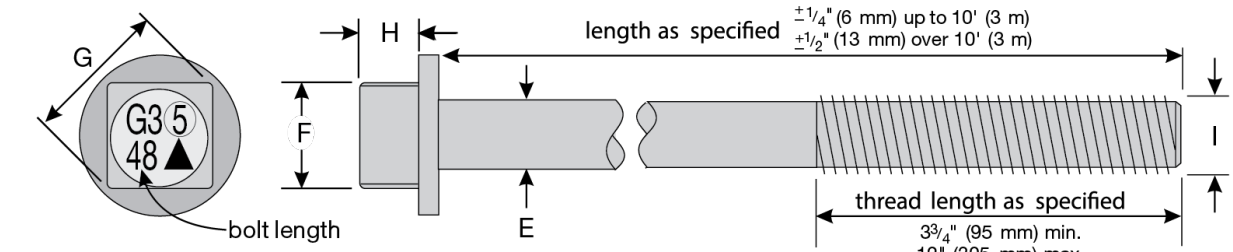
Mechanical rock bolt

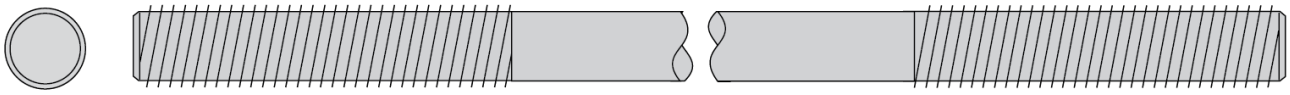
Category: Forged heads

Overview
Forged head (1-1/8" Square)



USA manufactured bolts: made to ASTM F432 and MSHA approved

Forged Threaded both end (TBE)



Dimensions

	Head Type	5/8" Bolt	3/4" Bolt	7/8" Bolt
Body Diameter E	All bolts	±0.56" (±14.2mm)	±0.68" (±17.3mm)	±0.79" (±20.1mm)
Head Across Flats F	11/8" Square	1.088" - 1.125" (27.64 - 28.58mm)		
Head Across Corners G	11/8" Square	1.425" - 1.591" (36.19 - 40.41mm)		
Minimum Head Height H	11/8" Square	0.6" (15.24mm)		
Thread Size (left and right) I	All Bolts	5/8"- 11 UNC	3/4"- 10 UNC	7/8"- 9 UNC

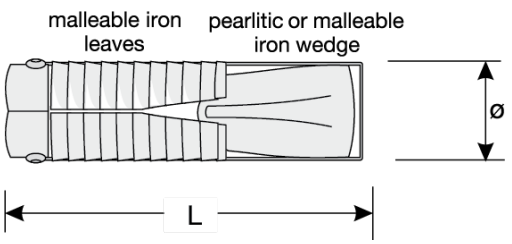
Technical data

	C1055M 5/8" Bolt	C1055M 3/4" Bolt	C1070 5/8" Bolt	C1070M 5/8" Bolt TBE
Yield Strength, min.	13,600 lbs (60 kN)	20,000 lbs (89 kN)	17,100 lbs (76 kN)	28,400 lbs (126 kN)
Tensile Strength, min.	22,600 lbs (100 kN)	33,400 lbs (148 kN)	31,200 lbs (139 kN)	35,000 lbs (156 kN)
Ultimate Axial Strain	Minimum 12%	Minimum 12%	Minimum 8%	Minimum 2.2%

All mechanical & physical properties in accordance with ASTM F432, ASTM A29 & CSA M430-90 specifications 5/8" steel special order

Installation accessories
Expansion shells

- For 5/8" & 3/4" UNC threads & 7/8" where applicable
- Ø = 1 1/32" (26 mm) hole size: model F1F, L = 3 1/4"
- Ø = 1 1/4" (32 mm) hole size: model F1 1/4B, L = 3 1/4"
- Ø = 1 3/8" (35 mm) hole size: model F2B, L = 2 7/8"
- Ø = 1 1/2" (38 mm) hole size: model D1L, L = 5"
- Ø = 1 1/2" (38 mm) hole size: model D10 L, L = 5"
- More options available.



