.04	*683*
	130	*5 1/8″*	60	*2 3/8″*	1.58	*355*	0.73	*164*	0.97	*219*	1.09	*246*	4.39	*987*	2.03	*456*	2.70	*607*	3.04	*683*
	140	*5 1/2″*	75	*2 3/4″*	1.58	*355*	0.73	*164*	0.97	*219*	1.09	*246*	4.39	*987*	2.03	*456*	2.70	*607*	3.04	*683*
	150	*6″*	75	*2 3/4″*	1.58	*355*	0.73	*164*	0.97	*219*	1.09	*246*	4.39	*987*	2.03	*456*	2.70	*607*	3.04	*683*
	160	*6 1/4″*	75	*2 3/4″*	1.58	*355*	0.73	*164*	0.97	*219*	1.09	*246*	4.39	*987*	2.03	*456*	2.70	*607*	3.04	*683*
	180	*7 1/8″*	75	*2 3/4″*	1.58	*355*	0.73	*164*	0.97	*219*	1.09	*246*	4.39	*987*	2.03	*456*	2.70	*607*	3.04	*683*
	200	*7 7/8″*	75	*2 3/4″*	1.58	*355*	0.73	*164*	0.97	*219*	1.09	*246*	4.39	*987*	2.03	*456*	2.70	*607*	3.04	*683*
	220	*8 5/8″*	75	*2 3/4″*	1.58	*355*	0.73	*164*	0.97	*219*	1.09	*246*	4.39	*987*	2.03	*456*	2.70	*607*	3.04	*683*
	240	*9 1/2″*	75	*2 3/4″*	1.58	*355*	0.73	*164*	0.97	*219*	1.09	*246*	4.39	*987*	2.03	*456*	2.70	*607*	3.04	*683*
	260	*10 1/4″*	75	*2 3/4″*	1.58	*355*	0.73	*164*	0.97	*219*	1.09	*246*	4.39	*987*	2.03	*456*	2.70	*607*	3.04	*683*
	280	*11″*	75	*2 3/4″*	1.58	*355*	0.73	*164*	0.97	*219*	1.09	*246*	4.39	*987*	2.03	*456*	2.70	*607*	3.04	*683*
	300	*11 7/8″*	75	*2 3/4″*	1.58	*355*	0.73	*164*	0.97	*219*	1.09	*246*	4.39	*987*	2.03	*456*	2.70	*607*	3.04	*683*
8 *5/16″ [inch]*	80	*3 1/8″*	52	*2″*	2.31	*519*	1.07	*239*	1.42	*319*	1.60	*359*	6.86	*1,542*	3.17	*712*	4.22	*949*	4.75	*1,068*
	100	*4″*	52	*2″*	2.31	*519*	1.07	*239*	1.42	*319*	1.60	*359*	6.86	*1,542*	3.17	*712*	4.22	*949*	4.75	*1,068*
	120	*4 3/4″*	60	*2 3/8″*	2.31	*519*	1.07	*239*	1.42	*319*	1.60	*359*	6.86	*1,542*	3.17	*712*	4.22	*949*	4.75	*1,068*
	140	*5 1/2″*	60	*2 3/8″*	2.31	*519*	1.07	*239*	1.42	*319*	1.60	*359*	6.86	*1,542*	3.17	*712*	4.22	*949*	4.75	*1,068*
	160	*6 1/4″*	80	*3 1/8″*	2.31	*519*	1.07	*239*	1.42	*319*	1.60	*359*	6.86	*1,542*	3.17	*712*	4.22	*949*	4.75	*1,068*
	180	*7 1/8″*	80	*3 1/8″*	2.31	*519*	1.07	*239*	1.42	*319*	1.60	*359*	6.86	*1,542*	3.17	*712*	4.22	*949*	4.75	*1,068*
	200	*7 7/8″*	80	*3 1/8″*	2.31	*519*	1.07	*239*	1.42	*319*	1.60	*359*	6.86	*1,542*	3.17	*712*	4.22	*949*	4.75	*1,068*
	220	*8 5/8″*	80	*3 1/8″*	2.31	*519*	1.07	*239*	1.42	*319*	1.60	*359*	6.86	*1,542*	3.17	*712*	4.22	*949*	4.75	*1,068*
	240	*9 1/2″*	80	*3 1/8″*	2.31	*519*	1.07	*239*	1.42	*319*	1.60	*359*	6.86	*1,542*	3.17	*712*	4.22	*949*	4.75	*1,068*
	260	*10 1/4″*	80	*3 1/8″*	2.31	*519*	1.07	*239*	1.42	*319*	1.60	*359*	6.86	*1,542*	3.17	*712*	4.22	*949*	4.75	*1,068*
	280	*11″*	80	*3 1/8″*	2.31	*519*	1.07	*239*	1.42	*319*	1.60	*359*	6.86	*1,542*	3.17	*712*	4.22	*949*	4.75	*1,068*
	300	*11 7/8″*	100	*4″*	2.31	*519*	1.07	*239*	1.42	*319*	1.60	*359*	6.86	*1,542*	3.17	*712*	4.22	*949*	4.75	*1,068*
	320	*12 5/8″*	100	*4″*	2.31	*519*	1.07	*239*	1.42	*319*	1.60	*359*	6.86	*1,542*	3.17	*712*	4.22	*949*	4.75	*1,068*
	340	*13 3/8″*	100	*4″*	2.31	*519*	1.07	*239*	1.42	*319*	1.60	*359*	6.86	*1,542*	3.17	*712*	4.22	*949*	4.75	*1,068*
	360	*14 1/4″*	100	*4″*	2.31	*519*	1.07	*239*	1.42	*319*	1.60	*359*	6.86	*1,542*	3.17	*712*	4.22	*949*	4.75	*1,068*
	380	*15″*	100	*4″*	2.31	*519*	1.07	*239*	1.42	*319*	1.60	*359*	6.86	*1,542*	3.17	*712*	4.22	*949*	4.75	*1,068*
	400	*15 3/4″*	100	*4″*	2.31	*519*	1.07	*239*	1.42	*319*	1.60	*359*	6.86	*1,542*	3.17	*712*	4.22	*949*	4.75	*1,068*
	440	*17 1/4″*	100	*4″*	2.31	*519*	1.07	*239*	1.42	*319*	1.60	*359*	6.86	*1,542*	3.17	*712*	4.22	*949*	4.75	*1,068*
	500	*19 3/4″*	100	*4″*	2.31	*519*	1.07	*239*	1.42	*319*	1.60	*359*	6.86	*1,542*	3.17	*712*	4.22	*949*	4.75	*1,068*





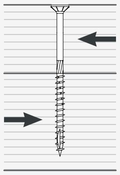
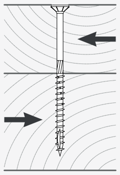


GEOMETRY					HEAD PENETRATION (4)								HEAD PENETRATION WITH WASHER (4)							
					CHARACTERISTIC VALUES		DESIGN VALUES (FACTORED RESISTANCE)						CHARACTERISTIC VALUES		DESIGN VALUES (FACTORED RESISTANCE)					
d_1	L		b		$R_{head,k}$		$R_{head,d}$ Load Case 1		$R_{head,d}$ Load Case 2&3		$R_{head,d}$ Load Case 4&5		$R_{head,k}$		$R_{head,d}$ Load Case 1		$R_{head,d}$ Load Case 2&3		$R_{head,d}$ Load Case 4&5	
[mm]	[mm]	*[inch]*	[mm]	*[inch]*	[kN]	*[lbf]*	[kN]	*[lbf]*	[kN]	*[lbf]*	[kN]	*[lbf]*	[kN]	*[lbf]*	[kN]	*[lbf]*	[kN]	*[lbf]*	[kN]	*[lbf]*
10 *3/8″ [inch]*	80	*3 1/8″*	52	*2″*	3.66	*822*	1.69	*379*	2.25	*506*	2.53	*569*	11.24	*2,527*	5.19	*1,166*	6.92	*1,555*	7.78	*1,749*
	100	*4″*	52	*2″*	3.66	*822*	1.69	*379*	2.25	*506*	2.53	*569*	11.24	*2,527*	5.19	*1,166*	6.92	*1,555*	7.78	*1,749*
	120	*4 3/4″*	60	*2 3/8″*	3.66	*822*	1.69	*379*	2.25	*506*	2.53	*569*	11.24	*2,527*	5.19	*1,166*	6.92	*1,555*	7.78	*1,749*
	140	*5 1/2″*	60	*2 3/8″*	3.66	*822*	1.69	*379*	2.25	*506*	2.53	*569*	11.24	*2,527*	5.19	*1,166*	6.92	*1,555*	7.78	*1,749*
	160	*6 1/4″*	80	*3 1/8″*	3.66	*822*	1.69	*379*	2.25	*506*	2.53	*569*	11.24	*2,527*	5.19	*1,166*	6.92	*1,555*	7.78	*1,749*
	180	*7 1/8″*	80	*3 1/8″*	3.66	*822*	1.69	*379*	2.25	*506*	2.53	*569*	11.24	*2,527*	5.19	*1,166*	6.92	*1,555*	7.78	*1,749*
	200	*7 7/8″*	80	*3 1/8″*	3.66	*822*	1.69	*379*	2.25	*506*	2.53	*569*	11.24	*2,527*	5.19	*1,166*	6.92	*1,555*	7.78	*1,749*
	220	*8 5/8″*	80	*3 1/8″*	3.66	*822*	1.69	*379*	2.25	*506*	2.53	*569*	11.24	*2,527*	5.19	*1,166*	6.92	*1,555*	7.78	*1,749*
	240	*9 1/2″*	80	*3 1/8″*	3.66	*822*	1.69	*379*	2.25	*506*	2.53	*569*	11.24	*2,527*	5.19	*1,166*	6.92	*1,555*	7.78	*1,749*
	260	*10 1/4″*	80	*3 1/8″*	3.66	*822*	1.69	*379*	2.25	*506*	2.53	*569*	11.24	*2,527*	5.19	*1,166*	6.92	*1,555*	7.78	*1,749*
	280	*11″*	80	*3 1/8″*	3.66	*822*	1.69	*379*	2.25	*506*	2.53	*569*	11.24	*2,527*	5.19	*1,166*	6.92	*1,555*	7.78	*1,749*
	300	*11 7/8″*	100	*4″*	3.66	*822*	1.69	*379*	2.25	*506*	2.53	*569*	11.24	*2,527*	5.19	*1,166*	6.92	*1,555*	7.78	*1,749*
	320	*12 5/8″*	100	*4″*	3.66	*822*	1.69	*379*	2.25	*506*	2.53	*569*	11.24	*2,527*	5.19	*1,166*	6.92	*1,555*	7.78	*1,749*
	340	*13 3/8″*	100	*4″*	3.66	*822*	1.69	*379*	2.25	*506*	2.53	*569*	11.24	*2,527*	5.19	*1,166*	6.92	*1,555*	7.78	*1,749*
	360	*14 1/4″*	100	*4″*	3.66	*822*	1.69	*379*	2.25	*506*	2.53	*569*	11.24	*2,527*	5.19	*1,166*	6.92	*1,555*	7.78	*1,749*
	380	*15″*	100	*4″*	3.66	*822*	1.69	*379*	2.25	*506*	2.53	*569*	11.24	*2,527*	5.19	*1,166*	6.92	*1,555*	7.78	*1,749*
	400	*15 3/4″*	100	*4″*	3.66	*822*	1.69	*379*	2.25	*506*	2.53	*569*	11.24	*2,527*	5.19	*1,166*	6.92	*1,555*	7.78	*1,749*
12 *1/2″ [inch]*	160	*6 1/4″*	80	*3 1/8″*	4.73	*1,063*	2.18	*490*	2.91	*654*	3.27	*736*	15.03	*3,378*	6.94	*1,559*	9.25	*2,079*	10.40	*2,339*
	200	*7 7/8″*	80	*3 1/8″*	4.73	*1,063*	2.18	*490*	2.91	*654*	3.27	*736*	15.03	*3,378*	6.94	*1,559*	9.25	*2,079*	10.40	*2,339*
	240	*9 1/2″*	80	*3 1/8″*	4.73	*1,063*	2.18	*490*	2.91	*654*	3.27	*736*	15.03	*3,378*	6.94	*1,559*	9.25	*2,079*	10.40	*2,339*
	280	*11″*	80	*3 1/8″*	4.73	*1,063*	2.18	*490*	2.91	*654*	3.27	*736*	15.03	*3,378*	6.94	*1,559*	9.25	*2,079*	10.40	*2,339*
	320	*12 5/8″*	120	*4 3/4″*	4.73	*1,063*	2.18	*490*	2.91	*654*	3.27	*736*	15.03	*3,378*	6.94	*1,559*	9.25	*2,079*	10.40	*2,339*
	360	*14 1/4″*	120	*4 3/4″*	4.73	*1,063*	2.18	*490*	2.91	*654*	3.27	*736*	15.03	*3,378*	6.94	*1,559*	9.25	*2,079*	10.40	*2,339*
	400	*15 3/4″*	120	*4 3/4″*	4.73	*1,063*	2.18	*490*	2.91	*654*	3.27	*736*	15.03	*3,378*	6.94	*1,559*	9.25	*2,079*	10.40	*2,339*
	440	*17 1/4″*	120	*4 3/4″*	4.73	*1,063*	2.18	*490*	2.91	*654*	3.27	*736*	15.03	*3,378*	6.94	*1,559*	9.25	*2,079*	10.40	*2,339*
	480	*19″*	120	*4 3/4″*	4.73	*1,063*	2.18	*490*	2.91	*654*	3.27	*736*	15.03	*3,378*	6.94	*1,559*	9.25	*2,079*	10.40	*2,339*
	520	*20 1/2″*	120	*4 3/4″*	4.73	*1,063*	2.18	*490*	2.91	*654*	3.27	*736*	15.03	*3,378*	6.94	*1,559*	9.25	*2,079*	10.40	*2,339*
	560	*22″*	120	*4 3/4″*	4.73	*1,063*	2.18	*490*	2.91	*654*	3.27	*736*	15.03	*3,378*	6.94	*1,559*	9.25	*2,079*	10.40	*2,339*
	600	*23 5/8″*	120	*4 3/4″*	4.73	*1,063*	2.18	*490*	2.91	*654*	3.27	*736*	15.03	*3,378*	6.94	*1,559*	9.25	*2,079*	10.40	*2,339*

NOTES

(4) The axial resistance to head penetration, with and without a washer, was calculated using wood elements.
In the case of steel-wood connections, generally the steel tensile strength is binding with respect to head separation or penetration.

MINIMUM DISTANCES FOR SHEAR LOADS - WOOD ELEMENTS

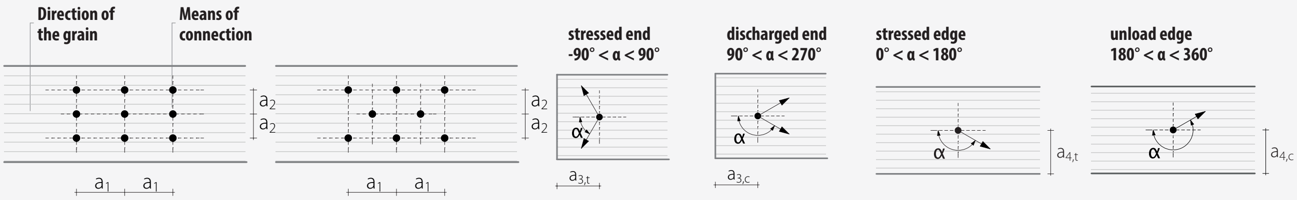
	ANGLE BETWEEN STRENGHT AND GRAIN α = 0°	ANGLE BETWEEN STRENGHT AND GRAIN α = 90°
		

SCREWS INSERTED WITH PRE-BORED HOLES

		α = 0°					α = 90°				
			6	**8**	**10**	**12**		**6**	**8**	**10**	**12**
a_1	[mm]	**5 d** (5)	30	40	50	60	**4 d** (5)	24	32	40	48
a_2	[mm]	**3 d**	18	24	30	36	**4 d**	24	32	40	48
$a_{3,t}$	[mm]	**12 d** (5)	72	96	120	144	**7 d** (5)	42	56	70	84
$a_{3,c}$	[mm]	**7 d** (5)	42	56	70	84	**7 d** (5)	42	56	70	84
$a_{4,t}$	[mm]	**3 d**	18	24	30	36	**7 d**	42	56	70	84
$a_{4,c}$	[mm]	**3 d**	18	24	30	36	**3 d**	18	24	30	36

SCREWS INSERTED WITHOUT PRE-BORED HOLES

		α = 0°					α = 90°				
			6	**8**	**10**	**12**		**6**	**8**	**10**	**12**
a_1	[mm]	**12 d** (5)	72	96	120	144	**5 d** (5)	30	40	50	60
a_2	[mm]	**5 d**	30	40	50	60	**5 d**	30	40	50	60
$a_{3,t}$	[mm]	**15 d** (5)	90	120	150	180	**10 d** (5)	60	80	100	120
$a_{3,c}$	[mm]	**10 d** (5)	60	80	100	120	**10 d** (5)	60	80	100	120
$a_{4,t}$	[mm]	**5 d**	30	40	50	60	**10 d**	60	80	100	120
$a_{4,c}$	[mm]	**5 d**	30	40	50	60	**5 d**	30	40	50	60



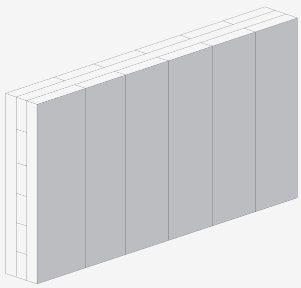
NOTES

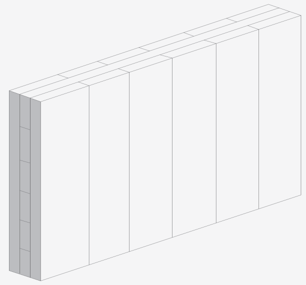
- The minimum distances are in accordance with the EN 1995:2008 standard, according to ETA-11/0030, considering a density of the wood elements $\rho_k \leq 420$ kg/m^3.
- For wood densities conversion (mean oven-dry relative density to 5th-percentile density 12% MC wt & vol) see pag. 23.

(5) For Douglas fir members minimum spacing and distances parallel to the grain shall be increased by 50%.
d = outer thread diameter

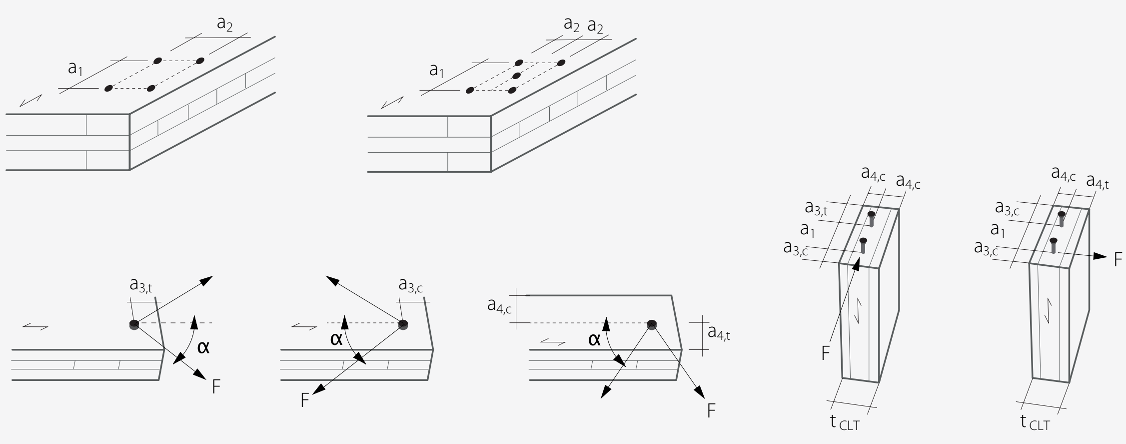
- In the case of OSB-wood joints, the minimum spacings (a_1, a_2) can be multiplied by a coefficient of 0.85.
- In the case of steel-wood joints, the minimum spacings (a_1, a_2) can be multiplied by a coefficient of 0.7.

