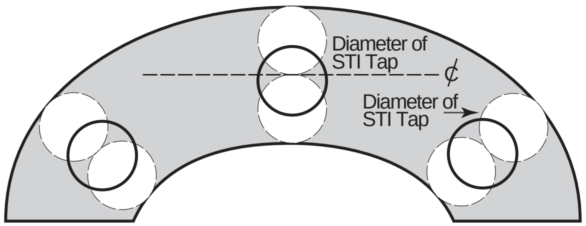
Design Considerations

The following design considerations should be evaluated to maximize the security and safety of the fastening assembly using Recoil wire inserts.

Boss Dimensions

Boss thickness is a function of size and strength requirements and also design of components. For optimum strength, the minimum wall thickness should be twice the maximum diameter of the STI Recoil Tap. For minimum requirements, a wall thickness of twice the bolt diameter to center line may be adequate.

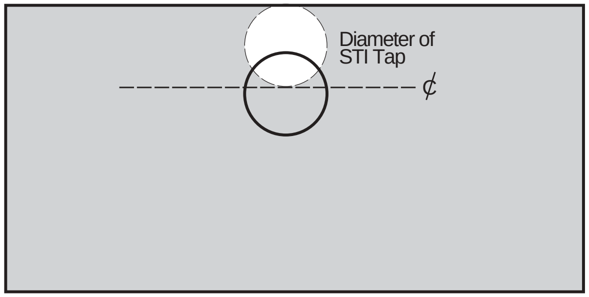
Boss Thickness



Edge Dimensions

The minimum edge distance recommended is the maximum diameter of the STI tap measured from the edge of the material to the center-line of the hole.

Edge Thickness



Minimum Material Thickness

The recommended minimum material thickness for through-hole applications is equal to the nominal length of the insert plus one pitch. This allows for proper countersinking and installation of the insert at 3/4 to 1-1/2 pitches below the surface of the component. In design critical applications, the minimum thickness may be reduced by eliminating the countersink and installing the insert to 1/4 to 1/2 pitch below the surface.

Class of Thread Fit

All Recoil inserts are produced to exacting tolerances where installation into the tapped hole will conform exactly to the parent material thread characteristics. It is therefore important that the tapped hole tolerances of either 2B or 3B (unified threads), or the applicable 4H5H and 5H (metric threads) combinations must be carefully controlled by precise tapping and gauging operations.

Gauging

Recoil inserts, when installed correctly in tapped and gauged holes, will conform with the tapped hole dimensions once the insert has been seated. Gauging of the tapped hole with the appropriate gauges prior to installing Recoil inserts is therefore highly recommended.

Bolt Engagement

Maximum strength of the bolted insert assembly will be achieved if the bolt or screw engages the full length of the insert. Ideally, the minimum bolt projection for safe engagement should be at least two pitches beyond the last coil of the insert.

Tang Removal

To achieve the optimum bolt engagement and hence maximum strength, the tang should be removed from the insert. Exceptions to this recommendation may be necessary in certain blind-hole applications involving light tensile bolt loading.

Design Method

The ultimate consideration is to design an assembly that balances the tensile strength of the bolt material against the shear strength of the parent material. With insert lengths available in 1, 1-1/2, 2, 2-1/2, and 3 times the nominal thread diameters, there are engagement lengths available to produce an assembly thread system where the bolt will fail without damage to the parent material or thread. The bolt must be fully engaged along the entire length of the insert to obtain this position.

Selection of the correct length insert can be determined from Table 1 referring to values for bolt ultimate strengths and parent material shear strengths. For intermediate strength value, use the next higher bolt tensile value or the next lower parent material shear strength.

Assembly strength is a function of shear area and the shear strength of the parent material, tensile strength and cross sectional area of the bolt. Table 1 provides a recommendation of the nominal length of insert which should be selected for a parent material of a certain shear strength, so that when a bolt is used with defined tensile properties, tensile failure of the bolt should occur before the insert is stripped away from the material in which it was inserted.

