SPAX®

TIMBER CONSTRUCTION

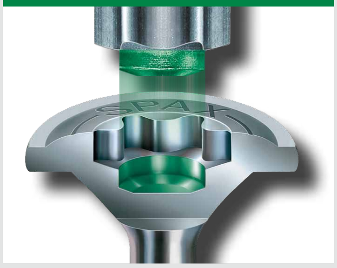
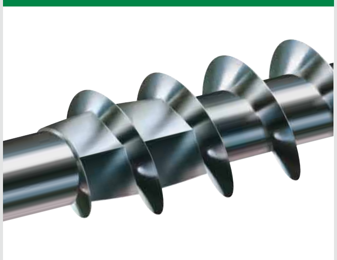
Connection Design according to AS1720.1 using SPAX screws

MADE IN Germany

SPAX®

SPAX Advantages

Guaranteed quality and innovation since 1823

T-STAR *plus*	*4CUT*	*Ground Seration / 4CUT*	
			MADE IN Germany
Ensures maximum torque transfer when driving screws.	From screw lengths over 160mm. Reduces the screwing-in torque significantly.	No pre-drilling (wood dependent), reduces splitting. Square end displaces the fibres and reduces screwing in torque.	Certified proof of origin offers a high degree of safety, quality and continuity.

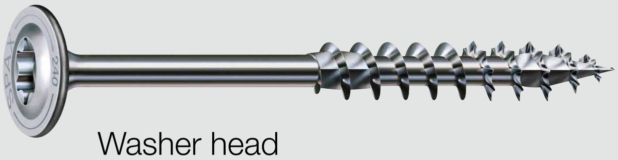
DELTA® - SEAL

Superior corrosion protection, especially in CCA/ACQ treated timber

High corrosion protection from the exclusive DELTA-SEAL coating, providing twice the corrosion protection compared to hot-dipped galvanised products. Ideal for CCA and ACQ treated timbers, all hardwoods and suitable for any external use away from direct exposure to salt water. Large range of stainless steel screws also available.

Screw types & applications

Partial Thread



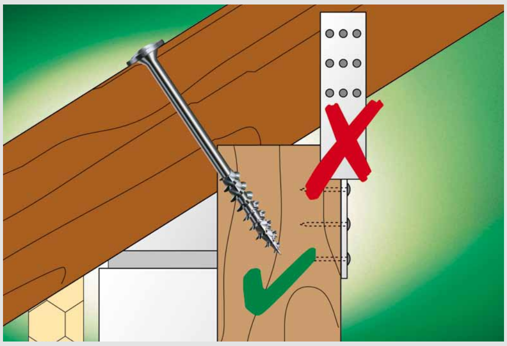
Washer head

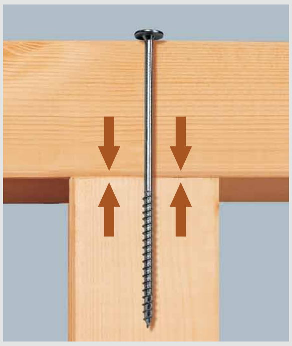
Countersunk head

The partial thread screw works like a clamp, pulling the two timber components together tightly. To achieve this clamping effect, the threadless shank must be equivalent to the thickness of the upper component.

- Washer head - the large bearing area of the head provides a high clamping force
- Countersunk head - used for flush fixings

Ideal for frame and roof structures, pergolas, boardwalks, retaining walls.

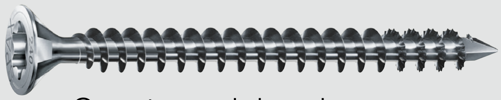




Screw types & applications (cont.)