MINIMUM DISTANCES FOR SHEAR LOADS - CLT





		SCREWS INSERTED WITHOUT PRE-BORED HOLES									
		lateral face (6)					**narrow face** (7)				
			6	**8**	**10**	**12**		**6**	**8**	**10**	**12**
$\mathbf{a_1}$	[mm]	**4 d**	24	32	40	48	**10 d**	60	80	100	120
$\mathbf{a_2}$	[mm]	**2.5 d**	15	20	25	30	**4 d**	24	32	40	48
$\mathbf{a_{3,t}}$	[mm]	**6 d**	36	48	60	72	**12 d**	72	96	120	144
$\mathbf{a_{3,c}}$	[mm]	**6 d**	36	48	60	72	**7 d**	42	56	70	84
$\mathbf{a_{4,t}}$	[mm]	**6 d**	36	48	60	72	**6 d**	36	48	60	72
$\mathbf{a_{4,c}}$	[mm]	**2.5 d**	15	20	25	30	**3 d**	18	24	30	36



NOTES

- The minimum distances are according to ETA-11/0030, unless otherwise specified in the technical specification (ETA or hEN) for the cross laminated timber.

(6) Minimum thickness of CLT members $t_{CLT,min}$ = 10 d
(7) Minimum thickness of CLT members $t_{CLT,min}$ = 10 d and minimum screw penetration depth perpendicular to the edge surface of 10 d

TBS

CE
ETA 11/0030

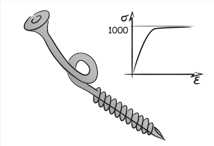
MY PROJECT SOFTWARE

Large head screw

Carbon steel with white galvanic zinc coating

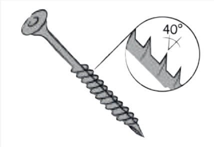
SPECIAL STEEL

Highly ductile (moves with the wood) and resistant steel ($f_{y,k}$ = 1000 N/mm²)

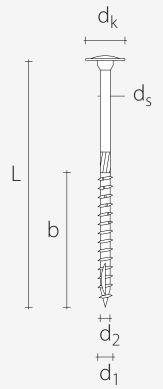


SPECIAL THREADING

Asymmetric "umbrella" threading for better wood penetration

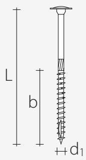
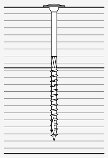
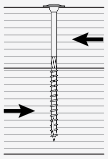


GEOMETRY AND MECHANICAL CHARACTERISTICS



TBS SCREW					
Nominal diameter	d_1	[mm]	**6**	**8**	**10**
		[inch]	***1/4″***	***5/16″***	***3/8″***
Head diameter	d_k	[mm]	15.50	19.00	25.00
		[inch]	*10/16″*	*3/4″*	*1″*
Tip diameter	d_2	[mm]	3.95	5.40	6.40
		[inch]	*5/32″*	*7/32″*	*1/4″*
Shank diameter	d_s	[mm]	4.30	5.80	7.00
		[inch]	*11/64″*	*15/64″*	*9/32″*
Pre-drilling diameter	d_v	[mm]	4.0	5.0	6.0
		[inch]	*5/32″*	*13/64″*	*15/64″*
Characteristic yield moment	$M_{y,k}$	[Nmm]	9,494	20,057	35,830
		[lbf.in]	*84.0*	*177.5*	*317.1*
Characteristic withdrawal parameter	$f_{ax,k}$	[N/mm²]	11.7	11.7	11.7
		[psi]	*1,697*	*1,697*	*1,697*
Characteristic head pull-through parameter	$f_{head,k}$	[N/mm²]	10.5	10.5	10.5
		[psi]	*1,523*	*1,523*	*1,523*
Characteristic tensile strength	$f_{tens,k}$	[kN]	11.3	20.1	31.4
		[lbf]	*2,540*	*4,519*	*7,059*
Characteristic yield strength	$f_{y,k}$	[N/mm²]	1,000	1,000	1,000
		[psi]	*145,038*	*145,038*	*145,038*

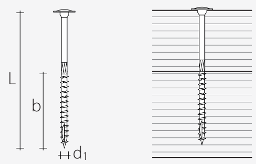
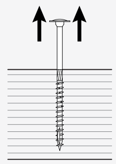
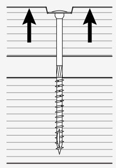
STATIC VALUES: SHEAR WOOD-WOOD

GEOMETRY					WOOD - WOOD							
 												
					CHARACTERISTIC VALUES		DESIGN VALUES (FACTORED RESISTANCE)					
d_1	L		b		$R_{V,k}$		$R_{V,d}$ Load Case 1		$R_{V,d}$ Load Case 2&3		$R_{V,d}$ Load Case 4&5	
[mm]	[mm]	*[inch]*	[mm]	*[inch]*	[kN]	*[lbf]*	[kN]	*[lbf]*	[kN]	*[lbf]*	[kN]	*[lbf]*
6 *1/4″* *[inch]*	80	*3 1/8″*	50	*2″*	2.09	*469*	0.96	*217*	1.28	*289*	1.44	*325*
	100	*4″*	60	*2 3/8″*	2.29	*516*	1.06	*238*	1.41	*317*	1.59	*357*
	120	*4 3/4″*	75	*2 3/4″*	2.29	*516*	1.06	*238*	1.41	*317*	1.59	*357*
	140	*5 1/2″*	75	*2 3/4″*	2.29	*516*	1.06	*238*	1.41	*317*	1.59	*357*
	160	*6 1/4″*	75	*2 3/4″*	2.29	*516*	1.06	*238*	1.41	*317*	1.59	*357*
	180	*7 1/8″*	75	*2 3/4″*	2.29	*516*	1.06	*238*	1.41	*317*	1.59	*357*
	200	*7 7/8″*	75	*2 3/4″*	2.29	*516*	1.06	*238*	1.41	*317*	1.59	*357*
	220	*8 5/8″*	100	*4″*	2.29	*516*	1.06	*238*	1.41	*317*	1.59	*357*
	240	*9 1/2″*	100	*4″*	2.29	*516*	1.06	*238*	1.41	*317*	1.59	*357*
	260	*10 1/4″*	100	*4″*	2.29	*516*	1.06	*238*	1.41	*317*	1.59	*357*
	280	*11″*	100	*4″*	2.29	*516*	1.06	*238*	1.41	*317*	1.59	*357*
	300	*11 7/8″*	100	*4″*	2.29	*516*	1.06	*238*	1.41	*317*	1.59	*357*
8 *5/16″* *[inch]*	40	*1 5/8″*	32	*1 1/8″*	1.04	*234*	0.48	*108*	0.64	*144*	0.72	*162*
	60	*2 3/8″*	52	*2″*	1.30	*292*	0.60	*135*	0.80	*180*	0.90	*202*
	80	*3 1/8″*	52	*2″*	2.93	*659*	1.35	*304*	1.80	*405*	2.03	*456*
	100	*4″*	80	*3 1/8″*	2.60	*585*	1.20	*270*	1.60	*360*	1.80	*405*
	120	*4 3/4″*	80	*3 1/8″*	3.30	*743*	1.53	*343*	2.03	*457*	2.29	*514*
	140	*5 1/2″*	80	*3 1/8″*	3.62	*813*	1.67	*375*	2.23	*500*	2.50	*563*
	160	*6 1/4″*	100	*4″*	3.62	*813*	1.67	*375*	2.23	*500*	2.50	*563*
	180	*7 1/8″*	100	*4″*	3.62	*813*	1.67	*375*	2.23	*500*	2.50	*563*
	200	*7 7/8″*	100	*4″*	3.62	*813*	1.67	*375*	2.23	*500*	2.50	*563*
	220	*8 5/8″*	100	*4″*	3.62	*813*	1.67	*375*	2.23	*500*	2.50	*563*
	240	*9 1/2″*	100	*4″*	3.62	*813*	1.67	*375*	2.23	*500*	2.50	*563*
	260	*10 1/4″*	100	*4″*	3.62	*813*	1.67	*375*	2.23	*500*	2.50	*563*
	280	*11″*	100	*4″*	3.62	*813*	1.67	*375*	2.23	*500*	2.50	*563*
	300	*11 7/8″*	100	*4″*	3.62	*813*	1.67	*375*	2.23	*500*	2.50	*563*
	320	*12 5/8″*	100	*4″*	3.62	*813*	1.67	*375*	2.23	*500*	2.50	*563*
	340	*13 3/8″*	100	*4″*	3.62	*813*	1.67	*375*	2.23	*500*	2.50	*563*
	360	*14 1/4″*	100	*4″*	3.62	*813*	1.67	*375*	2.23	*500*	2.50	*563*
	380	*15″*	100	*4″*	3.62	*813*	1.67	*375*	2.23	*500*	2.50	*563*
	400	*15 3/4″*	100	*4″*	3.62	*813*	1.67	*375*	2.23	*500*	2.50	*563*
10 *3/8″* *[inch]*	160	*6 1/4″*	80	*3 1/8″*	5.51	*1,239*	2.54	*572*	3.39	*762*	3.82	*858*
	180	*7 1/8″*	80	*3 1/8″*	5.51	*1,239*	2.54	*572*	3.39	*762*	3.82	*858*
	200	*7 7/8″*	100	*4″*	5.51	*1,239*	2.54	*572*	3.39	*762*	3.82	*858*
	220	*8 5/8″*	100	*4″*	5.51	*1,239*	2.54	*572*	3.39	*762*	3.82	*858*
	240	*9 1/2″*	100	*4″*	5.51	*1,239*	2.54	*572*	3.39	*762*	3.82	*858*
	260	*10 1/4″*	100	*4″*	5.51	*1,239*	2.54	*572*	3.39	*762*	3.82	*858*
	280	*11″*	100	*4″*	5.51	*1,239*	2.54	*572*	3.39	*762*	3.82	*858*
	300	*11 7/8″*	100	*4″*	5.51	*1,239*	2.54	*572*	3.39	*762*	3.82	*858*
	320	*12 5/8″*	100	*4″*	5.51	*1,239*	2.54	*572*	3.39	*762*	3.82	*858*
	340	*13 3/8″*	100	*4″*	5.51	*1,239*	2.54	*572*	3.39	*762*	3.82	*858*
	360	*14 1/4″*	100	*4″*	5.51	*1,239*	2.54	*572*	3.39	*762*	3.82	*858*
	380	*15″*	100	*4″*	5.51	*1,239*	2.54	*572*	3.39	*762*	3.82	*858*
	400	*15 3/4″*	100	*4″*	5.51	*1,239*	2.54	*572*	3.39	*762*	3.82	*858*

GENERAL PRINCIPLES

- Please refere to the general principles related to HBS screw.

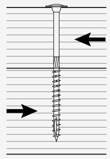
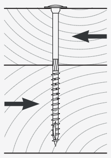
STATIC VALUES: TRACTION

GEOMETRY					THREAD WITHDRAWAL (1)								HEAD PENETRATION							
																				
					CHARACTERISTIC VALUES		DESIGN VALUES (FACTORED RESISTANCE)						CHARACTERISTIC VALUES		DESIGN VALUES (FACTORED RESISTANCE)					
d_1	L		b		$R_{ax,k}$		$R_{ax,d}$ Load Case 1		$R_{ax,d}$ Load Case 2&3		$R_{ax,d}$ Load Case 4&5		$R_{head,k}$		$R_{head,d}$ Load Case 1		$R_{head,d}$ Load Case 2&3		$R_{head,d}$ Load Case 4&5	
[mm]	[mm]	[inch]	[mm]	[inch]	[kN]	[lbf]	[kN]	[lbf]	[kN]	[lbf]	[kN]	[lbf]	[kN]	[lbf]	[kN]	[lbf]	[kN]	[lbf]	[kN]	[lbf]
6 1/4″ [inch]	80	3 1/8″	50	2″	3.67	825	1.69	381	2.26	508	2.54	571	2.64	593	1.22	274	1.62	365	1.83	410
	100	4″	60	2 3/8″	4.40	990	2.03	457	2.71	609	3.05	685	2.64	593	1.22	274	1.62	365	1.83	410
	120	4 3/4″	75	2 3/4″	5.50	1,237	2.54	571	3.39	761	3.81	857	2.64	593	1.22	274	1.62	365	1.83	410
	140	5 1/2″	75	2 3/4″	5.50	1,237	2.54	571	3.39	761	3.81	857	2.64	593	1.22	274	1.62	365	1.83	410
	160	6 1/4″	75	2 3/4″	5.50	1,237	2.54	571	3.39	761	3.81	857	2.64	593	1.22	274	1.62	365	1.83	410
	180	7 1/8″	75	2 3/4″	5.50	1,237	2.54	571	3.39	761	3.81	857	2.64	593	1.22	274	1.62	365	1.83	410
	200	7 7/8″	75	2 3/4″	5.50	1,237	2.54	571	3.39	761	3.81	857	2.64	593	1.22	274	1.62	365	1.83	410
	220	8 5/8″	100	4″	7.34	1,650	3.39	761	4.52	1,015	5.08	1,142	2.64	593	1.22	274	1.62	365	1.83	410
	240	9 1/2″	100	4″	7.34	1,650	3.39	761	4.52	1,015	5.08	1,142	2.64	593	1.22	274	1.62	365	1.83	410
	260	10 1/4″	100	4″	7.34	1,650	3.39	761	4.52	1,015	5.08	1,142	2.64	593	1.22	274	1.62	365	1.83	410
	280	11″	100	4″	7.34	1,650	3.39	761	4.52	1,015	5.08	1,142	2.64	593	1.22	274	1.62	365	1.83	410
	300	11 7/8″	100	4″	7.34	1,650	3.39	761	4.52	1,015	5.08	1,142	2.64	593	1.22	274	1.62	365	1.83	410
8 5/16″ [inch]	40	1 5/8″	32	1 1/8″	3.13	704	1.45	325	1.93	433	2.17	487	3.96	891	1.83	411	2.44	548	2.74	617
	60	2 3/8″	52	2″	5.09	1,144	2.35	528	3.13	704	3.52	792	3.96	891	1.83	411	2.44	548	2.74	617
	80	3 1/8″	52	2″	5.09	1,144	2.35	528	3.13	704	3.52	792	3.96	891	1.83	411	2.44	548	2.74	617
	100	4″	80	3 1/8″	7.83	1,760	3.61	812	4.82	1,083	5.42	1,218	3.96	891	1.83	411	2.44	548	2.74	617
	120	4 3/4″	80	3 1/8″	7.83	1,760	3.61	812	4.82	1,083	5.42	1,218	3.96	891	1.83	411	2.44	548	2.74	617
	140	5 1/2″	80	3 1/8″	7.83	1,760	3.61	812	4.82	1,083	5.42	1,218	3.96	891	1.83	411	2.44	548	2.74	617
	160	6 1/4″	100	4″	9.79	2,200	4.52	1,015	6.02	1,354	6.77	1,523	3.96	891	1.83	411	2.44	548	2.74	617
	180	7 1/8″	100	4″	9.79	2,200	4.52	1,015	6.02	1,354	6.77	1,523	3.96	891	1.83	411	2.44	548	2.74	617
	200	7 7/8″	100	4″	9.79	2,200	4.52	1,015	6.02	1,354	6.77	1,523	3.96	891	1.83	411	2.44	548	2.74	617
	220	8 5/8″	100	4″	9.79	2,200	4.52	1,015	6.02	1,354	6.77	1,523	3.96	891	1.83	411	2.44	548	2.74	617
	240	9 1/2″	100	4″	9.79	2,200	4.52	1,015	6.02	1,354	6.77	1,523	3.96	891	1.83	411	2.44	548	2.74	617
	260	10 1/4″	100	4″	9.79	2,200	4.52	1,015	6.02	1,354	6.77	1,523	3.96	891	1.83	411	2.44	548	2.74	617
	280	11″	100	4″	9.79	2,200	4.52	1,015	6.02	1,354	6.77	1,523	3.96	891	1.83	411	2.44	548	2.74	617
	300	11 7/8″	100	4″	9.79	2,200	4.52	1,015	6.02	1,354	6.77	1,523	3.96	891	1.83	411	2.44	548	2.74	617
	320	12 5/8″	100	4″	9.79	2,200	4.52	1,015	6.02	1,354	6.77	1,523	3.96	891	1.83	411	2.44	548	2.74	617
	340	13 3/8″	100	4″	9.79	2,200	4.52	1,015	6.02	1,354	6.77	1,523	3.96	891	1.83	411	2.44	548	2.74	617
	360	14 1/4″	100	4″	9.79	2,200	4.52	1,015	6.02	1,354	6.77	1,523	3.96	891	1.83	411	2.44	548	2.74	617
	380	15″	100	4″	9.79	2,200	4.52	1,015	6.02	1,354	6.77	1,523	3.96	891	1.83	411	2.44	548	2.74	617
	400	15 3/4″	100	4″	9.79	2,200	4.52	1,015	6.02	1,354	6.77	1,523	3.96	891	1.83	411	2.44	548	2.74	617
10 3/8″ [inch]	160	6 1/4″	80	3 1/8″	9.79	2,200	4.52	1,015	6.02	1,354	6.77	1,523	6.86	1,542	3.17	712	4.22	949	4.75	1,068
	180	7 1/8″	80	3 1/8″	9.79	2,200	4.52	1,015	6.02	1,354	6.77	1,523	6.86	1,542	3.17	712	4.22	949	4.75	1,068
	200	7 7/8″	100	4″	12.23	2,750	5.65	1,269	7.53	1,692	8.47	1,904	6.86	1,542	3.17	712	4.22	949	4.75	1,068
	220	8 5/8″	100	4″	12.23	2,750	5.65	1,269	7.53	1,692	8.47	1,904	6.86	1,542	3.17	712	4.22	949	4.75	1,068
	240	9 1/2″	100	4″	12.23	2,750	5.65	1,269	7.53	1,692	8.47	1,904	6.86	1,542	3.17	712	4.22	949	4.75	1,068
	260	10 1/4″	100	4″	12.23	2,750	5.65	1,269	7.53	1,692	8.47	1,904	6.86	1,542	3.17	712	4.22	949	4.75	1,068
	280	11″	100	4″	12.23	2,750	5.65	1,269	7.53	1,692	8.47	1,904	6.86	1,542	3.17	712	4.22	949	4.75	1,068
	300	11 7/8″	100	4″	12.23	2,750	5.65	1,269	7.53	1,692	8.47	1,904	6.86	1,542	3.17	712	4.22	949	4.75	1,068
	320	12 5/8″	100	4″	12.23	2,750	5.65	1,269	7.53	1,692	8.47	1,904	6.86	1,542	3.17	712	4.22	949	4.75	1,068
	340	13 3/8″	100	4″	12.23	2,750	5.65	1,269	7.53	1,692	8.47	1,904	6.86	1,542	3.17	712	4.22	949	4.75	1,068
	360	14 1/4″	100	4″	12.23	2,750	5.65	1,269	7.53	1,692	8.47	1,904	6.86	1,542	3.17	712	4.22	949	4.75	1,068
	380	15″	100	4″	12.23	2,750	5.65	1,269	7.53	1,692	8.47	1,904	6.86	1,542	3.17	712	4.22	949	4.75	1,068
	400	15 3/4″	100	4″	12.23	2,750	5.65	1,269	7.53	1,692	8.47	1,904	6.86	1,542	3.17	712	4.22	949	4.75	1,068

NOTES

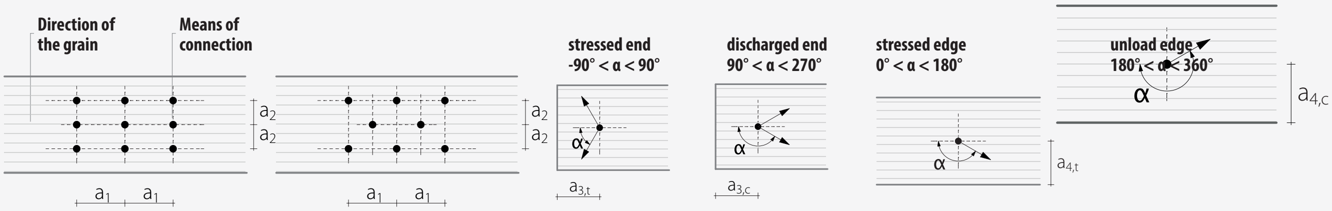
(1) The axial thread-extraction resistance was calculated considering a 90° angle between the grain and the connector and for a fixing length of b.