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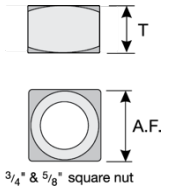
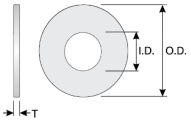
Date: 06.04.2023

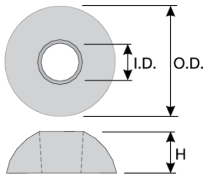
Nuts
— for TBE rock bolts only
— for 5/8" and 3/4" UNC thread:
— A.F. = 1 1/8" square
— T = 0.8"



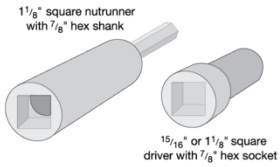
Hardened round washers
— To ASTM F436 specifications
— For 5/8" and 3/4" thread
— I.D. = 13/16"
— O.D. = 1 15/32"
— T = 0.122" to 0.177"



Spherical seat (compensation) washers
— Ductile iron ASTM A536 Gr. 65-45-12
— For 5/8" thread:
— I.D. = 11/16", O.D. = 2", H = 3/4" (model TSW-2)
— I.D. = 15/16", O.D. = 2", H = 1/2" (model TSW)
— for 3/4" thread:
— I.D. = 13/16", O.D. = 2", H = 13/16" (model TSW-4)
— I.D. = 15/16", O.D. = 2", H = 1/2" (model TSW)



Installation tools - for stopers/jacklegs
— For forged head rock bolts: 1 1/8" square driver
— For TBE bolts: 1 1/8" square nutrunner available with 7/8" hex shank or socket
— Rope thread and T-thread drivers and nutrunners available on request



Installation quality guidelines
The following are items to be aware of when installing mechanical rock bolts (forged head and threaded both end [TBE] bolts):

Type of Ground - The nature of the ground must be evaluated. Soft strata requires a larger plate washer and/or expansion shell bearing area. Greater expansion of the expansion shell leaves may be required. Soft ground results in larger hole sizes for a given bit size (bit rattling and reaming). Special anchors are available for soft ground. Excessively hard ground can be detrimental as well. Hard ground can result in poor anchorage as the shell is unable to “bite” into the rock.

Scaling - The ground should be thoroughly scaled i.e. barred down, before drilling and bolting. Periodic re-scaling may be required while drilling.

Strength and Yield Capacity of Bolt - The mechanical properties of the bolt should be appropriate for the ground conditions, bolt length and bolting pattern. Pull tests and torque-tension tests should be performed to determine yield strengths and anchorage capacities of the bolts being used.

Condition of Threads - Threads should be inspected before installation. Increased friction on the threads adversely affects the torque tension relationship.

Fillet on Forged Head - Forged head rock bolts should be inspected to ensure a fillet of 1/8 " radius is present where the shaft connects to the forged head. Sharp transitions may weaken the bolt.

Hole Length - Holes too short for the bolt in use may cause the shell to distort or inhibit proper tensioning of the bolt. Good practice suggests that the hole length should be equal to the bolt length plus shell length.
Hole Condition - The hole should be cleaned and examined to ensure the bolt will insert smoothly. Damage to the shell may result if it must be forced into the hole.

Oversize Holes - Holes 1/8 " oversized can reduce holding strength by 70%. Oversized holes can be caused using the wrong bit size, leaving the drill running while flushing the hole, soft ground (faults, gouge, etc.) and bent drill steel.

Undersized Holes - Undersized holes will not permit the plug in the expansion shell to seat properly. The leaves or bail can break and distort upon forced entry. Undersized holes are usually caused by worn bits and/or wrong bit sizes being used.

Friction Flair Expansion Shells - A recent improvement in expansion shell design is the addition of flairs or wings on the bail strap at the bottom of the leaves. Installation is improved as there is no need to set the anchor to keep the bolt from sliding out of the hole during installation. The anchor sets up faster as the plug engages the leaves freely. Spinning of the anchor in the hole is prevented, thereby eliminating the principal cause of bolt failure upon installation.