Full Thread

Cylinder head

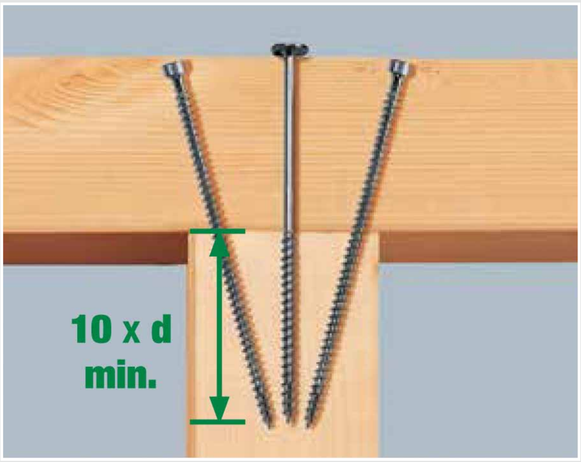


Countersunk head

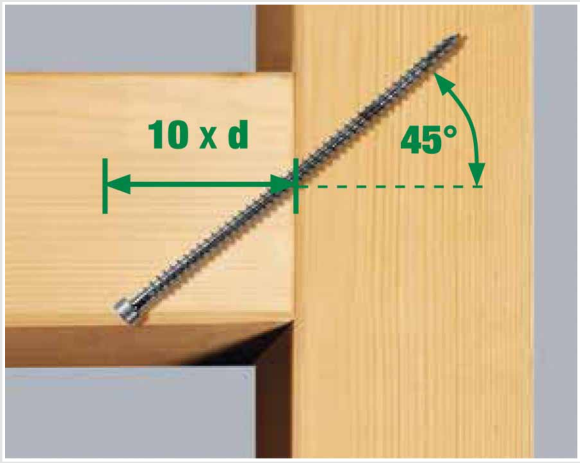
Fully threaded screws are available in countersunk and cylinder head screws up to 600mm long. They are ideal for three main applications:

- Joining two components together for a very high load capacity
- Tensile re-inforcement to prevent cracking of timber
- Compression re-inforcement to prevent crushing of timber

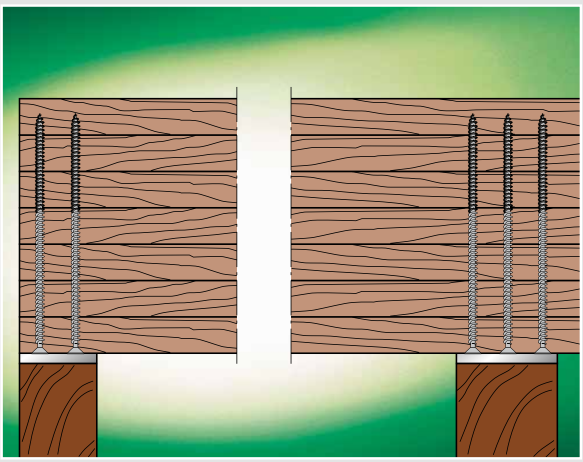
The cylindrical head can sink into the timber below the surface providing a fully concealed fixing.



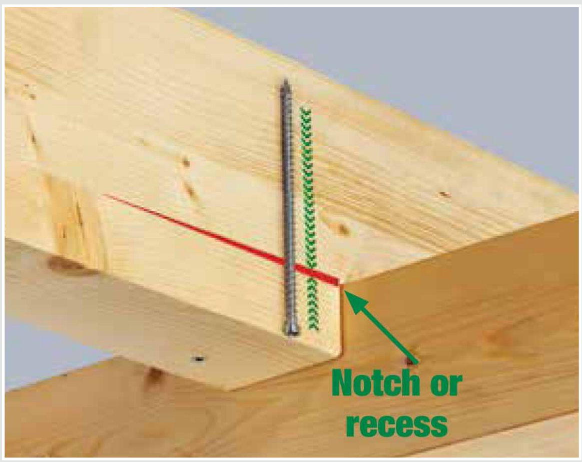
T-joint Beam
Clamp the two pieces together first with a SPAX partial thread washer head screw



Beam to Upright
Insert screw from below at a 45° angle



Compression Reinforcement
Prevents crushing of the timber



Notched Beam
Reinforcement and strengthening of notch or recess

Connection Design According to AS1720.1 Using SPAX Screws

Introduction
This design guide is derived from testing SPAX screws installed in Australian and New Zealand timber species and is designed to be used in conjunction with AS1720.1-2010 for quick predesign of load bearing connections with SPAX screws but is not intended to replace appropriate engineering and design by a design professional.

Testing was conducted according to AS1649-2001 and DIN EN 1382 to determine the limit state design lateral and withdrawal load capacities of SPAX screws in various timber types.

This guide has been established in good faith and to the best of our knowledge. No liability is, therefore, engaged or accepted for any errors.