MINIMUM DISTANCES FOR SHEAR LOADS - WOOD ELEMENTS

	ANGLE BETWEEN STRENGHT AND GRAIN α = 0°	ANGLE BETWEEN STRENGHT AND GRAIN α = 90°
		

		SCREWS INSERTED WITH PRE-BORED HOLES							
		α = 0°				α = 90°			
			6	8	10		6	8	12
a_1	[mm]	5 d (5)	30	40	50	4 d (5)	24	32	40
a_2	[mm]	3 d	18	24	30	4 d	24	32	40
$a_{3,t}$	[mm]	12 d (5)	72	96	120	7 d (5)	42	56	70
$a_{3,c}$	[mm]	7 d (5)	42	56	70	7 d (5)	42	56	70
$a_{4,t}$	[mm]	3 d	18	24	30	7 d	42	56	70
$a_{4,c}$	[mm]	3 d	18	24	30	3 d	18	24	30

		SCREWS INSERTED WITHOUT PRE-BORED HOLES							
		α = 0°				α = 90°			
			6	8	10		6	8	10
a_1	[mm]	12 d (2)	72	96	120	5 d (2)	30	40	50
a_2	[mm]	5 d	30	40	50	5 d	30	40	50
$a_{3,t}$	[mm]	15 d (2)	90	120	150	10 d (2)	60	80	100
$a_{3,c}$	[mm]	10 d (2)	60	80	100	10 d (2)	60	80	100
$a_{4,t}$	[mm]	5 d	30	40	50	10 d	60	80	100
$a_{4,c}$	[mm]	5 d	30	40	50	5 d	30	40	50



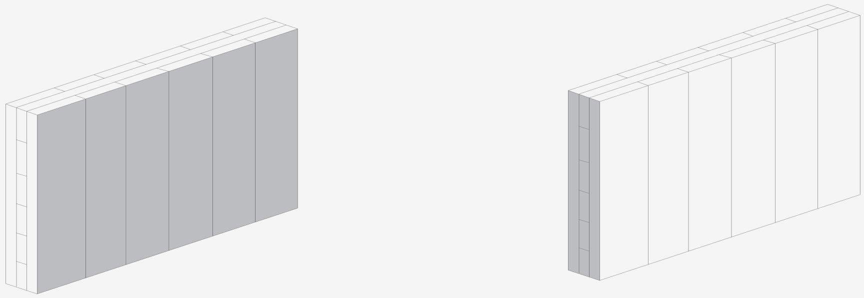
NOTES

- The minimum distances are in accordance with the EN 1995:2008 standard, according to ETA-11/0030, considering a density of the wood elements $\rho_k \leq 420$ kg/m³.
- For wood densities conversion (mean oven-dry relative density to 5th-percentile density 12% MC wt & vol) see pag. 23.

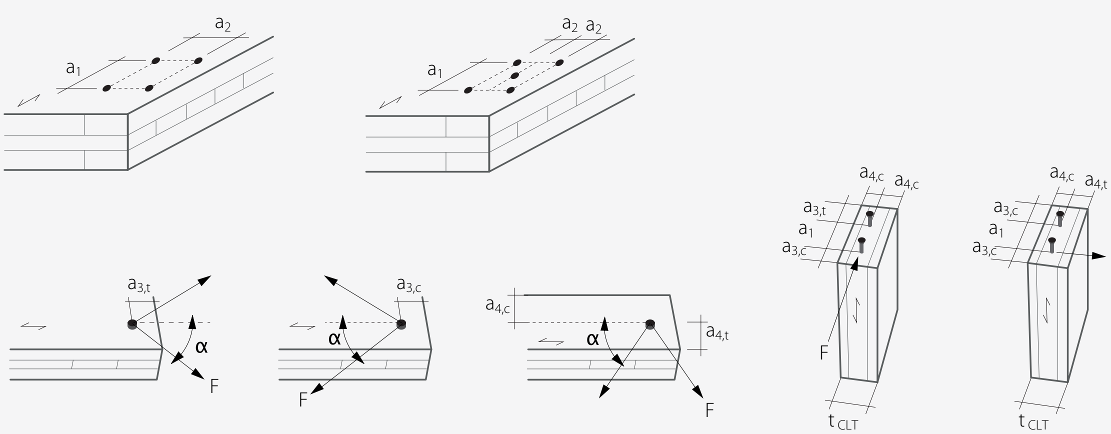
(2) For Douglas fir members minimum spacing and distances parallel to the grain shall be increased by 50%.
d = outer thread diameter

- In the case of OSB-wood joints, the minimum spacings (a_1, a_2) can be multiplied by a coefficient of 0.85.
- In the case of steel-wood joints, the minimum spacings (a_1, a_2) can be multiplied by a coefficient of 0.7.

MINIMUM DISTANCES FOR SHEAR LOADS - CLT



		SCREWS INSERTED WITHOUT PRE-BORED HOLES							
		lateral face (6)				**narrow face** (7)			
			6	**8**	**10**		**6**	**8**	**10**
$\mathbf{a_1}$	[mm]	**4 d**	24	32	40	**10 d**	60	80	100
$\mathbf{a_2}$	[mm]	**2.5 d**	15	20	25	**4 d**	24	32	40
$\mathbf{a_{3,t}}$	[mm]	**6 d**	36	48	60	**12 d**	72	96	120
$\mathbf{a_{3,c}}$	[mm]	**6 d**	36	48	60	**7 d**	42	56	70
$\mathbf{a_{4,t}}$	[mm]	**6 d**	36	48	60	**6 d**	36	48	60
$\mathbf{a_{4,c}}$	[mm]	**2.5 d**	15	20	25	**3 d**	18	24	30



NOTES

- The minimum distances are according to ETA-11/0030, unless otherwise specified in the technical specification (ETA or hEN) for the cross laminated timber.

(6) Minimum thickness of CLT members $t_{CLT,min}$ = 10 d
(7) Minimum thickness of CLT members $t_{CLT,min}$ = 10 d and minimum screw penetration depth perpendicular to the edge surface of 10 d

VGZ

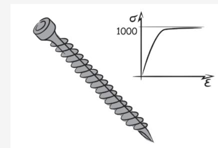
ETA 11/0030

Total thread connector with cylindrical head

Carbon steel with white galvanic zinc coating

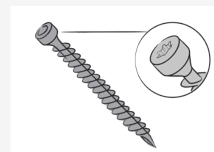
SPECIAL STEEL

Deep thread and high resistance steel ($f_{y,k}$ = 1000 N/mm²) for excellent tensile performance

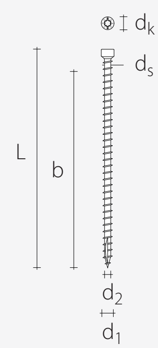


CYLINDRICAL HEAD

Cylindrical head that is hidden in the wood



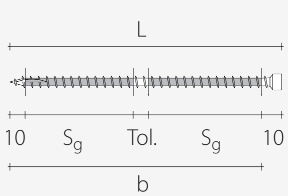
GEOMETRY AND MECHANICAL CHARACTERISTICS



VGZ CONNECTOR						
Nominal diameter	d_1	[mm]	**5.3**	**5.6**	**7**	**9**
		[inch]	***13/64″***	***7/32″***	***9/32″***	***11/32″***
Head diameter	d_k	[mm]	8.00	8.00	9.50	11.50
		[inch]	*5/16″*	*5/16″*	*3/8″*	*29/64″*
Tip diameter	d_2	[mm]	3.6	3.8	4.60	5.90
		[inch]	*9/64″*	*5/32″*	*3/16″*	*15/64″*
Shank diameter	d_s	[mm]	3.95	4.15	5.00	6.50
		[inch]	*5/32″*	*5/32″*	*13/64″*	*1/4″*
Pre-drilling diameter	d_v	[mm]	3.00	3.00	4.00	5.00
		[inch]	*1/8″*	*1/8″*	*5/32″*	*13/64″*
Characteristic yield moment	$M_{y,k}$	[Nmm]	6,303	7,274	14,174	27,244
		[lbf.in]	*55.8*	*64.4*	*125.5*	*241.1*
Characteristic withdrawal parameter	$f_{ax,k}$	[N/mm²]	11.7	11.7	11.7	11.7
		[psi]	*1,697*	*1,697*	*1,697*	*1,697*
Characteristic tensile strength	$f_{tens,k}$	[kN]	8.8	9.9	15.4	25.4
		[lbf]	*1,978*	*2,226*	*3,462*	*5,710*
Characteristic yield strength	$f_{y,k}$	[N/mm²]	1,000	1,000	1,000	1,000
		[psi]	*145,038*	*145,038*	*145,038*	*145,038*

* Screws diameter 5.3 and 5.6 have not CE mark.

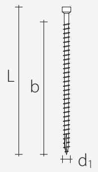
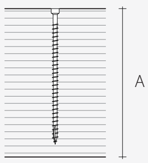
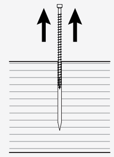
EFFECTIVE THREAD USED IN CALCULATION

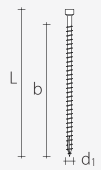
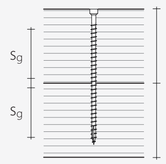
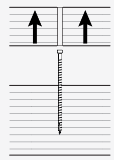


b = L - 10 mm represents the entire length of the threaded part.
S_g = (L - 10 mm - 10 mm - Tol.) / 2 represents the partial length of the threaded part net of a laying tolerance (Tol.) of 10 mm.

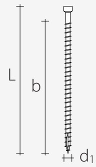
The extraction, shear and sliding values were calculated placing the centre of gravity of the connector in correspondence with the shear plane and considering an effective thread of S_g.

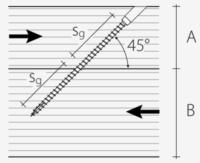
STATIC VALUES: TRACTION (1)

GEOMETRY			TOTAL THREAD WITHDRAWAL (2)												
															
							CHARACTERISTIC VALUES			DESIGN VALUES (FACTORED RESISTANCE)					
							WOOD		STEEL						
d_1	L		b		A_{MIN}		$R_{ax,k}$		$R_{tens,k}$	$R_{ax,d}$ Load Case 1		$R_{ax,d}$ Load Case 2&3		$R_{ax,d}$ Load Case 4&5	
[mm]	[mm]	[inch]	[mm]	[inch]	[mm]	[inch]	[kN]	[lbf]	[kN]	[kN]	[lbf]	[kN]	[lbf]	[kN]	[lbf]
5.3 13/64″ [inch]″	80	3 1/8″	70	9/32″	90	3 4/8″	4.54	1,020		2.09	471	2.79	628	3.14	706
	100	4″	90	3 4/8″	110	4 5/16″	5.83	1,312	8.80 1,978 [lbf]	2.69	605	3.59	807	4.04	908
	120	4 3/4″	110	4 5/16″	130	5 1/8″	7.13	1,603		3.29	740	4.39	987	4.94	1,110
5.6 7/32″ [inch]″	140	5 1/2″	130	5 1/8″	150	6″	8.90	2,002	9.90 2,226 [lbf]	4.11	924	5.48	1,232	6.16	1,386
	160	6 1/4″	150	6″	170	6 3/4″	10.27	2,310		4.74	1,066	6.32	1,421	7.11	1,599
7 9/32″ [inch]	100	4″	90	3 4/8″	110	4 3/8″	7.71	1,732		3.56	800	4.74	1,066	5.33	1,199
	140	5 1/2″	130	5 1/8″	150	6″	11.13	2,502		5.14	1,155	6.85	1,540	7.71	1,732
	180	7 1/8″	170	6 3/4″	190	7 1/2″	14.56	3,272		6.72	1,510	8.96	2,014	10.08	2,265
	220	8 5/8″	210	8 1/4″	230	9″	17.98	4,042	15.40 3,462 [lbf]	8.30	1,866	11.07	2,488	12.32	2,770
	260	10 1/4″	250	9 7/8″	270	10 5/8″	21.41	4,812		9.88	2,221	12.32	2,770	12.32	2,770
	300	11 7/8″	290	11 3/8″	310	12 1/4″	24.83	5,582		11.46	2,576	12.32	2,770	12.32	2,770
	340	13 3/8″	330	13″	350	13 6/8″	28.26	6,352		12.32	2,770	12.32	2,770	12.32	2,770
9 11/32″ [inch]	160	6 1/4″	150	6″	170	6 3/4″	16.51	3,712		7.62	1,713	10.16	2,284	11.43	2,570
	200	7 7/8″	190	7 1/2″	210	8 1/4″	20.92	4,702		9.65	2,170	12.87	2,894	14.48	3,255
	240	9 1/2″	230	9″	250	9 7/8″	25.32	5,692		11.69	2,627	15.58	3,503	17.53	3,941
	280	11″	270	10 5/8″	290	11 3/8″	29.72	6,682		13.72	3,084	18.29	4,112	20.32	4,568
	320	12 5/8″	310	12 1/4″	330	13″	34.13	7,672	25.40 5,710 [lbf]	15.75	3,541	20.32	4,568	20.32	4,568
	360	14 1/4″	350	13 6/8″	370	14 1/2″	38.53	8,662		17.78	3,998	20.32	4,568	20.32	4,568
	400	15 3/4″	390	15 3/8″	410	16 1/8″	42.93	9,652		19.82	4,455	20.32	4,568	20.32	4,568
	450	17 3/4″	440	17 1/4″	460	18 1/8″	48.44	10,889		20.32	4,568	20.32	4,568	20.32	4,568
	500	19 5/8″	490	19 1/4″	510	20 1/8″	53.94	12,127		20.32	4,568	20.32	4,568	20.32	4,568

GEOMETRY			PARTIAL THREAD WITHDRAWAL (2)												
															
							CHARACTERISTIC VALUES			DESIGN VALUES (FACTORED RESISTANCE)					
							WOOD		STEEL						
d_1	L		s_g		A_{MIN}		$R_{ax,k}$		$R_{tens,k}$	$R_{ax,d}$ Load Case 1		$R_{ax,d}$ Load Case 2&3		$R_{ax,d}$ Load Case 4&5	
[mm]	[mm]	*[inch]*	[mm]	*[inch]*	[mm]	*[inch]*	[kN]	*[lbf]*	[kN]	[kN]	*[lbf]*	[kN]	*[lbf]*	[kN]	*[lbf]*
5.3 *13/64″ [inch]″*	80	*3 1/8″*	25	*1″*	45	*1 3/4″*	1.62	*364*	8.80 *1,978 [lbf]*	0.75	*168*	1.00	*224*	1,12	*252*
	100	*4″*	35	*1 3/8″*	55	*2 1/8″*	2.27	*510*		1.05	*235*	1.40	*314*	1,57	*353*
	120	*4 3/4″*	45	*1 3/4″*	65	*2 1/2″*	2.92	*656*		1.35	*303*	1.80	*404*	2,02	*454*
5.6 *7/32″ [inch]″*	140	*5 1/2″*	55	*2 1/8″*	75	*3″*	3.77	*847*	9.90 *2,226 [lbf]*	1.74	*391*	2.32	*521*	2,61	*586*
	160	*6 1/4″*	65	*2 1/2″*	85	*3 3/8″*	4.45	*1,001*		2.05	*462*	2.74	*616*	3,08	*693*
7 *9/32″ [inch]*	100	*4″*	35	*1 3/8″*	55	*2 1/8″*	3.00	*674*	15.40 *3,462 [lbf]*	1.38	*311*	1.84	*415*	2.07	*466*
	140	*5 1/2″*	55	*2 1/8″*	75	*3″*	4.71	*1,059*		2.17	*489*	2.90	*651*	3.26	*733*
	180	*7 1/8″*	75	*3″*	95	*3 3/4″*	6.42	*1,444*		2.96	*666*	3.95	*888*	4.45	*999*
	220	*8 5/8″*	95	*3 3/4″*	115	*4 1/2″*	8.13	*1,829*		3.75	*844*	5.01	*1,125*	5.63	*1,266*
	260	*10 1/4″*	115	*4 1/2″*	135	*5 3/8″*	9.85	*2,214*		4.54	*1,022*	6.06	*1,362*	6.82	*1,533*
	300	*11 7/8″*	135	*5 3/8″*	155	*6 1/8″*	11.56	*2,599*		5.33	*1,199*	7.11	*1,599*	8.00	*1,799*
	340	*13 3/8″*	155	*6 1/8″*	175	*6 7/8″*	13.27	*2,984*		6.13	*1,377*	8.17	*1,836*	9.19	*2,066*
9 *11/32″ [inch]*	160	*6 1/4″*	65	*2 1/2″*	85	*3 3/8″*	7.16	*1,609*	25.40 *5,710 [lbf]*	3.30	*742*	4.40	*990*	4.95	*1,114*
	200	*7 7/8″*	85	*3 3/8″*	105	*4 1/8″*	9.36	*2,104*		4.32	*971*	5.76	*1,295*	6.48	*1,456*
	240	*9 1/2″*	105	*4 1/8″*	125	*4 7/8″*	11.56	*2,599*		5.33	*1,199*	7.11	*1,599*	8.00	*1,799*
	280	*11″*	125	*4 7/8″*	145	*5 3/4″*	13.76	*3,094*		6.35	*1,428*	8.47	*1,904*	9.53	*2,142*
	320	*12 5/8″*	145	*5 3/4″*	165	*6 1/2″*	15.96	*3,589*		7.37	*1,656*	9.82	*2,208*	11.05	*2,484*
	360	*14 1/4″*	165	*6 1/2″*	185	*7 1/4″*	18.16	*4,084*		8.38	*1,885*	11.18	*2,513*	12.58	*2,827*
	400	*15 3/4″*	185	*7 1/4″*	205	*8 1/8″*	20.37	*4,578*		9.40	*2,113*	12.53	*2,818*	14.10	*3,170*
	450	*17 3/4″*	210	*8 1/4″*	230	*9″*	23.12	*5,197*		10.67	*2,399*	14.23	*3,198*	16.00	*3,598*
	500	*19 5/8″*	235	*9 1/4″*	255	*10 1/16″*	25.87	*5,816*		11.94	*2,684*	15.92	*3,579*	17.91	*4,026*