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Resin Anchors - Using a resin cartridge to assist in anchoring mechanical rock bolts is gaining popularity. If used with an expansion shell, the shell must have provisions for the passage of resin around the shell wedge. This ensures proper encapsulation of the expansion shell without causing any damage to the assembly.

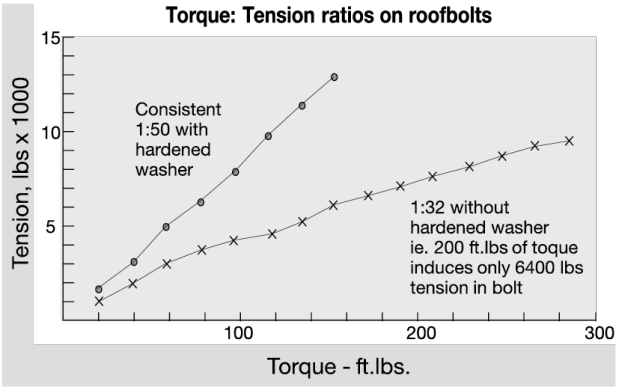
Expansion Shell Plastic Sleeve - The plastic sleeve holding the leaves together on an expansion shell should be removed prior to installation. If left on it could result in poor anchorage.

Set Up of Expansion Shell - Immediately prior to installation the expansion shell should be set to the correct diameter to enable the bolt to be pushed up the hole by hand, set and anchored. If not expanded enough there will be difficulties in anchoring. If expanded too much the end of the bolt can break the bail or leaf attachment prior to the leaves being set.

Rock Bolt Dollies - Rock bolt installation dollies should only transfer rotational energy to the rock bolt during installation, not percussive energy, when stopers and jacklegs are used. The shank end of the dollie must be short enough to avoid contact with the drill piston. Typically, these rock bolt dollies have a 7/8" hex shank and are only 31/4" long. In addition to being the proper size for the rock bolt head or nut, the dolly must also have sufficient socket depth to allow nuts to be run onto the ends of TBE bolts.

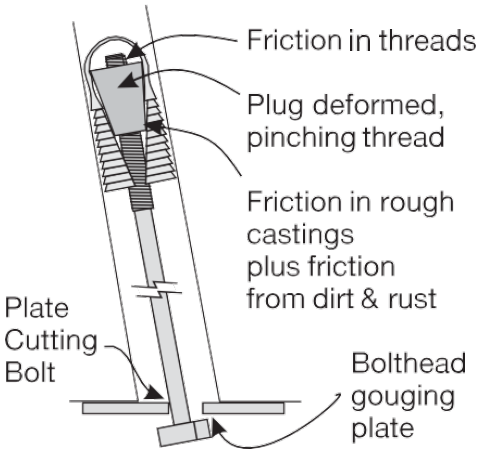
Proper Torquing of Bolts - Typically, 3.5 tons of installed tension is required for a rock bolt to set the anchor and tension the bolt to 50% of the yield strength. An approximately linear relationship exists between the applied torque and the tension in a forged head rock bolt.

*P=C*T,*
where
P = bolt tension (lbs),
T = torque (ft-lbs),
C = 50 for 5/8" forged head bolts
C = 40 for 3/4" forged head bolts
(add 10 to C if hardened steel washer or hemispherical washer is used)



As TBE bolts turn at both ends during torquing, they generally apply more tension for the same amount of applied torque due to the reduced resistance to friction. However, as a generality: All mechanical rock bolts should be torqued to a minimum of 150 ft-lbs (per ASTM F432).

Several Factors can affect the torque tension relationship. Thes include friction in the threads (affected by thread tolerances, rust, dirt, etc.),friction between the wedge and leaves in the expansion shell (affected by dirt, casting roughness, etc.), and friction between the bolt head (nut) and plate washer (influenced by angularity, rust, rough edges, on nuts/plates). As previously mentioned, hardened steel washers and hemispherical washers can alleviate this problem.



Overtorquing - Overtorquing of the bolts must be avoided. With forged head bolts, the heads can be weakened or sheared off. Overtorquing may tension the bolt past it's yield point which is undesirable.

Undertorquing - Undertorquing can result in poor anchorage. Under tensioned bolts are particularly susceptible to blasting damage. Bolts will not apply sufficient compressive force to the ground as per design requirements.