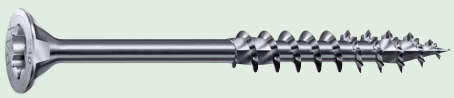
Characteristic Capacities for SPAX Screws
(read in conjunction with Sections 4.3 and 4.5 of AS1720.1 – 2010)

Type 1 Joints (fastener subjected to shear)

a) Lateral loads in side grain

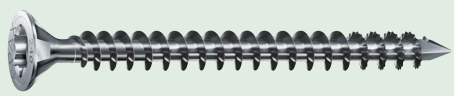
Table 1 – Characteristic Capacity for Single Screw in Side Grain Laterally Loaded in Single Shear

Partial Thread Screws



Joint Group	Characteristic Shear Capacity per Screw (Q_k)N*			
	Nominal Diameter d_1 (mm)			
	6.0	**8.0**	**10.0**	**12.0**
	Shank Diameter D (mm)			
	4.3	**5.7**	**6.8**	**8.5**
JD1	3788	6238	8447	12483
JD2	2846	4686	6346	9378
JD3	2237	3685	4990	7373
JD4	1597	2630	3561	5263
JD5	1138	1875	2538	3751
JD6	822	1398	1834	2710

Full Thread Screws



Joint Group	Characteristic Shear Capacity per Screw (Q_k)N*			
	Nominal Diameter d_1 (mm)			
	6.0	**8.0**	**10.0**	**12.0**
	Core Diameter d_2 (mm)			
	3.8	**5.0**	**6.1**	**7.5**
JD1	3051	4932	6985	10027
JD2	2292	3705	5247	7533
JD3	1802	2913	4126	5923
JD4	1286	2079	2945	4228
JD5	917	1482	2099	3013
JD6	780	1010	1620	2290

* Capacities for partial thread screws assume the shear plane is in line with the unthreaded screw shank.
These capacities are based on interpolation of capacities provided in AS1720.1. Actual values from test results vary slightly.

Timber Dimensions

Dimensions such as minimum thickness and depth of penetration as per clause 4.3.5 of AS1720.1.

For the characteristic capacities given in Table 1 to be applicable, timber thicknesses and screw length as shown in Figure 1 below shall be such that—

(a) thickness of first member ....t_1>10*D*; and
(b) depth of penetration into second member............t_p>7*D*.

where *D* = shank diameter

For lesser values of t_1 and t_p, the characteristic capacity shall be reduced in proportion to the decrease in t_1 or t_p and the screw shall be considered as non-load-bearing if t_1 or t_p is less than 4*D*.

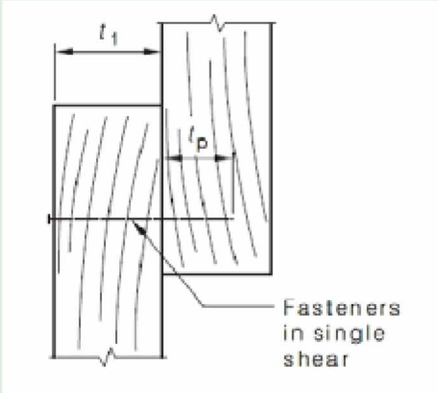


Figure 1

As SPAX screws with 4-CUT or CUT points significantly reduce the risk of splitting, the prescribed minimum thicknesses may be reduced.

b) Lateral loads in end grain

The characteristic capacities for screws laterally loaded in the end grain shall not exceed 60% of the values provided in Table 1 above determined in accordance with Clause 4.3.2.2(b) of AS1720.1.

Type 2 Joints (fastener subjected to tension)

a) Withdrawal loads from side grain

The characteristic capacities for SPAX screws axially loaded in withdrawal from the side grain of seasoned timber are provided in Table 2 below.

b) Withdrawal loads from end grain

The characteristic capacities for SPAX screws axially loaded in withdrawal from the end grain of seasoned timber shall not exceed 60% of the values provided in Table 2 below determined in accordance with Clause 4.3.2.3(b) of AS1720.1.

Table 2 – Characteristic Capacity for a Single Screw in Side Grain Loaded in Withdrawal

Joint Group	Characteristic Withdrawal Capacity per Screw (Q_k)N per mm Penetration of Thread — Nominal Diameter d_1 (mm)			
	6.0	**8.0**	**10.0**	**12.0**
JD1	180	240	300	360
JD2	138	184	230	276
JD3	107	142	178	213
JD4	81	108	135	162
JD5	64	86	107	129
JD6	50	66	83	100

Maximum Tensile Capacity

The maximum tensile capacity for a SPAX screw subject to direct axial loading shall not exceed the value appropriate to the diameter as per Table 3 below:

Table 3 – Maximum Tensile Capacity for Screws

	Design Steel Tensile Resistance $N_{d,tc}$			
	Nominal Diameter d_1 (mm)			
	6.0	**8.0**	**10.0**	**12.0**
High-carbon steel	8800	13600	22400	30400
Stainless steel	5700	10400	16000	22400

Head Pull-Through

AS1720.1 does not consider head pull-through as a failure mode for screws but it does consider crushing under the head for coach screws. Applying the equation $Q_b = f'_{pj} \times A_w$, where f'_{pj} is the stress factor from table 4.11 of AS1720.1 and A_w is the bearing area under the head from Table C6 of AS1720.1, we can provide the head pull-through values in Table 4 below (actual values may be higher).