STATIC VALUES: SLIDING WOOD-WOOD

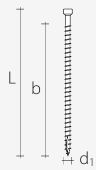


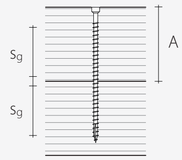


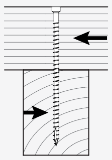
GEOMETRY			WOOD - WOOD (3)													
									CHARACTERISTIC VALUES		DESIGN VALUES (FACTORED RESISTANCE)					
d_1	L		s_g		A_{MIN}		B_{MIN}		$R_{V,k}$		$R_{V,d}$ Load Case 1		$R_{V,d}$ Load Case 2&3		$R_{V,d}$ Load Case 4&5	
[mm]	[mm]	[inch]	[mm]	[inch]	[mm]	[inch]	[mm]	[inch]	[kN]	[lbf]	[kN]	[lbf]	[kN]	[lbf]	[kN]	[lbf]
5.3 13/64 ″ [inch]″	80	3 1/8 ″	25	1 ″	30	1 3/16 ″	50	2 ″	1.04	234	0.48	108	0.64	144	0.72	162
	100	4 ″	35	1 3/8 ″	40	1 5/8 ″	55	2 1/8 ″	1.46	328	0.67	151	0.90	202	1.01	227
	120	4 3/4 ″	45	1 3/4 ″	45	1 3/4 ″	60	2 3/8 ″	1.88	422	0.87	195	1.15	259	1.30	292
5.6 7/32 ″ [inch]″	140	5 1/2 ″	55	2 1/8 ″	50	2 ″	70	2 3/4 ″	2.42	544	1.12	251	1.49	335	1.68	377
	160	6 1/4 ″	65	2 1/2 ″	60	2 3/8 ″	75	3 ″	2.86	643	1.32	297	1.76	396	1.98	445
7 9/32″ [inch]	100	4 ″	35	1 3/8 ″	40	1 5/8 ″	55	2 1/8 ″	1.93	433	0.89	200	1.19	267	1.33	300
	140	5 1/2 ″	55	2 1/8 ″	55	2 1/8 ″	70	2 3/4 ″	3.03	681	1.40	314	1.86	419	2.10	471
	180	7 1/8 ″	75	3 ″	65	2 1/2 ″	85	3 3/8 ″	4.13	928	1.91	428	2.54	571	2.86	642
	220	8 5/8 ″	95	3 3/4 ″	80	3 1/8 ″	100	4 ″	5.23	1,175	2.41	543	3.22	723	3.62	814
	260	10 1/4 ″	115	4 1/2 ″	95	3 3/4 ″	110	4 3/8 ″	6.33	1,423	2.92	657	3.90	876	4.38	985
	300	11 7/8 ″	135	5 3/8 ″	110	4 3/8 ″	125	4 7/8 ″	7.43	1,670	3.43	771	4.57	1,028	5.14	1,156
	340	13 3/8 ″	155	6 1/8 ″	125	4 7/8 ″	140	5 1/2 ″	8.53	1,918	3.94	885	5.25	1,180	5.91	1,328
9 11/32 ″ [inch]	160	6 1/4 ″	65	2 1/2 ″	60	2 3/8 ″	75	3 ″	4.60	1,034	2.12	477	2.83	636	3.18	716
	200	7 7/8 ″	85	3 3/8 ″	75	3 ″	90	3 4/8 ″	6.02	1,352	2.78	624	3.70	832	4.16	936
	240	9 1/2 ″	105	4 1/8 ″	90	3 4/8 ″	105	4 1/8 ″	7.43	1,670	3.43	771	4.57	1,028	5.14	1,156
	280	11″	125	4 7/8 ″	105	4 1/8 ″	120	4 3/4 ″	8.85	1,989	4.08	918	5.44	1,224	6.12	1,377
	320	12 5/8 ″	145	5 3/4 ″	115	4 1/2 ″	135	5 3/8 ″	10.26	2,307	4.74	1,065	6.31	1,420	7.10	1,597
	360	14 1/4 ″	165	6 1/2 ″	130	5 1/8 ″	145	5 3/4 ″	11.68	2,625	5.39	1,212	7.19	1,615	8.08	1,817
	400	15 3/4 ″	185	7 1/4 ″	145	5 3/4 ″	160	6 1/4 ″	13.09	2,943	6.04	1,358	8.06	1,811	9.06	2,038
	450	17 3/4 ″	210	8 1/4 ″	165	6 1/2 ″	180	7 1/8 ″	14.86	3,341	6.86	1,542	9.15	2,056	10.29	2,313
	500	19 5/8 ″	235	9 1/4 ″	180	7 1/8 ″	195	7 5/8 ″	16.63	3,739	7.68	1,726	10.23	2,301	11.51	2,588

STATIC VALUES: SHEAR WOOD-WOOD

GEOMETRY							WOOD - WOOD							
							CHARACTERISTIC VALUES		DESIGN VALUES (FACTORED RESISTANCE)					
d_1	L		s_g		A_{MIN}		$R_{V,k}$		$R_{V,d}$ Load Case 1		$R_{V,d}$ Load Case 2&3		$R_{V,d}$ Load Case 4&5	
[mm]	[mm]	*[inch]*	[mm]	*[inch]*	[mm]	*[inch]*	[kN]	*[lbf]*	[kN]	*[lbf]*	[kN]	*[lbf]*	[kN]	*[lbf]*
5.3 *13/64 ″ [inch]″*	80	*3 1/8 ″*	25	*1 ″*	40	*1 5/8 ″*	1.51	*338*	0.69	*156*	0.93	*208*	1.04	*234*
	100	*4 ″*	35	*1 3/8 ″*	50	*2 ″*	1.84	*414*	0.85	*191*	1.13	*255*	1.28	*287*
	120	*4 3/4 ″*	45	*1 3/4 ″*	60	*2 3/8 ″*	2.00	*451*	0.93	*208*	1.23	*277*	1.39	*312*
5.6 *7/32 ″ [inch]″*	140	*5 1/2 ″*	55	*2 1/8 ″*	70	*2 3/4 ″*	2.34	*526*	1.08	*243*	1.44	*323*	1.62	*364*
	160	*6 1/4 ″*	65	*2 1/2 ″*	80	*3 1/8 ″*	2.51	*564*	1.16	*260*	1.54	*347*	1.74	*391*
7 *9/32″ [inch]*	100	*4 ″*	35	*1 3/8 ″*	50	*2 ″*	2.60	*584*	1.20	*270*	1.60	*359*	1.80	*404*
	140	*5 1/2 ″*	55	*2 1/8 ″*	70	*2 3/4 ″*	3.28	*738*	1.52	*341*	2.02	*454*	2.27	*511*
	180	*7 1/8 ″*	75	*3 ″*	90	*3 4/8 ″*	3.71	*835*	1.71	*385*	2.28	*514*	2.57	*578*
	220	*8 5/8 ″*	95	*3 3/4 ″*	110	*4 3/8 ″*	4.14	*931*	1.91	*430*	2.55	*573*	2.87	*644*
	260	*10 1/4 ″*	115	*4 1/2 ″*	130	*5 1/8 ″*	4.21	*948*	1.95	*437*	2.59	*583*	2.92	*656*
	300	*11 7/8 ″*	135	*5 3/8 ″*	150	*6 ″*	4.21	*948*	1.95	*437*	2.59	*583*	2.92	*656*
	340	*13 3/8 ″*	155	*6 1/8 ″*	170	*6 3/4 ″*	4.21	*948*	1.95	*437*	2.59	*583*	2.92	*656*
9 *11/32 ″ [inch]*	160	*6 1/4 ″*	65	*2 1/2 ″*	80	*3 1/8 ″*	4.98	*1,119*	2.30	*517*	3.06	*689*	3.45	*775*
	200	*7 7/8 ″*	85	*3 3/8 ″*	100	*4 ″*	5.53	*1,243*	2.55	*574*	3.40	*765*	3.83	*861*
	240	*9 1/2 ″*	105	*4 1/8 ″*	120	*4 3/4 ″*	6.08	*1,367*	2.81	*631*	3.74	*841*	4.21	*946*
	280	*11″*	125	*4 7/8 ″*	140	*5 1/2 ″*	6.38	*1,434*	2.94	*662*	3.93	*883*	4.42	*993*
	320	*12 5/8 ″*	145	*5 3/4 ″*	160	*6 1/4 ″*	6.38	*1,434*	2.94	*662*	3.93	*883*	4.42	*993*
	360	*14 1/4 ″*	165	*6 1/2 ″*	180	*7 1/8 ″*	6.38	*1,434*	2.94	*662*	3.93	*883*	4.42	*993*
	400	*15 3/4 ″*	185	*7 1/4 ″*	200	*7 7/8 ″*	6.38	*1,434*	2.94	*662*	3.93	*883*	4.42	*993*
	450	*17 3/4 ″*	210	*8 1/4 ″*	225	*8 7/8 ″*	6.38	*1,434*	2.94	*662*	3.93	*883*	4.42	*993*
	500	*19 5/8 ″*	235	*9 1/4 ″*	250	*9 7/8 ″*	6.38	*1,434*	2.94	*662*	3.93	*883*	4.42	*993*





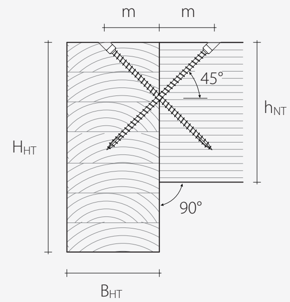


STATIC VALUES: SHEAR CONNECTION WITH CROSSED CONNECTORS

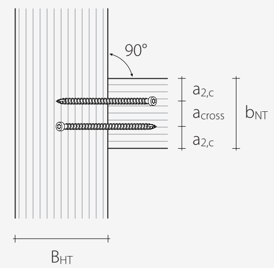
RIGHT-ANGLE JOINT - MAIN BEAM / SECONDARY BEAM

d_1	L		s_g		$B_{HT\,min}$		$H_{HT\,min} = h_{NT\,min}$		$b_{NT\,min}$ without pre-bored hole		$b_{NT\,min}$ with pre-bored hole (4)	
[mm]	[mm]	[inch]	[mm]	[inch]	[mm]	[inch]	[mm]	[inch]	[mm]	[inch]	[mm]	[inch]
5.3 13/64″ [inch]″	100	4″	35	1 3/8″	55	2 1/8″	90	3 4/8″	50	2″	40	1 5/8″
									77	3″	66	2 5/8″
									103	4 1/8″	93	3 5/8″
	120	4 3/4″	45	1 3/4″	60	2 3/8″	105	4 1/8″	50	2″	40	1 5/8″
									77	3″	66	2 5/8″
									103	4 1/8″	93	3 5/8″
5.6 7/32″ [inch]″	140	5 1/2″	55	2 1/8″	65	2 1/2″	120	4 3/4″	53	2 1/8″	42	1 5/8″
									81	3 2/8″	70	2 3/4″
									109	4 2/8″	98	3 7/8″
	160	6 1/4″	65	2 1/2″	75	3″	135	5 3/8″	53	2 1/8″	42	1 5/8″
									81	3 2/8″	70	2 3/4″
									109	4 2/8″	98	3 7/8″
7 9/32″ [inch]	140	5 1/2″	55	2 1/8″	65	2 1/2″	120	4 3/4″	67	2 5/8″	53	2 1/8″
									102	4″	88	3 4/8″
									137	5 3/8″	123	4 7/8″
	180	7 1/8″	75	3″	80	3 1/8″	150	6″	67	2 5/8″	53	2 1/8″
									102	4″	88	3 4/8″
									137	5 3/8″	123	4 7/8″
	220	8 5/8″	95	3 3/4″	95	3 3/4″	175	6 7/8″	67	2 5/8″	53	2 1/8″
									102	4″	88	3 4/8″
									137	5 3/8″	123	4 7/8″
	260	10 1/4″	115	4 1/2″	110	4 3/8″	205	8 1/8″	67	2 5/8″	53	2 1/8″
									102	4″	88	3 4/8″
									137	5 3/8″	123	4 7/8″
	300	11 7/8″	135	5 3/8″	125	4 7/8″	235	9 1/4″	67	2 5/8″	53	2 1/8″
									102	4″	88	3 4/8″
									137	5 3/8″	123	4 7/8″
	340	13 3/8″	155	6 1/8″	140	5 1/2″	260	10 1/4″	67	2 5/8″	53	2 1/8″
									102	4″	88	3 4/8″
									137	5 3/8″	123	4 7/8″
9 11/32″ [inch]	160	6 1/4″	65	2 1/2″	75	3″	135	5 3/8″	86	3 3/8″	68	2 5/8″
									131	5 1/8″	113	4 3/8″
									176	6 7/8″	158	6 1/4″
	200	7 7/8″	85	3 3/8″	90	3 4/8″	165	6 1/2″	86	3 3/8″	68	2 5/8″
									131	5 1/8″	113	4 3/8″
									176	6 7/8″	158	6 1/4″
	240	9 1/2″	105	4 1/8″	100	4″	190	7 1/2″	86	3 3/8″	68	2 5/8″
									131	5 1/8″	113	4 3/8″
									176	6 7/8″	158	6 1/4″
	280	11″	125	4 7/8″	115	4 1/2″	220	8 5/8″	86	3 3/8″	68	2 5/8″
									131	5 1/8″	113	4 3/8″
									176	6 7/8″	158	6 1/4″
	320	12 5/8″	145	5 3/4″	130	5 1/8″	250	9 7/8″	86	3 3/8″	68	2 5/8″
									131	5 1/8″	113	4 3/8″
									176	6 7/8″	158	6 1/4″
	360	14 1/4″	165	6 1/2″	145	5 3/4″	275	10 5/8″	86	3 3/8″	68	2 5/8″
									131	5 1/8″	113	4 3/8″
									176	6 7/8″	158	6 1/4″
	400	15 3/4″	185	7 1/4″	160	6 1/4″	305	12″	86	3 3/8″	68	2 5/8″
									131	5 1/8″	113	4 3/8″
									176	6 7/8″	158	6 1/4″
	450	17 3/4″	210	8 1/4″	175	6 7/8″	340	13 3/8″	86	3 3/8″	68	2 5/8″
									131	5 1/8″	113	4 3/8″
									176	6 7/8″	158	6 1/4″
	500	19 5/8″	235	9 1/4″	195	7 5/8″	375	14 3/4″	86	3 3/8″	68	2 5/8″
									131	5 1/8″	113	4 3/8″
									176	6 7/8″	158	6 1/4″

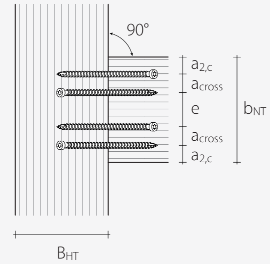
SECTION:



PLAN - 1 PAIR



PLAN - 2 OR MORE PAIRS



No. pairs	$R_{1V,k}$ (5) extraction (7)		$R_{2V,k}$ (5) instability		$R_{V,d}$ Load Case 1		$R_{V,d}$ Load Case 2&3		$R_{V,d}$ Load Case 4&5		m (6)	
	[kN]	[lbf]	[kN]	[lbf]	[kN]	[lbf]	[kN]	[lbf]	[kN]	[lbf]	[mm]	[inch]
1	3,0	670	8,2	1.835	1,4	309	1,8	412	2,1	464		
2	5,6	1.250	15,2	3.425	2,6	577	3,4	769	3,8	865	38	1 3/8″
3	8,0	1.801	21,9	4.933	3,7	831	4,9	1.108	5,5	1.247		
1	3,8	861	8,2	1.835	1,8	398	2,4	530	2,7	596		
2	7,1	1.607	15,2	3.425	3,3	742	4,4	989	4,9	1.113	45	1 3/4″
3	10,3	2.315	21,9	4.933	4,8	1.069	6,3	1.425	7,1	1.603		
1	4,9	1.112	9,1	2.052	2,3	513	3,0	685	3,4	770		
2	9,2	2.076	17,0	3.829	4,3	958	5,7	1.277	6,4	1.437	52	2 3/64″
3	13,3	2.990	24,5	5.516	6,1	1.380	8,2	1.840	9,2	2.070		
1	5,8	1.315	9,1	2.052	2,7	607	3,6	809	4,0	910		
2	10,9	2.453	17,0	3.829	5,0	1.132	6,7	1.510	7,6	1.698	59	2 21/64″
3	15,7	3.533	24,5	5.516	7,3	1.631	9,7	2.174	10,9	2.446		
1	6.1	1,361	13.5	3,035	2.8	628	3.7	838	4.2	942		
2	11.3	2,540	25.2	5,663	5.2	1,172	7.0	1,563	7.8	1,758	53	2 1/8″
3	16.3	3,658	36.3	8,157	7.5	1,689	10.0	2,251	11.3	2,533		
1	8.3	1,856	13.5	3,035	3.8	857	5.1	1,142	5.7	1,285		
2	15.4	3,463	25.2	5,663	7.1	1,599	9.5	2,131	10.7	2,398	67	2 5/8″
3	22.2	4,989	36.3	8,157	10.2	2,303	13.7	3,070	15.4	3,454		
1	10.5	2,351	13.5	3,035	4.8	1,085	6.4	1,447	7.2	1,628		
2	19.5	4,387	25.2	5,663	9.0	2,025	12.0	2,700	13.5	3,037	81	3 1/4″
3	28.1	6,319	36.3	8,157	13.0	2,917	17.3	3,889	19.5	4,375		
1	12.7	2,846	13.5	3,035	5.8	1,314	7.8	1,751	8.8	1,970		
2	23.6	5,311	25.2	5,663	10.9	2,451	14.5	3,268	16.4	3,677	95	3 3/4″
3	34.0	7,650	36.3	8,157	15.7	3,531	20.9	4,707	23.6	5,296		
1	14.9	3,341	13.5	3,035	6.9	1,542	9.1	2,056	10.3	2,313		
2	27.7	6,234	25.2	5,663	12.8	2,877	17.1	3,836	19.2	4,316	109	4 1/4″
3	39.9	8,980	36.3	8,157	18.4	4,145	24.6	5,526	27.7	6,217		
1	17.1	3,836	13.5	3,035	7.9	1,770	10.5	2,361	11.8	2,656		
2	31.8	7,158	25.2	5,663	14.7	3,304	19.6	4,405	22.0	4,955	124	4 7/8″
3	45.9	10,310	36.3	8,157	21.2	4,759	28.2	6,345	31.8	7,138		
1	9.2	2,068	22.7	5,095	4.2	955	5.7	1,273	6.4	1,432		
2	17.2	3,859	42.3	9,508	7.9	1,781	10.6	2,375	11.9	2,672	61	2 3/8″
3	24.7	5,559	60.9	13,695	11.4	2,566	15.2	3,421	17.1	3,849		
1	12.0	2,705	22.7	5,095	5.6	1,248	7.4	1,664	8.3	1,872		
2	22.4	5,047	42.3	9,508	10.4	2,329	13.8	3,106	15.5	3,494	75	3″
3	32.3	7,269	60.9	13,695	14.9	3,355	19.9	4,473	22.4	5,033		
1	14.9	3,341	22.7	5,095	6.9	1,542	9.1	2,056	10.3	2,313		
2	27.7	6,234	42.3	9,508	12.8	2,877	17.1	3,836	19.2	4,316	89	3 4/8″
3	39.9	8,980	60.9	13,695	18.4	4,145	24.6	5,526	27.7	6,217		
1	17.7	3,977	22.7	5,095	8.2	1,836	10.9	2,448	12.2	2,753		
2	33.0	7,422	42.3	9,508	15.2	3,425	20.3	4,567	22.9	5,138	103	4″
3	47.6	10,690	60.9	13,695	21.9	4,934	29.3	6,579	32.9	7,401		
1	20.5	4,614	22.7	5,095	9.5	2,129	12.6	2,839	14.2	3,194		
2	38.3	8,609	42.3	9,508	17.7	3,974	23.6	5,298	26.5	5,960	117	4 5/8″
3	55.2	12,401	60.9	13,695	25.5	5,723	33.9	7,631	38.2	8,585		
1	23.4	5,250	22.7	5,095	10.8	2,423	14.4	3,231	16.2	3,635		
2	43.6	9,797	42.3	9,508	20.1	4,522	26.8	6,029	30.2	6,782	131	5 1/8″
3	62.8	14,111	60.9	13,695	29.0	6,513	38.6	8,684	43.5	9,769		
1	26.2	5,886	22.7	5,095	12.1	2,717	16.1	3,622	18.1	4,075		
2	48.9	10,984	42.3	9,508	22.6	5,070	30.1	6,760	33.8	7,604	145	5 3/4″
3	70.4	15,822	60.9	13,695	32.5	7,302	43.3	9,736	48.7	10,953		
1	29.7	6,682	22.7	5,095	13.7	3,084	18.3	4,112	20.6	4,626		
2	55.5	12,469	42.3	9,508	25.6	5,755	34.1	7,673	38.4	8,632	163	6 3/8″
3	79.9	17,960	60.9	13,695	36.9	8,289	49.2	11,052	55.3	12,434		
1	33.3	7,477	22.7	5,095	15.4	3,451	20.5	4,601	22.7	5,095		
2	62.1	13,953	42.3	9,508	28.6	6,440	38.2	8,586	42.3	9,508	181	7 1/8″
3	89.4	20,098	60.9	13,695	41.3	9,276	55.0	12,368	60.9	13,695		