Table 1 (Source BS 7752: Part 1:1994)

	TENSILE STRENGTH OF BOLT SELECTED (Ultimate Tensile Strength)						
SHEAR STRENGTH PARENT MATERIAL	400 (MPa) 58,000 (psi)	500 (MPa) 72,000 (psi)	600 (MPa) 87,000 (psi)	800 (MPa) 116,000 (psi)	1000 (MPa) 145,000 (psi)	1200 (MPa) 174,000 (psi)	1400 (MPa) 203,000 (psi)
70 to 99 MPa (10.0 to 14.4 Ksi)	2.0D	2.5D	2.5D	-	-	-	-
100 to 149 MPa (14.5 to 21.5 Ksi)	1.5D	1.5D	2.0D	3.0D	-	-	-
150 to 199 MPa (21.7 to 28.9 Ksi)	1.0D	1.5D	1.5D	2.0D	2.5D	3.0D	-
200 to 249 MPa (29.0 to 36.1 Ksi)	1.0D	1.0D	1.0D	1.5D	2.0D	2.0D	2.5D
250 to 299 MPa (36.2 to 43.3 Ksi)	1.0D	1.0D	1.0D	1.5D	1.5D	2.0D	2.0D
300 to 349 MPa (43.5 to 50.6 Ksi)	1.0D	1.0D	1.0D	1.0D	1.5D	1.5D	2.0D
> 350 MPa (50.7 Ksi)	1.0D	1.0D	1.0D	1.0D	1.0D	1.5D	1.5D

Note: Inserts are available in different lengths which are measured by the diameter of the thread. For example the length of a 3D insert would be three times the diameter.

Note: Table 1 is for guidance only. It remains the responsibility of the user to ensure that the insert nominal length chosen is suitable for the particular application concerned.

Design Method

The following procedure can be used to verify a joint design incorporating a wire thread insert:

1. Select size and strength of bolt to be used (refer to table 2).

2. Determine tensile failure load of the selected bolt.

3. Determine shear strength of parent material for the installation of the insert (refer to table 3).

4. Determine length of insert based on the shear strength capability of parent material.

Note: Information in referring to joint strength is intended as a guide only. Professional engineering advice must be sought when exact design calculations are required.

Step One:

Select size and strength of bolt to be used

Design Example (Metric) Units

Type	M16 x 2.0, SAE Grade 8
Nominal Diameter	16.0 mm
Pitch	2.0 mm
Shear Strength	1034 MPa (refer table 2)

Design Example (Inch) Units

Type	1/2"-13 UNC, Socket Head Cap Screw
Nominal Diameter	0.500"
TPI	13
Tensile Strength	181,000psi (refer table 2)

Table 2 Strength, Bolt (Metric)

BOLT GRADE	Tensile strength MPa (minimum)
SAE Grade 1 1/4" to 1"	413
SAE Grade 5 1/4" to 1 1/2"	827
SAE Grade 7 1/4" to 1 1/2"	917
SAE Grade 8 1/4" to 1 1/2"	1034
ASTM A354 BC 1/4" to 2 1/2"	862
BD 1/4" to 2 1/2"	1034
Socket head screw products	1250

Table 2 Strength, Bolt (Inch)

BOLT GRADE	Tensile strength psi (minimum)
SAE Grade 1 1/4" to 1"	60,000
SAE Grade 5 1/4" to 1 1/2"	120,000
SAE Grade 7 1/4" to 1 1/2"	133,000
SAE Grade 8 1/4" to 1 1/2"	150,000
ASTM A354 BC 1/4" to 2 1/2"	125,000
BD 1/4" to 2 1/2"	150,000
Socket head screw products	181,000

Step Two: ***Determine tensile failure load of selected bolt***

Min Thread Diameter 13.797mm (handbook)
Shear Area 149.5mm^2 (calculated)*
Tensile Failure Load 154.59kN (calculated)#

***Area based on minor thread diameter.**
#Parent material shear strength must exceed this.

Min Thread Diameter 0.407" (handbook)
Shear Area 0.130"^{2} (calculated)*
Tensile Failure Load 23,550 Pounds Force (lbf) (calculated)#