Table 4 – Characteristic Capacity for Head Pull-Through

Joint Group	**Head Type**	**Characteristic Capacity per Screw for Head Pull-through (Q_b)N**			
		Nominal Diameter d_1 (mm)			
		6.0	**8.0**	**10.0**	**12.0**
JD1	Countersunk	2690	4531	6945	10161
	Washer Head	3857	8690	13411	NA
JD2	Countersunk	2051	3456	5297	7750
	Washer Head	2942	6628	10229	NA
JD3	Countersunk	1550	2611	4002	5856
	Washer Head	2223	5008	7728	NA
JD4	Countersunk	1140	1920	2943	4306
	Washer Head	1635	3682	5683	NA
JD5	Countersunk	821	1382	2119	3100
	Washer Head	1177	2651	4092	NA
JD6	Countersunk	556	937	1436	2101
	Washer Head	798	1797	2773	NA

Joint Groups

The corresponding joint groups for timber types is provided in Table 5 below. Radiata pine is, in most cases, used with the heart excluded and will conform with joint group JD4 according to AS1684.2.

Table 5 – Joint Groups

Material	Joint Group
MGP10 (heart excluded)	JD4
MGP10 (heart included)	JD5
F5 (heart excluded)	JD4
F5 (heart included)	JD5
LVL13	JD4
Spotted Gum	JD1

Design Capacity of SPAX Screwed Joints (as per AS 1720.1 section 4.3.3)

Type 1 Joints

The design capacity ($N_{d,j}$) for a joint containing n screws to resist shear loads for Type 1 joints shall satisfy the following:

$N_{d,j} \geq N^*$

where

$N_{d,j} = \varphi\, k_1\, k_{13} k_{14} k_{16}\, k_{17}\, n\, Q_k$

and

N^* = design action effect in shear

φ = capacity factor (see Clause 2.3 of AS1720.1)

k_1 = factor for duration of load for fasteners (see Clause 2.4.1.1 of AS1720.1)

k_{13} = 1.0 for screws in side grain

= 0.6 for screws in end grain

k_{14} = 1.0 for screws in single shear
= 2.0 for screws in double shear

k_{16} = 1.2 where the load is applied through metal side plates of adequate strength to transfer the load and the screws are a close fit to the holes in these plates
= 1.1 for screws through plywood gusset plates
= 1.0 otherwise

k_{17} = factor for multiple screwed joints given in Table 4.3(A) in AS1720.1 for type 1 joints to resist direct loads in either compression or tension.

n = number of screws in the connection

Q_k = characteristic capacity given in Table 1

Type 2 Joints

The design capacity ($N_{d,j}$) for screw joints axially loaded in withdrawal shall satisfy the following:

$N_{d,j} \geq N^*$

where $N_{d,j}$ is the lesser of—

$N_{d,j} = n\ N_{d,tc}$

$N_{d,j} = \varphi\ k_{13}\ l_p\ n\ Qk$

or where crushing under the head poses a limit to the strength

$N_{d,j} = \varphi\ k_1\ n\ Q_b$

N^* = design load action effect on the joint produced by strength limit states design loads (tension across the joint)

n = number of screws in the connection

$N_{d,tc}$ = design maximum tensile capacity of a single screw given inTable 3

φ = capacity factor (see Clause 2.3 of AS1720.1)

k_{13} = 1.0 for withdrawal from side grain
= 0.60 for withdrawal from end grain

l_p = depth of penetration of the threaded portion of the screw into the innermost member