MINIMUM RECOMMENDED DISTANCES [mm]

without pre-bored hole	$a_{2,c}$	a_{cross}	e
5.3	21	8	19
5.6	22	8	20
7	28	11	25
9	36	14	32
11	44	17	39

with pre-bored hole	$a_{2,c}$	a_{cross}	e
5.3	16	8	19
5.6	17	8	20
7	21	11	25
9	27	14	32
11	33	17	39

	pre-bored hole d_v [mm]
5.3	3.0
5.6	3.0
7	4.0
9	5.0
11	6.0

Pre-bored hole required for connectors Ø11 ≥ 400 mm

STATIC VALUES: SHEAR CONNECTION WITH CROSSED CONNECTORS

RIGHT-ANGLE JOINT - MAIN BEAM / SECONDARY BEAM

d_1	L		s_g		$B_{HT\,min}$		$H_{HT\,min} = h_{NT\,min}$		$b_{NT\,min}$ without pre-bored hole		$b_{NT\,min}$ with pre-bored hole (4)	
[mm]	[mm]	[inch]	[mm]	[inch]	[mm]	[inch]	[mm]	[inch]	[mm]	[inch]	[mm]	[inch]
									105	4 1/8″	83	3 1/4″
	200	7 7/8″	85	3 3/8″	90	2 1/8″	165	6 1/2″	160	6 1/4″	138	5 3/8″
									215	8 1/2″	193	7 5/8″
									105	4 1/8″	83	3 1/4″
	250	9 7/8″	110	4 3/8″	105	2 3/4″	200	7 7/8″	160	6 1/4″	138	5 3/8″
									215	8 1/2″	193	7 5/8″
									105	4 1/8″	83	3 1/4″
	300	11 7/8″	135	5 3/8″	125	3 4/8″	235	9 1/4″	160	6 1/4″	138	5 3/8″
									215	8 1/2″	193	7 5/8″
									105	4 1/8″	83	3 1/4″
	350	13 6/8″	160	6 1/4″	140	4 1/8″	270	10 5/8″	160	6 1/4″	138	5 3/8″
									215	8 1/2″	193	7 5/8″
11									105	4 1/8″	83	3 1/4″
7/16″	400	15 3/4″	185	7 1/4″	160	4 7/8″	305	12″	160	6 1/4″	138	5 3/8″
[inch]									215	8 1/2″	193	7 5/8″
									105	4 1/8″	83	3 1/4″
	450	17 3/4″	210	8 1/4″	175	5 1/2″	340	13 3/8″	160	6 1/4″	138	5 3/8″
									215	8 1/2″	193	7 5/8″
									105	4 1/8″	83	3 1/4″
	500	19 5/8″	235	9 1/4″	195	6 1/4″	380	15″	160	6 1/4″	138	5 3/8″
									215	8 1/2″	193	7 5/8″
									105	4 1/8″	83	3 1/4″
	550	21 5/8″	260	10 1/4″	210	6 7/8″	415	16 3/8″	160	6 1/4″	138	5 3/8″
									215	8 1/2″	193	7 5/8″
									105	4 1/8″	83	3 1/4″
	600	23 5/8″	285	11 1/4″	230	7 5/8″	450	17 3/4″	160		138	5 3/8″
									215	8 1/2″	193	7 5/8″

NOTES

(1) The design strength of the connector is the lower between the wood-side design strength ($R_{ax,d}$) and the steel-side design strength ($R_{tens,d}$).

$$R_{ax,d} = \min \begin{cases} R_{ax,k} \cdot DMF \\ R_{tens,k} / \gamma_{M2} \end{cases}$$

γ_{M2}: partial factor for resistance of cross-sections in tension to fracture according to EN 1993-1-1. Please see notes pag. 25.

(2) The axial resistance of the thread to extraction was calculated considering a 90° angle between the fibres and the connector and for a effective thread length of b or s_g. For intermediate s_g values it is possible to interpolate linearly.

(3) The axial resistance of the thread to extraction was calculated considering a 45° angle between the fibres and the connector and for an effective thread length of s_g.

(4) In practice it is possible to reduce the minimum distances by inserting the connectors with a pre-bored hole.

(5) The design strength of the connector is the lower between the extraction-side design strength ($R_{1\,V,d}$) and the instability design strength ($R_{2\,V,d}$).

$$R_{V,d} = \min \begin{cases} R_{1\,V,k} \cdot DMF \\ R_{2\,V,k} / \gamma_{M1} \end{cases}$$

γ_{M1}: partial factor for resistance of members to instability according to EN 1993-1-1. Please see notes pag. 25.

(6) The assembly figure (m) is valid in the case of laying of the connectors flush over the elements.

(7) The axial resistance of the thread to extraction was calculated considering an effective thread length equal to s_g. The connectors must be inserted at 45° with respect to the shear plane. The centre of gravity of the connectors must be placed in correspondence with the shear plane.

- For different calculation methods, the myProject software is available (www. rothoblaas.com).

No. pairs	$R_{1V,k}$ (5) extraction (7)		$R_{2V,k}$ (5) instability		$R_{V,d}$ Load Case 1		$R_{V,d}$ Load Case 2&3		$R_{V,d}$ Load Case 4&5		m (6)	
	[kN]	*[lbf]*	[kN]	*[lbf]*	[kN]	*[lbf]*	[kN]	*[lbf]*	[kN]	*[lbf]*	[mm]	*[inch]*
1	14.7	*3,306*	28.9	*6,493*	6.8	*1,526*	9.0	*2,034*	10.2	*2,288*		
2	27.4	*6,168*	53.9	*12,117*	12.7	*2,847*	16.9	*3,796*	19.0	*4,270*	78	*3 1/8"*
3	39.5	*8,885*	77.6	*17,454*	18.2	*4,101*	24.3	*5,468*	27.4	*6,151*		
1	19.0	*4,278*	28.9	*6,493*	8.8	*1,974*	11.7	*2,632*	13.2	*2,962*		
2	35.5	*7,983*	53.9	*12,117*	16.4	*3,684*	21.9	*4,912*	24.6	*5,526*	95	*3 3/4"*
3	51.1	*11,498*	77.6	*17,454*	23.6	*5,307*	31.5	*7,076*	35.4	*7,960*		
1	23.4	*5,250*	28.9	*6,493*	10.8	*2,423*	14.4	*3,231*	16.2	*3,635*		
2	43.6	*9,797*	53.9	*12,117*	20.1	*4,522*	26.8	*6,029*	30.2	*6,782*	113	*4 3/8"*
3	62.8	*14,111*	77.6	*17,454*	29.0	*6,513*	38.6	*8,684*	43.5	*9,769*		
1	27.7	*6,222*	28.9	*6,493*	12.8	*2,872*	17.0	*3,829*	19.2	*4,308*		
2	51.6	*11,611*	53.9	*12,117*	23.8	*5,359*	31.8	*7,145*	35.8	*8,038*	131	*5 1/8"*
3	74.4	*16,724*	77.6	*17,454*	34.3	*7,719*	45.8	*10,292*	51.5	*11,578*		
1	32.0	*7,194*	28.9	*6,493*	14.8	*3,320*	19.7	*4,427*	22.2	*4,981*		
2	59.7	*13,425*	53.9	*12,117*	27.6	*6,196*	36.7	*8,262*	41.3	*9,294*	148	*5 7/8"*
3	86.0	*19,338*	77.6	*17,454*	39.7	*8,925*	52.9	*11,900*	59.6	*13,388*		
1	36.3	*8,167*	28.9	*6,493*	16.8	*3,769*	22.4	*5,026*	25.1	*5,654*		
2	67.8	*15,239*	53.9	*12,117*	31.3	*7,034*	41.7	*9,378*	46.9	*10,550*	166	*6 1/2"*
3	97.6	*21,951*	77.6	*17,454*	45.1	*10,131*	60.1	*13,508*	67.6	*15,197*		
1	40.7	*9,139*	28.9	*6,493*	18.8	*4,218*	25.0	*5,624*	28.1	*6,327*		
2	75.9	*17,054*	53.9	*12,117*	35.0	*7,871*	46.7	*10,495*	52.5	*11,806*	184	*7 1/4"*
3	109.3	*24,564*	77.6	*17,454*	50.4	*11,337*	67.2	*15,116*	75.6	*17,006*		
1	45.0	*10,111*	28.9	*6,493*	20.8	*4,667*	27.7	*6,222*	28.9	*6,493*		
2	83.9	*18,868*	53.9	*12,117*	38.7	*8,708*	51.6	*11,611*	53.9	*12,117*	201	*7 7/8"*
3	120.9	*27,177*	77.6	*17,454*	55.8	*12,543*	74.4	*16,724*	77.6	*17,454*		
1	49.3	*11,083*	28.9	*6,493*	22.8	*5,115*	28.9	*6,493*	28.9	*6,493*		
2	92.0	*20,682*	53.9	*12,117*	42.5	*9,546*	53.9	*12,117*	53.9	*12,117*	219	*8 5/8"*
3	132.5	*29,790*	77.6	*17,454*	61.2	*13,749*	77.6	*17,454*	77.6	*17,454*		

Minimum distances for shear and for axial loads: See VGS connectors: pag. 52

VGS connectors, countersunk head Ø9 and Ø11: see pag. 52

GENERAL PRINCIPLES

- Characteristic values comply with the EN 1995:2008 standard in accordance with ETA-11/0030.
- According to EN 1995:2008 for shear characteristic values the contribution from the rope effect ($F_{ax,Rk}$ / 4) is considered. This is resulting in higher shear resistances compared to shear resistances calculated in accordance with CSA O86-14.
- Design values for wood-side are obtained from the following characteristic values:

  $$R_d = R_k \cdot DMF$$

  DMF: design modification factor based on k_{mod} as per Table 8 and for γ_M as per Table 9 (γ_M = 1.3). See pag. 24.

Load case	Load Combination		Design Modification Factor DMF
	Principal Load	Companion Load	
1	1.4D	-	**0.46**
2	(1.25D or 0.9D) + 1.5L	1.0S or 0.4W	**0.62** (1)
3	(1.25D or 0.9D) + 1.5S	1.0L or 0.4W	**0.62**
4	(1.25D or 0.9D) + 1.4W	0.5L or 0.5S	**0.69**
5	1.0D + 1.0E	0.5L or 0.25S	**0.69**

(1) *If Live Load L is associated with long term loads such as storage, equipment areas etc., use 0,54*

- For the mechanical resistance values and the geometry of the screws, reference was made to ETA-11/0030.
- In the calculations, the density of the wood elements was considered equal to ρ_k = 370 kg/m^3 (S-P-F sawn lumber). For wood densities conversion (mean oven-dry relative density to 5th-percentile density 12% MC wt & vol) see pag. 23 Characteristic resistances can also be considered as valid for higher densities, for the purposes of safety.
- Values were calculated considering the threaded part as being completely inserted into the wood.
- Sizing and verification of the wooden elements and steel plates must be done separately.
- The shear characteristic resistances are calculated for screws inserted without pre-bored holes. In the case of screws inserted with pre-bored holes, greater resistance values can be obtained.
- For different calculation methods, the myProject software is available free of charge (www.rothoblaas.com).
- The characteristic resistances were calculated using solid wood or glulam. In the case of joints with CLT elements, the resistance values may be different and should be calculated on the basis of the characteristics of the panel and the connection configuration.

VGS

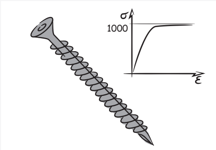
ETA 11/0030

Total thread connector with countersunk head

Carbon steel with white galvanic zinc coating

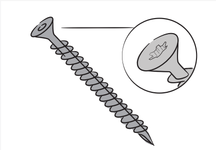
SPECIAL STEEL

Deep thread and high resistance steel ($f_{y,k}$ = 1000 N/mm²) for excellent tensile performance

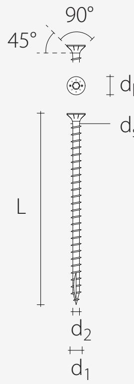


COUNTERSUNK HEAD

Countersunk head for use on steel plates

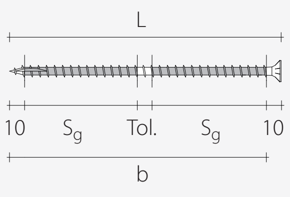


GEOMETRY AND MECHANICAL CHARACTERISTICS



VGS CONNECTOR				
Nominal diameter	d_1	[mm]	**9**	**11**
		[inch]	***11/32″***	***7/16″***
Head diameter	d_k	[mm]	16.0	19.3
		[inch]	*5/8″*	*49/64″*
Tip diameter	d_2	[mm]	5.90	6.60
		[inch]	*15/64″*	*17/64″*
Shank diameter	d_s	[mm]	6.50	7.70
		[inch]	*1/4″*	*19/64″*
Pre-drilling diameter	d_v	[mm]	5.00	6.00
		[inch]	*13/64″*	*15/64″*
Characteristic yield moment	$M_{y,k}$	[Nmm]	27,244	45,905
		[lbf.in]	*241.1*	*406.3*
Characteristic withdrawal parameter	$f_{ax,k}$	[N/mm²]	11.7	11.7
		[psi]	*1.697*	*1.697*
Characteristic tensile strength	$f_{tens,k}$	[kN]	25.4	38.0
		[lbf]	*5,710*	*8,543*
Characteristic yield strength	$f_{y,k}$	[N/mm²]	1,000	1,000
		[psi]	*145,038*	*145,038*

EFFECTIVE THREAD USED IN CALCULATION



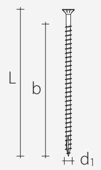
b = L - 10 mm represents the entire length of the threaded part.
S_g = (L - 10 mm - 10 mm - Tol.) / 2 represents the partial length of the threaded part net of a laying tolerance (Tol.) of 10 mm.

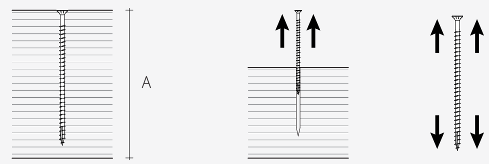
The extraction, shear and sliding values were calculated placing the centre of gravity of the connector in correspondence with the shear plane and considering an effective thread of S_g.