***Area based on minor thread diameter.**
#Parent material shear strength must exceed this.

Step Three: ***Determine shear strength of parent material for the installation of the insert (refer table 3)***

Type	2024 Wrought Aluminum, T62 temper	Type	5083 Wrought Aluminum, annealed Condition
Shear Strength	283 MPa (refer table 3)	Shear Strength	25,000 psi (refer table 3)

Table 3 Shear Strength, Parent Material (Metric)

ALLOY	TEMPER	SHEAR STRENGTH MPa (typical)
SHEET & PLATE		
1200	0	62
2024	T62	283
5005	H34	97
5251	H34	138
5083	0	172
5083	H321	179
7075	T6	331
EXTRUSIONS (including machine rod)		
1350	H112	55
2011	T3	221
2011	T6	234
2014	T6	290
6060	T5	117
6061	T6	207
CASTINGS (Properties refer to test bars only)		
CA401 {LM6+ A413#}	F1-Sand	125
Heat Treating Alloy		
AC601 {LM25+ A356#}	T6-Sand	125
AC601 {LM25+ A356#}	T5-Sand	180
AC601 {LM25+ A356#}	T6-Perm	190

Table 3 Shear Strength, Parent Material (Inch)

ALLOY	TEMPER	SHEAR STRENGTH psi (typical)
SHEET & PLATE		
1200	0	9,000
2024	T62	41,000
5005	H34	14,000
5251	H34	20,000
5083	0	25,000
5083	H321	26,000
7075	T6	48,000
EXTRUSIONS (including machine rod)		
1350	H112	8,000
2011	T3	32,000
2011	T6	34,000
2014	T6	42,000
6060	T5	17,000
6061	T6	30,000
CASTINGS (Properties refer to test bars only)		
CA401 {LM6+ A413#}	F1-Sand	18,000
Heat Treating Alloy		
AC601 {LM25+ A356#}	T6-Sand	18,000
AC601 {LM25+ A356#}	T5-Sand	26,000
AC601 {LM25+ A356#}	T6-Perm	27,000

Shear strength of standard parent materials, (indication only refer supplier for specific properties)
+Nearest British Equivalent
#Nearest US Equivalent

Step Four, Determine the length of insert based on shear strength of parent material

Nominal Diameter 16.0 mm (selected bolt)
Pitch 2.0 mm
Pitch Diameter (min) 17.299mm
(refer taped hole data)

$$L = \frac{\text{Tensile Strength of Bolt}}{\text{Shear Circumference Strength of Hole x Arbitrary Constant}}$$

L = Required length of fitted insert
Arbitrary Constant = 0.5
(0.5 Based on shearing of the parent material occurring along the pitch diameter of the tapped hole)

$$L = \frac{1034 \text{ X } (13.797^2 \text{ X } \pi/4)}{283 \text{ X } 17.299\,\pi \text{ X } 0.5}$$

L = 20.1mm

Conclusion:
For this application a 16mm diameter bolt has been selected. Insert engagement of 20.1mm was calculated. The suitable diameter of the insert can be determined by dividing the length of the insert by the diameter of the bolt.

For example:
L/dia = 20.1mm/16mm
= 1.26 select next highest size
Therefore use a 1.5D insert

Nominal Diameter 0.500" (selected bolt)
TPI 13
Pitch Diameter (min) 0.550"
(refer taped hole data)

$$L = \frac{\text{Tensile Strength of Bolt}}{\text{Shear Circumference Strength of Hole x Arbitrary Constant}}$$

L = Required length of fitted insert
Arbitrary Constant = 0.5
(0.5 Based on shearing of the parent material occurring along the pitch diameter of the tapped hole)