Q_k = characteristic capacity given in Table 2

Q_b = characteristic capacity given in Table 4

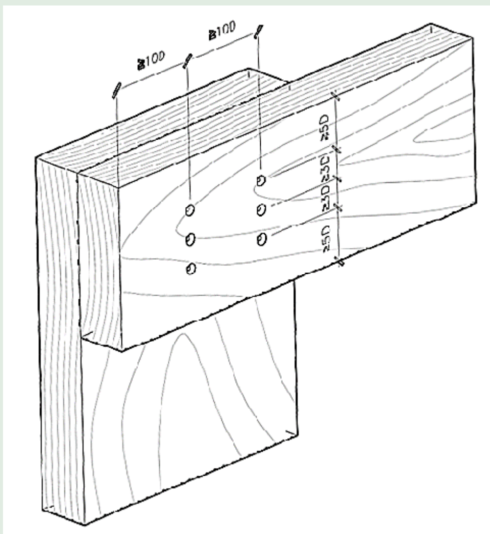
NOTE: The duration of load factor k_1 does not apply to withdrawal capacity.

Spacing, Edge and End Distance (refer to section 4.3.4 of AS1720.1)

Table 6 – Minimum Spacing, Edge and End Distance

Spacing	Minimum distance
End distance	10*D*
Edge distance	5*D*
Between screws	
- along grain	10*D*
- across grain	3*D*

D = shank diameter of screws



Pre-drilling

SPAX screws can be driven into radiata pine and other softwoods with or without pre-drilling . We recommend pre-drilling in hardwood and LVL according to the below diameters:

Outer Thread Diameter	Drill Hole Diameter (mm)	
	Softwood	Hardwood
4.0	2.5	3.0
4.5	3.0	3.0
5.0	3.0	3.5
6.0	4.0	4.0
8.0	5.0	6.0
10.0	6.0	7.0
12.0	7.0	8.0

How to Specify SPAX

When specifying SPAX screws, the following items should be included:

- Screw diameter and length
- Head type
- Thread type i.e. full thread or partial thread
- Material / corrosion protection
- Edge distances and spacings on drawing

e.g. SPAX 8 x 240 DELTA-SEAL cylinder head full thread.

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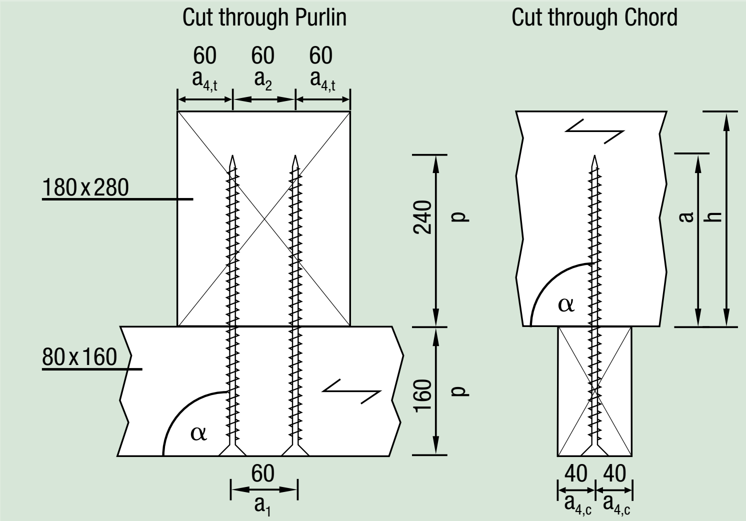
Example 1



Selected fastener: SPAX 8.0x400 countersunk head, full thread with CUT point, w/o predrilling subject to shear and withdrawal. Timber is radiata pine (JD4).

Minimum dimensions

Min. thickness	t_1 = 10 x D = 10 x 5.7 = 57< 160mm	OK
	t_p = 7 x D = 7 x 5.7 = 40< 280mm	OK
Edge distance	= 5 x D = 5 x 5.7 = 28.5	OK