STATIC VALUES: TRACTION (1)

TOTAL THREAD WITHDRAWAL (2)

GEOMETRY

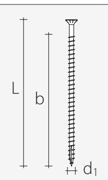


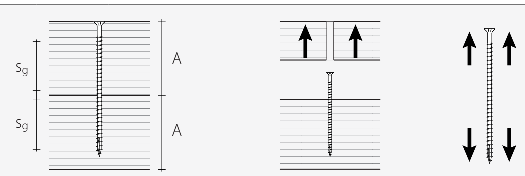


d1	L		b		A_{MIN}		CHARACTERISTIC VALUES WOOD $R_{ax,k}$		CHARACTERISTIC VALUES STEEL $R_{tens,k}$	DESIGN VALUES (FACTORED RESISTANCE) $R_{ax,d}$ Load Case 1		$R_{ax,d}$ Load Case 2&3		$R_{ax,d}$ Load Case 4&5	
[mm]	[mm]	[inch]	[mm]	[inch]	[mm]	[inch]	[kN]	[lbf]	[kN]	[kN]	[lbf]	[kN]	[lbf]	[kN]	[lbf]
9 11/32" [inch]	160	6 1/4"	150	6"	170	6 3/4"	16.51	3,712	25.40 5,710 [lbf]	7.62	1,713	10.16	2,284	11.43	2,570
	200	7 7/8"	190	7 1/2"	210	8 1/4"	20.92	4,702		9.65	2,170	12.87	2,894	14.48	3,255
	240	9 1/2"	230	9"	250	9 7/8"	25.32	5,692		11.69	2,627	15.58	3,503	17.53	3,941
	280	11"	270	10 5/8"	290	11 3/8"	29.72	6,682		13.72	3,084	18.29	4,112	20.32	4,568
	320	12 5/8"	310	12 1/4"	330	13"	34.13	7,672		15.75	3,541	20.32	4,568	20.32	4,568
	360	14 1/4"	350	13 6/8"	370	14 1/2"	38.53	8,662		17.78	3,998	20.32	4,568	20.32	4,568
	400	15 3/4"	390	15 3/8"	410	16 1/8"	42.93	9,652		19.82	4,455	20.32	4,568	20.32	4,568
	450	17 3/4"	440	17 1/4"	460	18 1/8"	48.44	10,889		20.32	4,568	20.32	4,568	20.32	4,568
	500	19 5/8"	490	19 1/4"	510	20 1/8"	53.94	12,127		20.32	4,568	20.32	4,568	20.32	4,568
11 7/16" [inch]	100	4"	90	3 4/8"	110	4 3/8"	12.11	2,722	38.00 8,543 [lbf]	5.59	1,256	7.45	1,675	8.38	1,885
	150	6"	140	5 1/2"	160	6 1/4"	18.84	4,235		8.69	1,954	11.59	2,606	13.04	2,932
	200	7 7/8"	190	7 1/2"	210	8 1/4"	25.56	5,747		11.80	2,653	15.73	3,537	17.70	3,979
	250	9 7/8"	240	9 1/2"	260	10 1/4"	32.29	7,260		14.90	3,351	19.87	4,467	22.36	5,026
	300	11 7/8"	290	11 3/8"	310	12 1/4"	39.02	8,772		18.01	4,049	24.01	5,398	27.01	6,073
	350	13 6/8"	340	13 3/8"	360	14 1/4"	45.75	10,284		21.11	4,747	28.15	6,329	30.40	6,834
	400	15 3/4"	390	15 3/8"	410	16 1/8"	52.47	11,797		24.22	5,445	30.40	6,834	30.40	6,834
	450	17 3/4"	440	17 1/4"	460	18 1/8"	59.20	13,309		27.32	6,143	30.40	6,834	30.40	6,834
	500	19 5/8"	490	19 1/4"	510	20 1/8"	65.93	14,822		30.40	6,834	30.40	6,834	30.40	6,834
	550	21 5/8"	540	21 1/4"	560	22"	72.66	16,334		30.40	6,834	30.40	6,834	30.40	6,834
	600	23 5/8"	590	23 1/4"	610	24"	79.38	17,846		30.40	6,834	30.40	6,834	30.40	6,834

PARTIAL THREAD WITHDRAWAL (2)

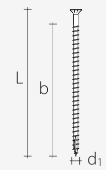
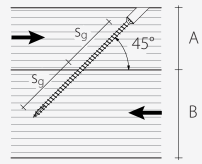
GEOMETRY





d1	L		b		A_{MIN}		CHARACTERISTIC VALUES WOOD $R_{ax.k}$		CHARACTERISTIC VALUES STEEL $R_{tens.k}$	DESIGN VALUES (FACTORED RESISTANCE) $R_{ax.d}$ Load Case 1		$R_{ax.d}$ Load Case 2&3		$R_{ax.d}$ Load Case 4&5	
[mm]	[mm]	[inch]	[mm]	[inch]	[mm]	[inch]	[kN]	[lbf]	[kN]	[kN]	[lbf]	[kN]	[lbf]	[kN]	[lbf]
9 11/32" [inch]	160	6 1/4"	65	2 1/2"	85	6 3/4"	7.16	1,609	25.40 5,710 [lbf]	3.30	742	4.40	990	4.95	1,114
	200	7 7/8"	85	3 3/8"	105	8 1/4"	9.36	2,104		4.32	971	5.76	1,295	6.48	1,456
	240	9 1/2"	105	4 1/8"	125	9 7/8"	11.56	2,599		5.33	1,199	7.11	1,599	8.00	1,799
	280	11"	125	4 7/8"	145	11 3/8"	13.76	3,094		6.35	1,428	8.47	1,904	9.53	2,142
	320	12 5/8"	145	5 3/4"	165	13"	15.96	3,589		7.37	1,656	9.82	2,208	11.05	2,484
	360	14 1/4"	165	6 1/2"	125	14 1/2"	18.16	4,084		8.38	1,885	11.18	2,513	12.58	2,827
	400	15 3/4"	185	7 1/4"	205	16 1/8"	20.37	4,578		9.40	2,113	12.53	2,818	14.10	3,170
	450	17 3/4"	210	8 1/4"	230	18 1/8"	23.12	5,197		10.67	2,399	14.23	3,198	16.00	3,598
	500	19 5/8"	235	9 1/4"	255	20 1/8"	25.87	5,816		11.94	2,684	15.92	3,579	17.91	4,026
11 7/16" [inch]	100	4"	35	1 3/8"	55	4 3/8"	4.71	1,059	38.00 8,543 [lbf]	2.17	489	2.90	651	3.26	733
	150	6"	60	2 3/8"	80	6 1/4"	8.07	1,815		3.73	838	4.97	1,117	5.59	1,256
	200	7 7/8"	85	3 3/8"	105	8 1/4"	11.44	2,571		5.28	1,187	7.04	1,582	7.92	1,780
	250	9 7/8"	110	4 3/8"	130	10 1/4"	14.80	3,327		6.83	1,536	9.11	2,048	10.25	2,304
	300	11 7/8"	135	5 3/8"	155	12 1/4"	18.16	4,084		8.38	1,885	11.18	2,513	12.58	2,827
	350	13 6/8"	160	6 1/4"	180	14 1/4"	21.53	4,840		9.94	2,234	13.25	2,978	14.90	3,351
	400	15 3/4"	185	7 1/4"	205	16 1/8"	24.89	5,596		11.49	2,583	15.32	3,444	17.23	3,874
	450	17 3/4"	210	8 1/4"	230	18 1/8"	28.26	6,352		13.04	2,932	17.39	3,909	19.56	4,398
	500	19 5/8"	235	9 1/4"	255	20 1/8"	31.62	7,108		14.59	3,281	19.46	4,374	21.89	4,921
	550	21 5/8"	260	10 1/4"	280	22"	34.98	7,865		16.15	3,630	21.53	4,840	24.22	5,445
	600	23 5/8"	285	11 1/4"	305	24"	38.35	8,621		17.70	3,979	23.60	5,305	26.55	5,968

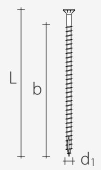
STATIC VALUES: SLIDING (3)

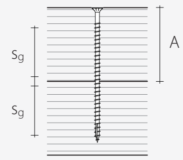
GEOMETRY			WOOD - WOOD													
																
									CHARACTERISTIC VALUES		DESIGN VALUES (FACTORED RESISTANCE)					
d_1	L		s_g		A_{MIN}		B_{MIN}		$R_{V,k}$		$R_{V,d}$ Load Case 1		$R_{V,d}$ Load Case 2&3		$R_{V,d}$ Load Case 4&5	
[mm]	[mm]	*[inch]*	[mm]	*[inch]*	[mm]	*[inch]*	[mm]	*[inch]*	[kN]	*[lbf]*	[kN]	*[lbf]*	[kN]	*[lbf]*	[kN]	*[lbf]*
9 *11/32″ [inch]*	**160**	*6 1/4″*	65	*2 1/2″*	60	*2 3/8″*	75	*3″*	4.60	*1,034*	2.12	*477*	2.83	*636*	3.18	*716*
	200	*7 7/8″*	85	*3 3/8″*	75	*3″*	90	*3 4/8″*	6.02	*1,352*	2.78	*624*	3.70	*832*	4.16	*936*
	240	*9 1/2″*	105	*4 1/8″*	90	*3 4/8″*	105	*4 1/8″*	7.43	*1,670*	3.43	*771*	4.57	*1,028*	5.14	*1,156*
	280	*11″*	125	*4 7/8″*	105	*4 1/8″*	120	*4 3/4″*	8.85	*1,989*	4.08	*918*	5.44	*1,224*	6.12	*1,377*
	320	*12 5/8″*	145	*5 3/4″*	120	*4 1/2″*	135	*5 3/8″*	10.26	*2,307*	4.74	*1,065*	6.31	*1,420*	7.10	*1,597*
	360	*14 1/4″*	165	*6 1/2″*	135	*5 1/8″*	145	*5 3/4″*	11.68	*2,625*	5.39	*1,212*	7.19	*1,615*	8.08	*1,817*
	400	*15 3/4″*	185	*7 1/4″*	145	*5 3/4″*	160	*6 1/4″*	13.09	*2,943*	6.04	*1,358*	8.06	*1,811*	9.06	*2,038*
	450	*17 3/4″*	210	*8 1/4″*	165	*6 1/2″*	180	*7 1/8″*	14.86	*3,341*	6.86	*1,542*	9.15	*2,056*	10.29	*2,313*
	500	*19 5/8″*	235	*9 1/4″*	180	*7 1/8″*	195	*7 5/8″*	16.63	*3,739*	7.68	*1,726*	10.23	*2,301*	11.51	*2,588*
11 *7/16″ [inch]*	**100**	*4″*	35	*1 3/8″*	40	*1 5/8″*	55	*2 1/8″*	3.03	*681*	1.40	*314*	1.86	*419*	2.10	*471*
	150	*6″*	60	*2 3/8″*	60	*2 3/8″*	75	*3″*	5.19	*1,167*	2.40	*538*	3.19	*718*	3.59	*808*
	200	*7 7/8″*	85	*3 3/8″*	80	*3 1/8″*	90	*3 4/8″*	7.35	*1,653*	3.39	*763*	4.52	*1,017*	5.09	*1,144*
	250	*9 7/8″*	110	*4 3/8″*	95	*3 3/4″*	110	*4 3/8″*	9.51	*2,139*	4.39	*987*	5.85	*1,316*	6.59	*1,481*
	300	*11 7/8″*	135	*5 3/8″*	115	*4 1/2″*	125	*4 7/8″*	11.68	*2,625*	5.39	*1,212*	7.19	*1,615*	8.08	*1,817*
	350	*13 6/8″*	160	*6 1/4″*	130	*5 1/8″*	145	*5 3/4″*	13.84	*3,111*	6.39	*1,436*	8.52	*1,915*	9.58	*2,154*
	400	*15 3/4″*	185	*7 1/4″*	150	*6″*	160	*6 1/4″*	16.00	*3,597*	7.39	*1,660*	9.85	*2,214*	11.08	*2,490*
	450	*17 3/4″*	210	*8 1/4″*	165	*6 1/2″*	180	*7 1/8″*	18.16	*4,083*	8.38	*1,885*	11.18	*2,513*	12.57	*2,827*
	500	*19 5/8″*	235	*9 1/4″*	185	*7 1/4″*	195	*7 5/8″*	20.33	*4,569*	9.38	*2,109*	12.51	*2,812*	14.07	*3,163*
	550	*21 5/8″*	260	*10 1/4″*	200	*7 7/8″*	215	*8 1/2″*	22.49	*5,056*	10.38	*2,333*	13.84	*3,111*	15.57	*3,500*
	600	*23 5/8″*	285	*11 1/4″*	220	*8 5/8″*	230	*9″*	24.65	*5,542*	11.38	*2,558*	15.17	*3,410*	17.07	*3,837*

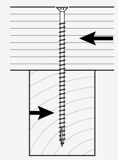
SLIDING STEEL-WOOD: see VGU connectors: pag. 58

STATIC VALUES: SHEAR WOOD-WOOD

GEOMETRY							WOOD - WOOD							
							CHARACTERISTIC VALUES		DESIGN VALUES (FACTORED RESISTANCE)					
d_1	L		s_g		A_{MIN}		$R_{V,k}$		$R_{V,d}$ Load Case 1		$R_{V,d}$ Load Case 2&3		$R_{V,d}$ Load Case 4&5	
[mm]	[mm]	[inch]	[mm]	[inch]	[mm]	[inch]	[kN]	[lbf]	[kN]	[lbf]	[kN]	[lbf]	[kN]	[lbf]
	160	6 1/4″	65	2 1/2″	80	3 1/8″	4.98	1,119	2.30	517	3.06	689	3.45	775
9	200	7 7/8″	85	3 3/8″	100	4″	5.53	1,243	2.55	574	3.40	765	3.83	861
	240	9 1/2″	105	4 1/8″	120	4 3/4″	6.08	1,367	2.81	631	3.74	841	4.21	946
11/32″	280	11″	125	4 7/8″	140	5 1/2″	6.38	1,434	2.94	662	3.93	883	4.42	993
[inch]	320	12 5/8″	145	5 3/4″	160	6 1/4″	6.38	1,434	2.94	662	3.93	883	4.42	993
	360	14 1/4″	165	6 1/2″	180	7 1/8″	6.38	1,434	2.94	662	3.93	883	4.42	993
	400	15 3/4″	185	7 1/4″	200	7 7/8″	6.38	1,434	2.94	662	3.93	883	4.42	993
	450	17 3/4″	210	8 1/4″	225	8 7/8″	6.38	1,434	2.94	662	3.93	883	4.42	993
	500	19 5/8″	235	9 1/4″	250	9 7/8″	6.38	1,434	2.94	662	3.93	883	4.42	993
	100	4″	35	1 3/8″	50	2″	4.11	925	1.90	427	2.53	569	2.85	640
	150	6″	60	2 3/8″	75	3″	6.19	1,392	2.86	643	3.81	857	4.29	964
	200	7 7/8″	85	3 3/8″	100	4″	7.30	1,642	3.37	758	4.49	1,010	5.06	1,136
	250	9 7/8″	110	4 3/8″	125	4 7/8″	8.14	1,831	3.76	845	5.01	1,127	5.64	1,267
11	300	11 7/8″	135	5 3/8″	150	6″	8.89	1,997	4.10	922	5.47	1,229	6.15	1,383
7/16″	350	13 6/8″	160	6 1/4″	175	6 7/8″	8.89	1,997	4.10	922	5.47	1,229	6.15	1,383
[inch]	400	15 3/4″	185	7 1/4″	200	7 7/8″	8.89	1,997	4.10	922	5.47	1,229	6.15	1,383
	450	17 3/4″	210	8 1/4″	225	8 7/8″	8.89	1,997	4.10	922	5.47	1,229	6.15	1,383
	500	19 5/8″	235	9 1/4″	250	9 7/8″	8.89	1,997	4.10	922	5.47	1,229	6.15	1,383
	550	21 5/8″	260	10 1/4″	275	10 5/8″	8.89	1,997	4.10	922	5.47	1,229	6.15	1,383
	600	23 5/8″	285	11 1/4″	300	11 7/8″	8.89	1,997	4.10	922	5.47	1,229	6.15	1,383







CROSSED CONNECTORS: The shear connection of the main/secondary beam with crossed VGS connectors is shown on pag. 43.

GENERAL PRINCIPLES

- Characteristic values comply with the EN 1995:2008 standard in accordance with ETA-11/0030.
- According to EN 1995:2008 for shear characteristic values the contribution from the rope effect ($F_{ax,Rk}$ / 4) is considered. This is resulting in higher shear resistances compared to shear resistances calculated in accordance with CSA O86-14.
- Design values for wood-side are obtained from the following characteristic values:

$$R_d = R_k \cdot DMF$$

DMF: design modification factor based on k_{mod} as per Table 8 and for γ_M as per Table 9 (γ_M = 1.3). See pag. 24

Load case	Load Combination		Design Modification Factor DMF
	Principal Load	Companion Load	
1	1.4D	-	**0.46**
2	(1.25D or 0.9D) + 1.5L	1.0S or 0.4W	**0.62** (1)
3	(1.25D or 0.9D) + 1.5S	1.0L or 0.4W	**0.62**
4	(1.25D or 0.9D) + 1.4W	0.5L or 0.5S	**0.69**
5	1.0D + 1.0E	0.5L or 0.25S	**0.69**

(1) *If Live Load L is associated with long term loads such as storage, equipment areas etc., use 0,54*

- For the mechanical resistance values and the geometry of the screws, reference was made to ETA-11/0030.
- In the calculations, the density of the wood elements was considered equal to ρ_k = 370 kg/m^3 (S-P-F sawn lumber). For wood densities conversion (mean oven-dry relative density to 5th-percentile density 12% MC wt & vol) see pag. 23. Characteristic resistances can also be considered as valid for higher densities, for the purposes of safety.
- Sizing and verification of the wooden elements and steel plates must be done separately.
- The shear characteristic resistances are calculated for screws inserted without pre-bored holes. In the case of screws inserted with pre-bored holes, greater resistance values can be obtained.
- The wood-wood extraction, shear and sliding values were calculated considering the centre of gravity of the connector placed in correspondence with the shear plane.
- The characteristic resistances were calculated using solid wood or glulam. In the case of joints with CLT elements, the resistance values may be different and should be calculated on the basis of the characteristics of the panel and the connection configuration.

NOTES

(1) The tensile design strength of the connector is the lower between the wood-side design strength ($R_{ax,d}$) and the steel-side design strength ($R_{tens,d}$).

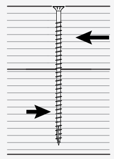
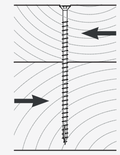
$$R_{ax,d} = \min \begin{cases} R_{ax,k} \cdot DMF \\ R_{tens,k} / \gamma_{M2} \end{cases}$$

γ_{M2}: partial factor for resistance of cross-sections in tension to fracture according to EN 1993-1-1. Please see notes pag. 25.

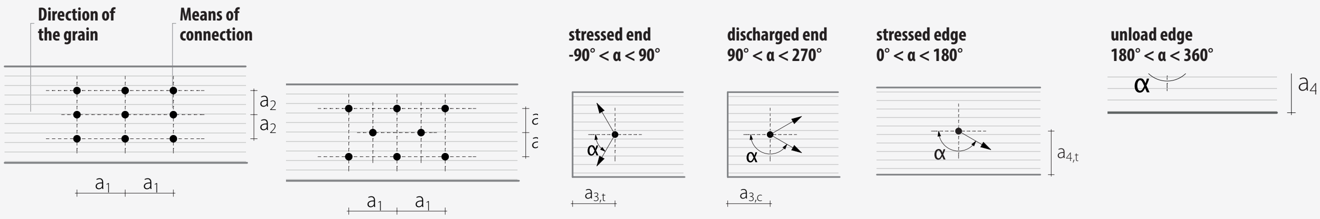
(2) The axial resistance of the thread to extraction was calculated considering a 90° angle between the fibres and the connector and for a effective thread length of b or s_g. For intermediate s_g values it is possible to interpolate linearly.

(3) The axial thread extraction resistance was calculated considering a 45° angle between the fibres and the connector and for an effective thread length of s_g.

MINIMUM DISTANCES FOR SHEAR LOADS - WOOD ELEMENTS

		ANGLE BETWEEN STRENGHT AND GRAIN α = 0°						ANGLE BETWEEN STRENGHT AND GRAIN α = 90°				
												
		SCREWS INSERTED WITH PRE-BORED HOLES										
		α = 0°						α = 90°				
			5.3	**5.6**	**7**	**9**	**11**		**5.3**	**5.6**	**7**	**9**	**11**
a_1	[mm]	**5 d (4)**	27	28	35	45	55	**4 d (4)**	21	22	28	36	44
a_2	[mm]	**3 d**	16	17	21	27	33	**4 d**	21	22	28	36	44
$a_{3,t}$	[mm]	**12 d (4)**	64	67	84	108	132	**7 d (4)**	37	39	49	63	77
$a_{3,c}$	[mm]	**7 d (4)**	37	39	49	63	77	**7 d (4)**	37	39	49	63	77
$a_{4,t}$	[mm]	**3 d**	16	17	21	27	33	**7 d**	37	39	49	63	77
$a_{4,c}$	[mm]	**3 d**	16	17	21	27	33	**3 d**	16	17	21	27	33

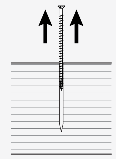
		SCREWS INSERTED WITHOUT PRE-BORED HOLES										
		α = 0°						α = 90°				
			5.3	**5.6**	**7**	**9**	**11**		**5.3**	**5.6**	**7**	**9**	**11**
a_1	[mm]	**12 d (4)**	64	67	84	108	132	**5 d (4)**	27	28	35	45	55
a_2	[mm]	**50 d**	27	28	35	45	55	**5 d**	27	28	35	45	55
$a_{3,t}$	[mm]	**15 d (4)**	80	84	105	135	165	**10 d (4)**	53	56	70	90	110
$a_{3,c}$	[mm]	**10 d (4)**	53	56	70	90	110	**10 d (4)**	53	56	70	90	110
$a_{4,t}$	[mm]	**5 d**	27	28	35	45	55	**10 d**	53	56	70	90	110
$a_{4,c}$	[mm]	**5 d**	27	28	35	45	55	**5 d**	27	28	35	45	55



NOTES

- The minimum distances are in accordance with the EN 1995:2008 standard, according to ETA-11/0030, considering a mass density of the wood elements equal to $\rho_k \leq 420$ kg/m^3.
- For wood densities conversion (mean oven-dry relative density to 5th-percentile density 12% MC wt & vol) see pag. 23.
- (5) For Douglas fir members minimum spacing and distances parallel to the grain shall be increased by 50%.
- d = outer thread diameter
- In the case of OSB-wood joints, the minimum spacings (a_1, a_2) can be multiplied by a coefficient of 0.85.
- In the case of steel-wood joints, the minimum spacings (a_1, a_2) can be multiplied by a coefficient of 0.7.