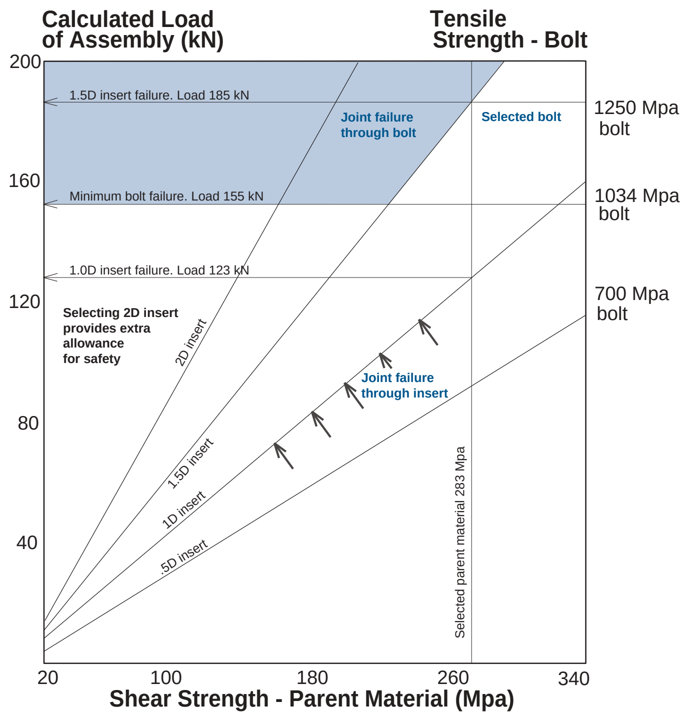
$$L = \frac{181{,}000 \text{ X } (0.407^2 \text{ X } \pi/4)}{25{,}000 \text{ X } 0.550\,\pi \text{ X } 0.5}$$

L = 1.09"

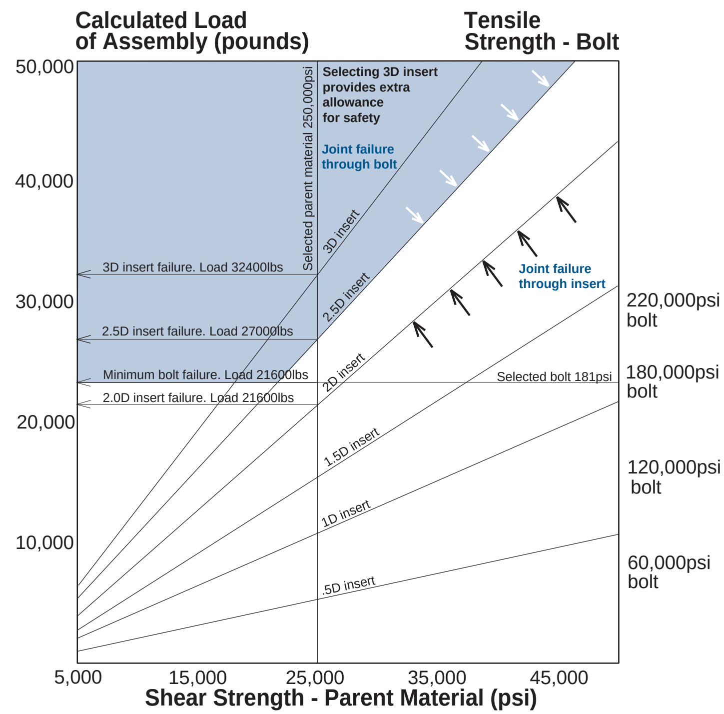
Conclusion:
For this application a 1/2" diameter bolt has been selected. Insert engagement of 1.09" was calculated. The suitable diameter of the insert can be determined by dividing the length of the insert by the diameter of the bolt.

For example:
L/dia = 1.09"/0.5"
= 2.2 select next highest size
Therefore use a 2.5D insert

Assembly Design



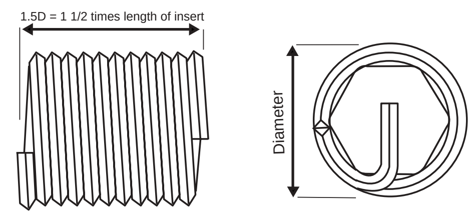
The shaded area in the graph indicates the region in which bolt failure will occur.



The shaded area in the graph indicates the region in which bolt failure will occur.

Note: Inserts are available in standard lengths which are multiples of the diameter. For example an insert with a length of 1.5D will measure one and a half times as long as the diameter when installed.

Note: The example above is an indication only. Professional engineering advice must be sought when exact design calculations are required.



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