No end distance

Spacing (along grain) = 10 x d_1 = 10 x 5.7 = 57 — OK

Shear resistance – per screw

1. Characteristic resistance Q_k = 2079 N — Table 1

$N_{d,j} = \varphi\, k_1\, k_{13}\, k_{14}\, k_{16}\, k_{17}\, n\, Q_k$

$N_{d,j}$ = 0.8 x 0.86 x 1 x 1 x 1 x 2x 2079 = 2860 N

Withdrawal resistance – per screw

1. Withdrawal of threaded part

Q_k = 108 x l_p = 108 x 240 = 25920 N — Table 2

$N_{d,j} = \phi\, k_{13} Q_k$ = 0.8 x 1.0 x 25920 = 20736 N

2. Tensile steel resistance

$N_{d,tc}$ = 13600 N — Table 3

3. Head pull-through

$N_{d,j}$ = max (3.1 head pull-through
(3.2 withdrawal of thread headside

3.1 Head pull-through

$N_{d,j} = \varphi\, k_1\, n\, Q_b$= 0.8 x 1 x 1920 = 1536 N — Table 4

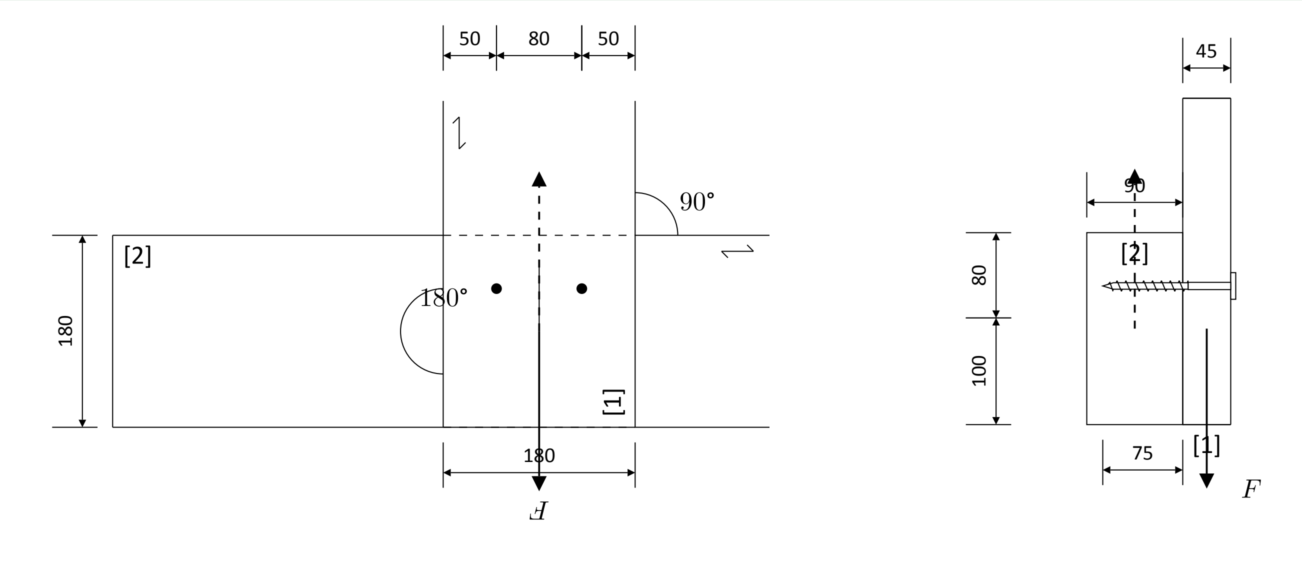
3.2 Withdrawal of thread headside

$N_{d,j} = \phi\, k_{13} l_p\, Q_k$ = 0.8 x 1.0 x 160 x 108 = 13824 N (max) — Table 2

Governing resistance is tensile steel resistance $N_{d,tc}$=13600 N per screw

For joint $N_{d,tc}$ =2 x13600 = 27200 N

Example 2



Selected fastener: SPAX 8x120 washer head, partial thread, w/o predrilling subject to shear.

Minimum dimensions

Min. thickness	$t_1 = 10 \times D = 10 \times 5.7 = 57 > 45mm$	Reduce capacity by 45/57 = 0.79
	$t_p = 7 \times D = 7 \times 5.7 = 40 < 90mm$	OK
Edge distance	$= 5 \times D = 5 \times 5.7 = 28.5$	OK
End distance	$= 10 \times D = 10 \times 5.7 = 57$	OK
Spacing (along grain)	$= 10 \times D = 10 \times 5.7 = 57$	OK
Spacing (across grain)	$= 3 \times D = 3 \times 5.7 = 15$	OK

Shear resistance – per screw

1. Characteristic resistance Q_k =	2630 N	Table 1
Reduction for thickness	2630 x 0.79 = 2077	

$N_{d,j} = \varphi\, k_1\, k_{13}\, k_{14} k_{16}\, k_{17}\, n\, Q_k$

$N_{d,j} = 0.8 \times 0.86 \times 1 \times 1 \times 1 \times 2 \times 2077 = 2858$ N

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Production is carried out at our site in Ennepetal and we export SPAX products to more than 40 countries across all continents.

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