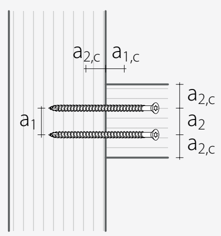
MINIMUM DISTANCES FOR AXIAL LOADS - WOOD ELEMENTS



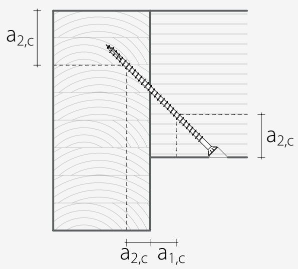
			SCREWS INSERTED WITHOUT PRE-BORED HOLES						SCREWS INSERTED WITH PRE-BORED HOLES				
			5.3	5.6	7	9	11		5.3	5.6	7	9	11
a_1	[mm]	5 d	27	28	35	45	55	5 d	27	28	35	45	55
a_2	[mm]	5 d	27	28	35	45	55	5 d	27	28	35	45	55
$a_{2,LIM}$ (6)	[mm]	2.5 d	13	14	18	23	28	2.5 d	13	14	18	23	28
$a_{1,C}$	[mm]	10 d	53	56	70	90	110	10 d	53	56	70	90	110
$a_{2,C}$	[mm]	4 d	21	22	28	36	44	3 d	16	17	21	27	33
a_{CROSS}	[mm]	1.5 d	8	8	11	14	17	1.5 d	8	8	11	14	17

SCREWS UNDER TRACTION INSERTED WITH AN ANGLE α WITH RESPECT TO THE GRAIN

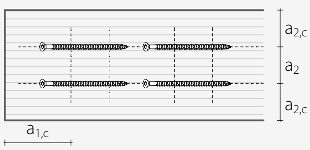
Plan



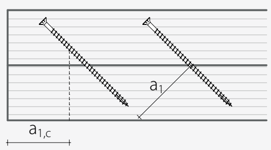
Front



Plan

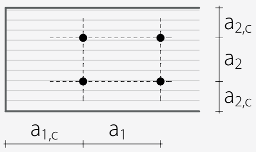


Front

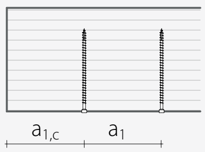


SCREWS INSERTED WITH A 90° ANGLE WITH RESPECT TO THE GRAIN

Plan

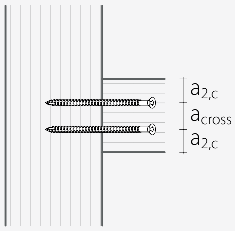


Front

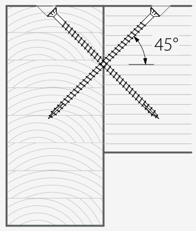


CROSS SCREWS INSERTED WITH AN ANGLE α WITH RESPECT TO THE GRAIN

Plan



Front



NOTES

- The minimum distances for connectors stressed axially are independent of the insertion angle of the connector and the angle of the force with respect to the grain, in accordance with ETA-11/0030.

(6) The axial distance a_2 can be reduced down to $2.5 \cdot d_1$ if for each connector a "joint surface" $a_1 \cdot a_2 = 25 \cdot d_1^2$ is maintained.

VGU

45° washer for VGS

Bright zinc plated carbon steel

RESISTANCE

Use of 45° inclined VGS screws, in combination with steel plates, guarantees very high sliding-resistance values

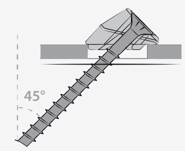
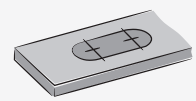
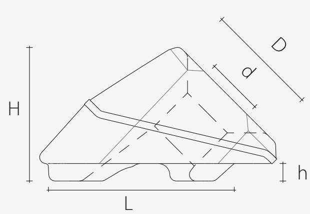


PLATE ADAPTER

The VGU washer allows to insert VGS screws at a 45° angleon plates without countersunk holes

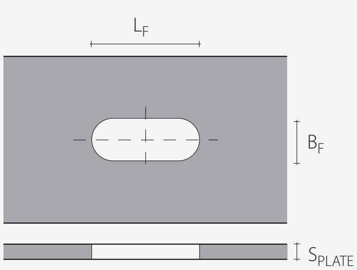


GEOMETRY AND MECHANICAL CHARACTERISTICS



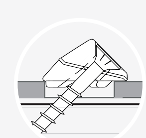
VGU WASHER			VGU945	VGU1145
VGS screw diameter	**d1**	[mm]	**9**	**11**
		[inch]	*11/32 ″*	*7/16 ″*
Hinternal diameter	**d**	[mm]	9.7	11.8
		[inch]	*3/8 ″*	*15/32 ''*
External diameter	**D**	[mm]	19.0	23.0
		[inch]	*3/4 ''*	*29/32 ''*
Base lenght	**L**	[mm]	31.8	38.8
		[inch]	*1 1/4 ''*	*1 17/32 ''*
Base hieght	**h**	[mm]	3.0	3.6
		[inch]	*1/8 ''*	*9/64 ''*
Global height	**H**	[mm]	23.0	28.0
		[inch]	*29/32 ''*	*1 1/8 ''*

INSTALLATION



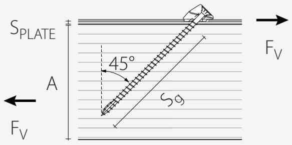
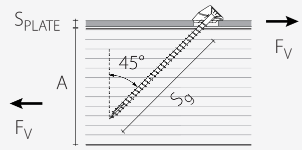
WASHER			VGU945	VGU1145
Slotted-hole length	**L_F**	[mm]	min 35.0	min 43.0
		[inch]	*min 1 3/8 ''*	*min 1 11/16 ''*
		[mm]	max 36.0	max 44.0
		[inch]	*max 1 27/64 ''*	*max 1 47/64 ''*
Slotted-hole width	**B_F**	[mm]	min 14.0	min 17.0
		[inch]	*min 35/64 ''*	*min 43/64 ''*
		[mm]	max 15.0	max 18.0
		[inch]	*max 19/32 ''*	*max 45/64 ''*
Steel plate thickness	**S_{PLATE}**	[mm]	min 3.0	min 4.0
		[inch]	*min 1/8 ''*	*min 5/32 ''*
		[mm]	max 12.0 *	max 15.0 *
		[inch]	*max 15/32 '' **	*max 19/32 '' **

* For thicker plates it is necessary to realize a countersink in the lower part of the steel plate.



For VGS screw-lengths > 300 mm a Ø5 predrill is recommended.
The assembly must be performed so as to guarantee that the stress is evenly distributed among all the installed VGU washers.

STATIC VALUES: STEEL-TO-TIMBER JOINT

GEOMETRY	STEEL - WOOD	
		

d_1 [mm]	L [mm]	L [inch]	S_g [mm]	S_g [inch]	A_{MIN} [mm]	A_{MIN} [inch]	WOOD $R_{V,k}$ [kN]	WOOD $R_{V,k}$ [lbf]	STEEL $R_{tens,k}$ 45° [kN]	$R_{V,d}$ Load Case 1 [kN]	$R_{V,d}$ Load Case 1 [lbf]	$R_{V,d}$ Load Case 2&3 [kN]	$R_{V,d}$ Load Case 2&3 [lbf]	$R_{V,d}$ Load Case 4&5 [kN]	$R_{V,d}$ Load Case 4&5 [lbf]
							S_{PLATE} = 3 mm								
9 11/32" [inch]	160	6 1/4"	140		120		10.1	2,275	17.96 4.038 [lbf]	4.67	1,050	6.23	1,400	7.01	1,575
	200	7 7/8"	180		145		13.0	2,925		6.01	1,350	8.01	1,800	9.01	2,025
	240	9 1/2"	220		175		15.9	3,575		7.34	1,650	9.79	2,200	11.01	2,475
	280	11"	260		205		18.8	4,226		8.68	1,950	11.57	2,600	13.01	2,925
	320	12 5/8"	300		230		21.7	4,876		10.01	2,250	13.35	3,000	14.37	3,230
	360	14 1/4"	340		260		24.6	5,526		11.34	2,550	14.37	3,230	14.37	3,230
	400	15 3/4"	380		290		27.5	6,176		12.68	2,850	14.37	3,230	14.37	3,230
	450	17 3/4"	430		325		31.1	6,988		14.35	3,225	14.37	3,230	14.37	3,230
	500	19 5/8"	480		360		34.7	7,801		14.37	3,230	14.37	3,230	14.37	3,230
							S_{PLATE} = 12 mm								
9 11/32" [inch]	160	6 1/4"	125		110		9.0	2,031	17.96 4.038 [lbf]	4.17	938	5.56	1,250	6.26	1,406
	200	7 7/8"	165		135		11.9	2,682		5.51	1,238	7.34	1,650	8.26	1,856
	240	9 1/2"	205		165		14.8	3,332		6.84	1,538	9.12	2,050	10.26	2,307
	280	11"	245		195		17.7	3,982		8.17	1,838	10.90	2,450	12.26	2,757
	320	12 5/8"	285		220		20.6	4,632		9.51	2,138	12.68	2,850	14.26	3,207
	360	14 1/4"	325		250		23.5	5,282		10.84	2,438	14.37	3,230	14.37	3,230
	400	15 3/4"	365		280		26.4	5,932		12.18	2,738	14.37	3,230	14.37	3,230
	450	17 3/4"	415		315		30.0	6,745		13.85	3,113	14.37	3,230	14.37	3,230
	500	19 5/8"	465		350		33.6	7,557		14.37	3,230	14.37	3,230	14.37	3,230
							S_{PLATE} = 4 mm								
11 7/16" [inch]	100	4"	80		75		7.1	1,589	26.87 6.041 [lbf]	3.26	733	4.35	978	4.89	1,100
	150	6"	130		110		11.5	2,582		5.30	1,192	7.07	1,589	7.95	1,788
	200	7 7/8"	180		145		15.9	3,575		7.34	1,650	9.79	2,200	11.01	2,475
	250	9 7/8"	230		185		20.3	4,569		9.38	2,109	12.51	2,811	14.07	3,163
	300	11 7/8"	280		220		24.7	5,562		11.42	2,567	15.22	3,423	17.13	3,850
	350	13 6/8"	330		255		29.2	6,555		13.46	3,025	17.94	4,034	20.19	4,538
	400	15 3/4"	380		290		33.6	7,548		15.50	3,484	20.66	4,645	21.50	4,832
	450	17 3/4"	430		325		38.0	8,541		17.54	3,942	21.50	4,832	21.50	4,832
	500	19 5/8"	480		360		42.4	9,535		19.57	4,401	21.50	4,832	21.50	4,832
	550	21 5/8"	530		395		46.8	10,528		21.50	4,832	21.50	4,832	21.50	4,832
	600	23 5/8"	580		430		51.2	11,521		21.50	4,832	21.50	4,832	21.50	4,832
							S_{PLATE} = 15 mm								
11 7/16" [inch]	100	4"	65		60		5.7	1,291	26.87 6.041 [lbf]	2.65	596	3.53	795	3.98	894
	150	6"	115		95		10.2	2,284		4.69	1,054	6.25	1,406	7.03	1,581
	200	7 7/8"	165		130		14.6	3,277		6.73	1,513	8.97	2,017	10.09	2,269
	250	9 7/8"	215		170		19.0	4,271		8.77	1,971	11.69	2,628	13.15	2,957
	300	11 7/8"	265		205		23.4	5,264		10.81	2,429	14.41	3,239	16.21	3,644
	350	13 6/8"	315		240		27.8	6,257		12.85	2,888	17.13	3,850	19.27	4,332
	400	15 3/4"	365		275		32.3	7,250		14.88	3,346	19.85	4,462	21.50	4,832
	450	17 3/4"	415		310		36.7	8,243		16.92	3,805	21.50	4,832	21.50	4,832
	500	19 5/8"	465		345		41.1	9,237		18.96	4,263	21.50	4,832	21.50	4,832
	550	21 5/8"	515		380		45.5	10,230		21.00	4,721	21.50	4,832	21.50	4,832
	600	23 5/8"	565		415		49.9	11,223		21.50	4,832	21.50	4,832	21.50	4,832

GENERAL PRINCIPLES

- Characteristic values comply with the EN 1995:2008 standard in accordance with ETA-11/0030.
- According to EN 1995:2008 for shear characteristic values the contribution from the rope effect ($F_{ax,Rk}$ / 4) is considered. This is resulting in higher shear resistances compared to shear resistances calculated in accordance with CSA O86-14.
- Design values for wood-side are obtained from the following characteristic values:

$$R_d = R_k \cdot DMF$$

DMF: design modification factor based on k_{mod} as per Table 8 and for γ_M as per Table 9 (γ_M = 1.3). See pag. 24.

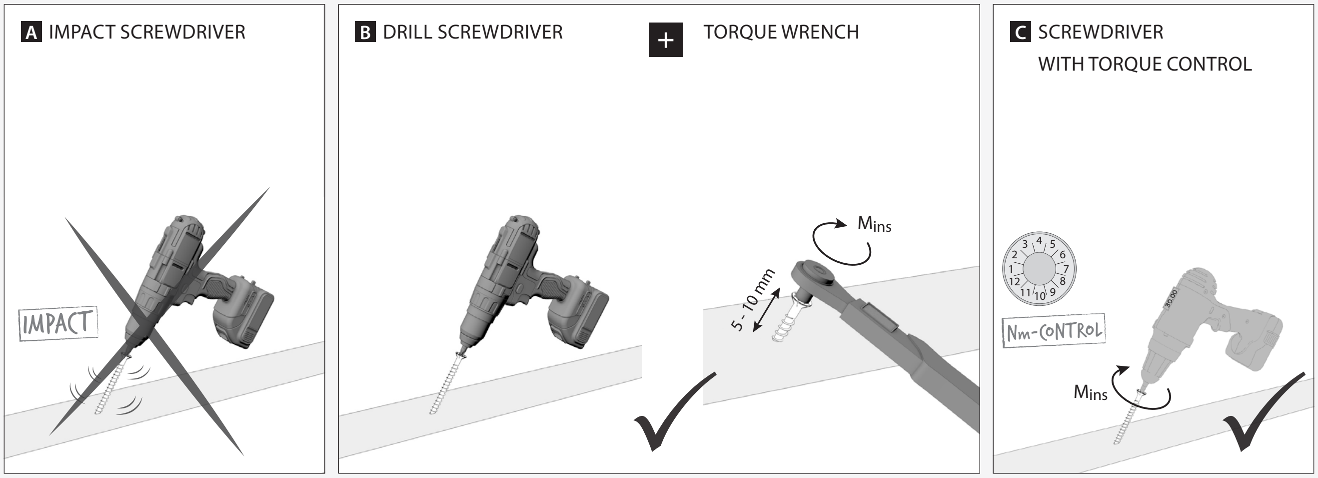
Load case	Load Combination: Principal Load	Load Combination: Companion Load	Design Modification Factor DMF
1	1.4D	-	**0.46**
2	(1.25D or 0.9D) + 1.5L	1.0S or 0.4W	**0.62** (1)
3	(1.25D or 0.9D) + 1.5S	1.0L or 0.4W	**0.62**
4	(1.25D or 0.9D) + 1.4W	0.5L or 0.5S	**0.69**
5	1.0D + 1.0E	0.5L or 0.25S	**0.69**

(1) *If Live Load L is associated with long term loads such as storage, equipment areas etc., use 0,54*

- For the mechanical resistance values and the geometry of the screws, reference was made to ETA-11/0030.
- In the calculations, the density of the wood elements was considered equal to ρ_k = 370 kg/m^3 (S-P-F sawn lumber). For wood densities conversion (mean oven-dry relative density to 5th-percentile density 12% MC wt & vol) see pag. 23 Characteristic resistances can also be considered as valid for higher densities, for the purposes of safety.
- Values were calculated considering the threaded part as being completely inserted into the wood.
- Sizing and verification of the wooden elements and steel plates must be done separately.
- The shear characteristic resistances are calculated for screws inserted without pre-bored holes. In the case of screws inserted with pre-bored holes, greater resistance values can be obtained.
- For different calculation methods, the myProject software is available free of charge (www.rothoblaas.com).
- The characteristic resistances were calculated using solid wood or glulam. In the case of joints with CLT elements, the resistance values may be different and should be calculated on the basis of the characteristics of the panel and the connection configuration.

INSTALLATION GUIDE

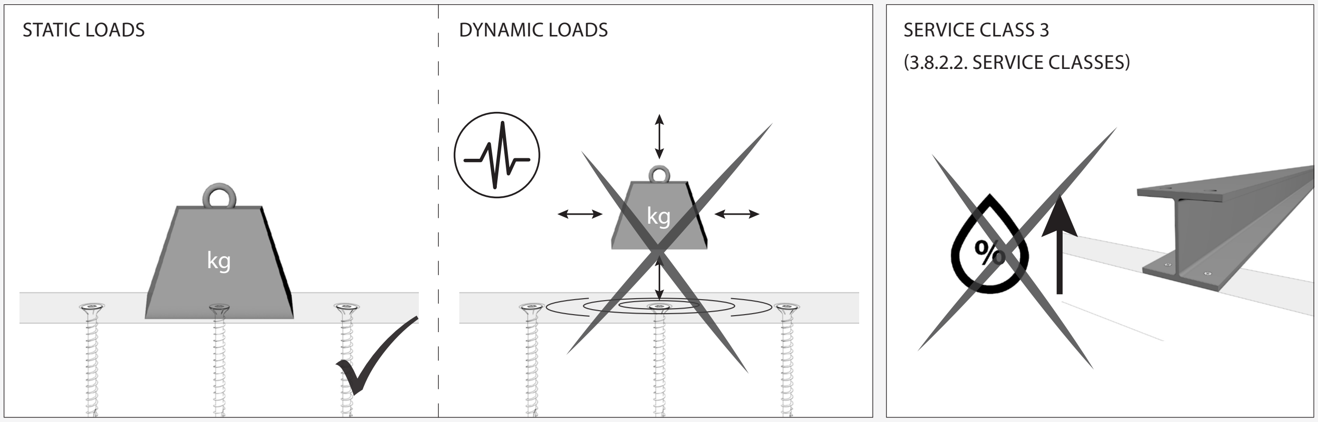
1. INSTALLATION EQUIPMENT



M_{ins} Recommended insertion moment

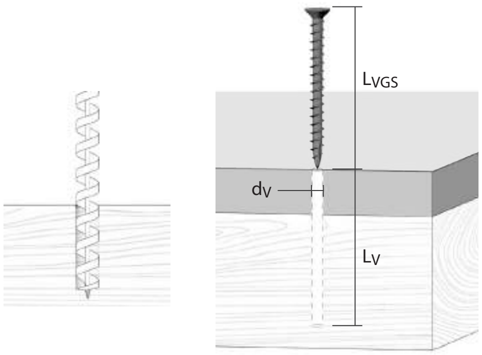
VGS Ø11 L < 400 mm	M_{ins} = 30 Nm
VGS Ø11 L ≥ 400 mm	M_{ins} = 40 Nm
VGS Ø9	M_{ins} = 20 Nm

2. AREAS OF APPLICATION



Pre-drilling required

- Woods with high density: $\rho_k \geq 420$ kg/m^3
- VGS Ø11 L ≥ 400 mm
- Very precise angle of insertion

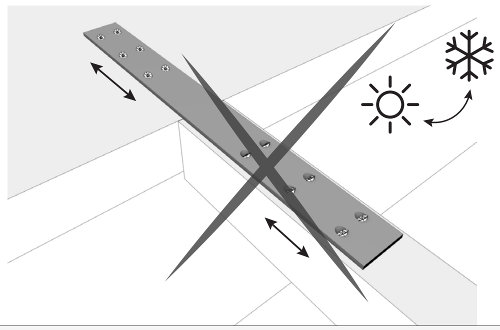


- VGS Ø11: d_V = 6 mm
- VGS Ø9: d_V = 5 mm

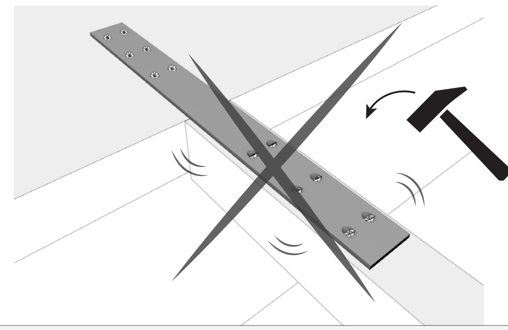
$L_V = L_{VGS}$

3. STEEL TO TIMBER CONNECTIONS

PREVENT STEEL DIMENSIONAL ALTERATIONS

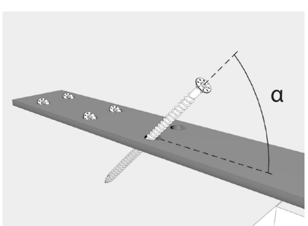


AVOID APPLYING ACCIDENTAL STRESS DURING ASSEMBLY

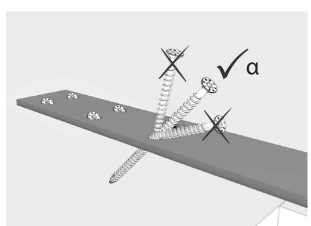


A SHAPED STEEL PLATE WITH COUNTERSUNK HOLES

ENSURE THE ANGLE OF INSERTION

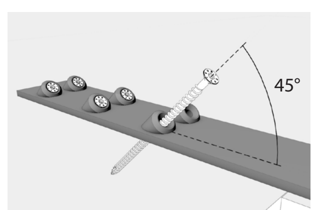


PREVENT BENDING OF SCREW

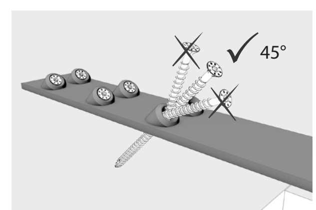


B VGU WASHER

ENSURE THE ANGLE OF INSERTION 45°

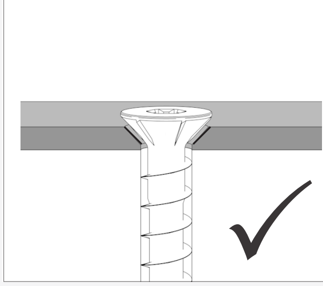


PREVENT BENDING OF SCREW

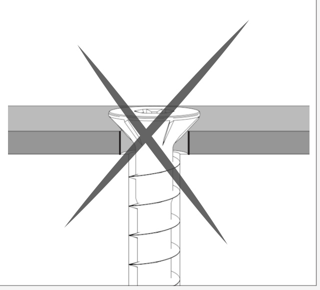


A SHAPED STEEL PLATE

COUNTERSUNK HOLES

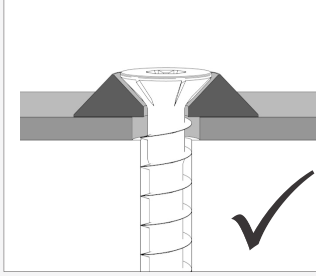


CYLINDRICAL HOLES

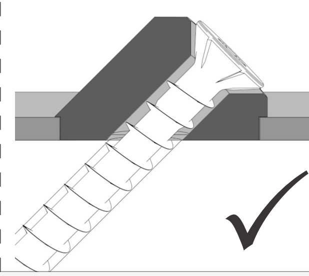


B WASHERS

COUNTERSUNK WASHER



VGU WASHER



APPENDIX A

Building types, design situations, geographical locations and associated typical dead (D), live (L) snow (S),wind (W) and seismic (E) loads.

1. FLOOR LOADS AND LOAD COMBINATIONS

Load combinations			Example Floor ULS Loading (kPa)		
			Office Floor D = 3.6 kPa L = 2.4 kPa	Office Corridor D = 2.6 kPa L = 4.8 kPa	Residential Floor D = 2.5 kPa L = 1.9 kPa
NBCC	ULS =	1.25·D + 1.5·L	8.10	10.45	5.98
EN 1990	E_d =	1.35·D + 1.5·L	8.46	10.71	6.23
		% Difference	4.3%	2.5%	4.1%

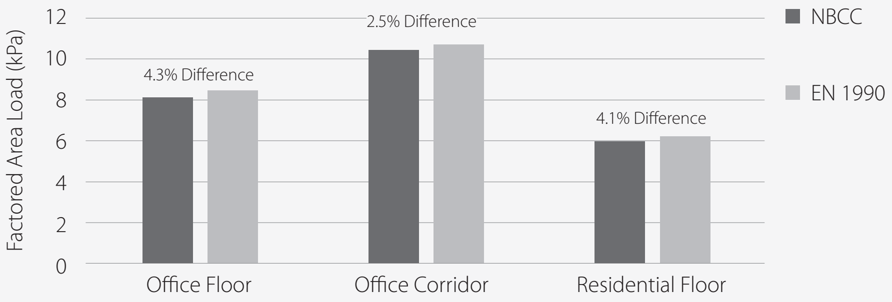


Figure A.1: Comparison of NBCC & EN1990 - Factored Floor Loads

2. ROOF LOADS AND LOAD COMBINATIONS - SLOPED ROOF

Load combinations			Sloped Roof ULS Loading (kPa)						
			Vancouver	Whistler	Kelowna	Calgary	Winnipeg	Toronto	Halifax
			S = 1.29 kPa	S = 6.64 kPa	S = 1.13 kPa	S = 0.76 kPa	S = 1.35 kPa	S = 0.94 kPa	S = 1.75 kPa
NBCC	ULS =	1.25·D + 1.5·S	2.9	11.0	2.7	2.5	3.0	2.5	3.6
EN 1990	E_d =	1.35·D + 1.5·S	3.0	11.0	2.8	2.6	3.1	2.6	3.7
		% Difference	2.7%	0.7%	2.9%	3.1%	2.6%	3.1%	2.2%

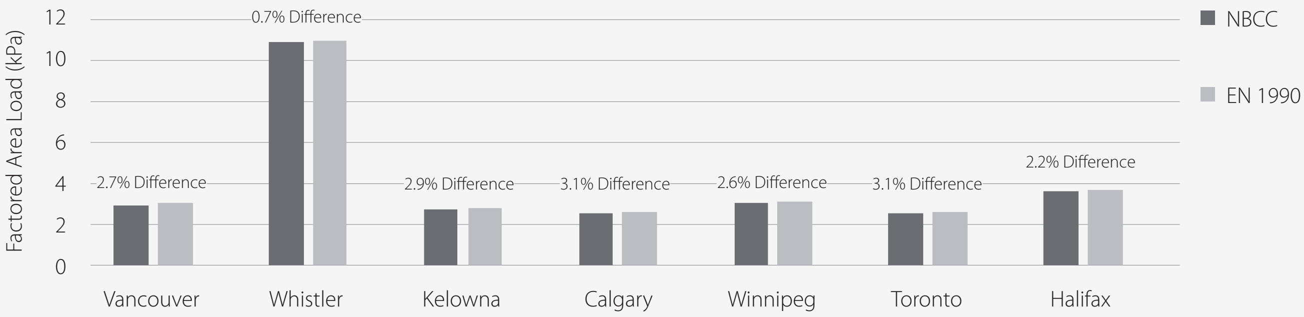


Figure A.2: Comparison of NBCC & EN Factored Loads - Sloped Roof

ASSUMPTIONS

$D_{\text{Sloped roof}}$ = 0.8 kPa - L = 1.0 kPa - Cs α = 0° (NBCC 2015) = 1.0 - Cs α = 40° (NBCC 2015) = 1.0 - $\psi_{0,\text{ Roofs - Category H}}$ (EN 1990) = 0.0

3. ROOF LOADS AND LOAD COMBINATIONS - FLAT ROOF

Load combinations		Flat Roof ULS Loading (kPa)						
		Vancouver	Whistler	Kelowna	Calgary	Winnipeg	Toronto	Halifax
		S = 1.64 kPa	S = 8.50 kPa	S = 1.46 kPa	S = 0.98 kPa	S = 1.72 kPa	S = 1.12 kPa	S = 2.12 kPa
NBCC	ULS = 1.25·D + 1.5·S	3.5	13.8	3.2	2.5	3.6	2.7	4.2
EN 1990	E_d = 1.35·D + 1.5·S	3.5	13.8	3.3	2.6	3.7	2.8	4.3
	% Difference	**2.3%**	**0.6%**	**2.5%**	**3.1%**	**2.2%**	**2.9%**	**1.9%**

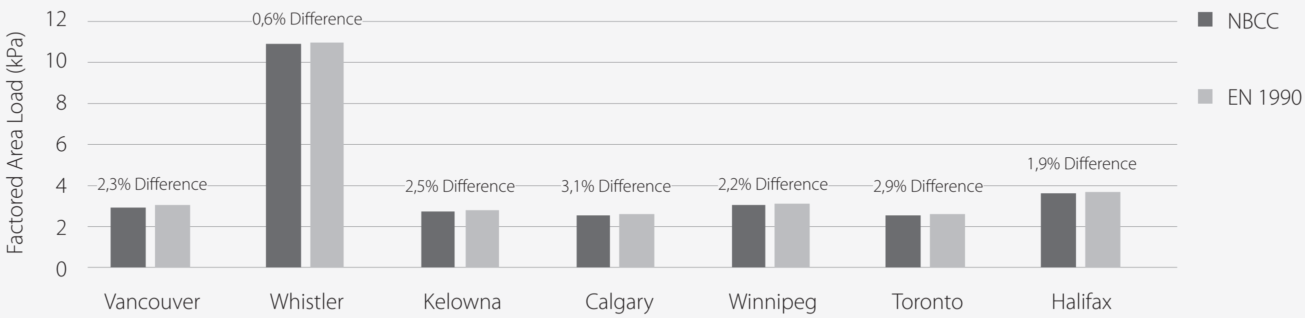


Figure A.3: Comparison of NBCC & EN Factored Loads - Flat Roof

ASSUMPTIONS

$D_{\text{Flat roof}}$ = 0,8 kPa - L = 1,0 kPa - Cs α = 0° (NBCC 2015) = 1,0 - Cs α = 40° (NBCC 2015) = 1,0 - $\psi_{0,\text{ Roofs - Category H}}$ (EN 1990) = 0,0

4. LATERAL LOADS COMBINATION

4.1 WIND

Location	D	W	NBCC Loadcase 4	EN Load combination 1	Difference
	[kPa]	[kPa]	[kPa]	[kPa]	
Vancouver	0.8	0.45	1.63	1.76	**-7.7%**
Whistler	0.8	0.32	1.45	1.56	**-7.7%**
Kelowna	0.8	0.4	1.56	1.68	**-7.7%**
Calgary	0.8	0.48	1.67	1.80	**-7.7%**
Edmonton	0.8	0.45	1.63	1.76	**-7.7%**
Winnipeg	0.8	0.45	1.63	1.76	**-7.7%**
Ottawa	0.8	0.41	1.57	1.70	**-7.7%**
Toronto	0.8	0.44	1.62	1.74	**-7.7%**
Quebec City	0.8	0.41	1.57	1.70	**-7.7%**
Montreal	0.8	0.42	1.59	1.71	**-7.7%**
Halifax	0.8	0.58	1.81	1.95	**-7.6%**
St. Johns	0.8	0.78	2.09	2.25	**-7.6%**

4.1 SEISMIC

Location	D_{ROOF}	D_{FLOOR}	L_{ROOF}	L_{FLOOR}	S_{FLAT}	$\psi_{2,\ FLOOR}$	$\psi_{2,\ SNOW}$	NBCC Loadcase 5	EN Load combination 1	Difference
	[kPa]	[kPa]	[kPa]	[kPa]	[kPa]			[kPa]	[kPa]	
Vancouver	0.80	2.60	1.00	2.40	1.64	0.30	0.00	8.8	7.4	**16%**
Whistler	0.80	2.60	1.00	2.40	8.50	0.30	0.00	10.5	7.4	**29%**
Kelowna	0.80	2.60	1.00	2.40	1.46	0.30	0.00	8.8	7.4	**15%**
Calgary	0.80	2.60	1.00	2.40	0.98	0.30	0.00	8.6	7.4	**14%**
Edmonton	0.80	2.60	1.00	2.40	1.46	0.30	0.00	8.8	7.4	**15%**
Winnipeg	0.80	2.60	1.00	2.40	1.72	0.30	0.00	8.8	7.4	**16%**
Ottawa	0.80	2.60	1.00	2.40	2.32	0.30	0.00	9.0	7.4	**17%**
Toronto	0.80	2.60	1.00	2.40	1.12	0.30	0.00	8.7	7.4	**14%**
Quebec City	0.80	2.60	1.00	2.40	3.48	0.30	0.00	9.3	7.4	**20%**
Montreal	0.80	2.60	1.00	2.40	2.48	0.30	0.00	9.0	7.4	**18%**
Halifax	0.80	2.60	1.00	2.40	2.12	0.30	0.00	8.9	7.4	**17%**
St. Johns	0.80	2.60	1.00	2.40	3.02	0.30	0.00	9.2	7.4	**19%**

ASSUMPTIONS

Shearwall suporting 1 level of flat roof and 2 levels of office floor 1
Seismic base shear is irrelevant in that case
D_{Roof} = 0.8 kPa - D_{Floor} = 2.6 kPa - L_{Roof} = 1.0 kPa - L_{Floor} = 2.4 kPa - Cs α = 0 (NBCC 2015) = 1.0 - $\psi_{2,\text{ Office and Residential - Category A and B (EN 1990)}}$ = 0.3
$\psi_{2,\text{ Roofs - Category H (EN 1990)}}$ = 0.0 - $\psi_{2,\text{ Snow}}$ (EN 1990) = 0.0

NOTES

NOTES

NOTES

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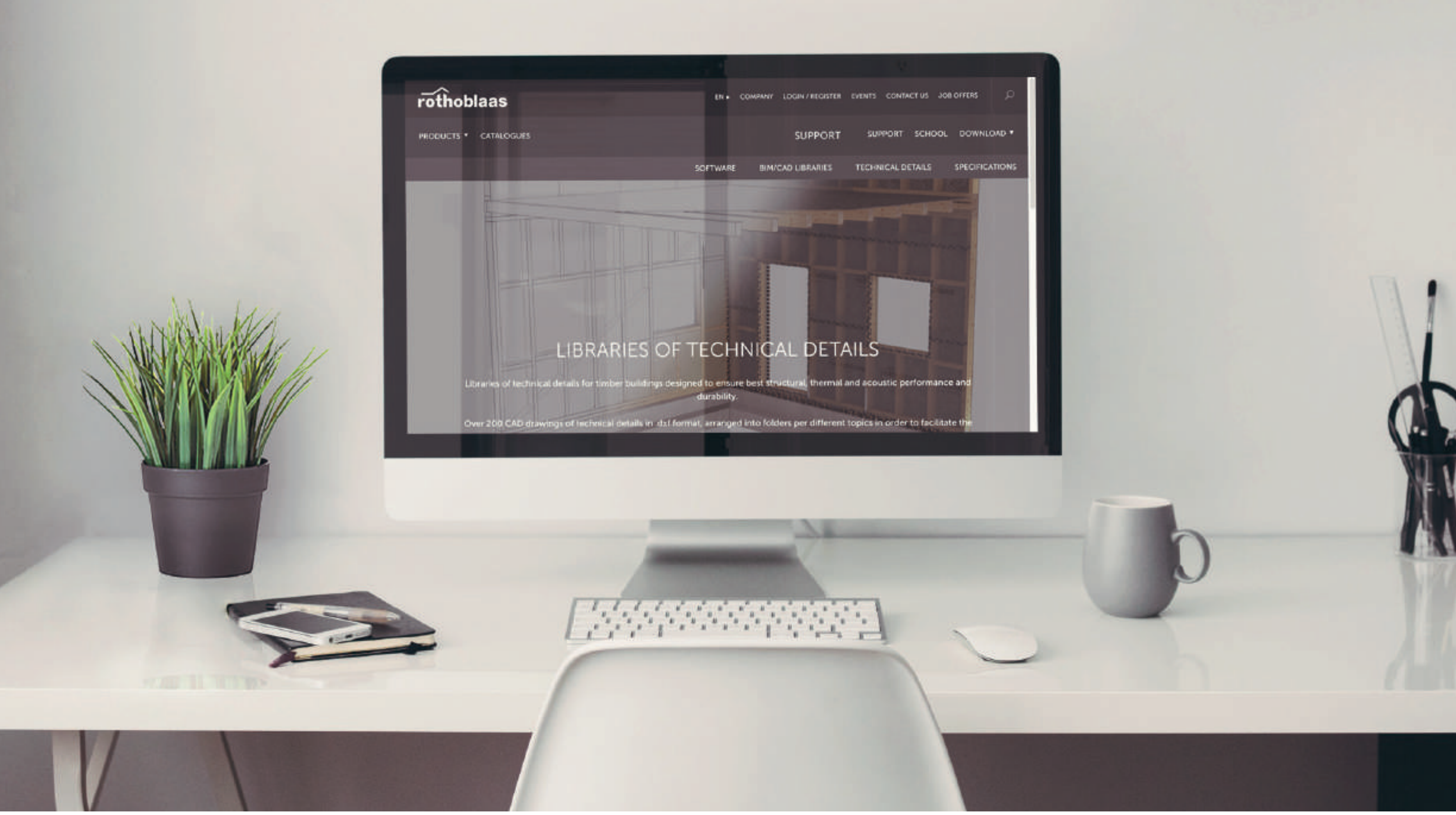

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