Monitoring - In practice, rock bolt tension often drops after installation. Expansion shells can slip due to blasting vibrations, shells can move as high stress concentrations along the leaves cause localized failure of the ground, and finally, the rock can fail under the plate washer.

The installation of any ground support system must be monitored to ensure proper procedures and installation quality are maintained. For rock bolts this requires verifying torque and the placement and spacing of bolts. Torque measurements can be recorded on the wall or plate of the bolt which will permit monitoring of the load on the bolt during the mining cycle. If necessary, bolts can also be re-torqued if loss in tension occurs. Torque testing is best done by a crew supervisor (or dedicated technician) while visiting work areas during his rounds.

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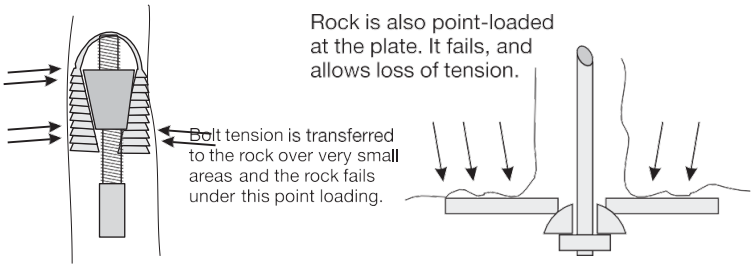
Education - Proper education of mining personnel and supervisors is mandatory. As manpower turnover is relatively frequent in bolting crews, education must be continuous. Forget this and you waste money.

Packaging - Vendors must package bolting products in an acceptable manner both for convenience of use as well as prevention of damage to the product during shipping and handling. Particular care must be paid to wrapping of the thread ends to prevent damage and corrosion. Good packaging costs more but is worth the added cost by reducing wastage on site.



Matching Bolt and Shell Threads - While North American mines typically use UNC thread specs, other countries can use different thread types. Care must be taken not to mismatch shells and bolts from various manufacturers. A minimum UNC class 1A thread spec should be met on all threads as per ASTM F432 guidelines. DSI - Mining exceeds ASTM specs and rolls threads to a class 2A specification.

Support Nuts - While they are sometimes used on TBE bolts, the practice of installing a nut below the anchor shell should be avoided on forged head bolts. If the support nut comes in contact with the shell, friction between these two surfaces will prevent the bolt from elongating properly and will give false torque readings as the bolt is tensioned. Headed bolts should be free to elongate into the hole through the expansion shell.

TBE Bolt Nuts - Do not run the nut on a TBE bolt to the end of the threads and onto the shank. Strength can be reduced by as much as 50%. Each revolution of the nut onto the shank reduces the thread engagement length.

Notching of TBE bolt threads - Notching threads on TBE bolts is a poor installation practice and must be avoided. This practice locks the nut onto the bolt which then makes the TBE bolt act as a forged head bolt. Deep gouging can reduce the bolts strength.

Proper Grade Plates - Thin or weak plates will deform at low bolt tension. High torques will produce lower tension values. The bolt could also rip through the plate during installation or by bolt loading. Plate should meet ASTM F432 specs. The minimum spec is a grade 2 plate which has less than 0.25 deflection when the load on the plate is increased from 6,000 to 20,000 lbs.

Hardened Steel Washers - Hardened steel washers should be used between the forged head or nut and the plate washer. The washer reduces friction and enhances the torque-tension relationship. Minimum grade should be Type 2 (ASTM F432 spec) and hole size in plate washer should be no more than 3/8" diameter larger than bolt size. A spherical seat washer can also be used to reduce friction.

Wooden Washers - Although seldom used nowadays, wooden washers help prevent the plate from cutting into mine screen (mesh) when present. The wood may cause tension bleed-off, however. Care must be used to watch for rotting of the wood.

Perpendicular Installation - Bolts should be installed as near perpendicular to the rock surface as possible. Bolts not perpendicular to the plate and rock surface will be marginally weaker and will not be pretensioned properly. The following example using a 5/8 " forged head rock bolt installed with 180 ft-lbs torque illustrates the scope of the problem.

Technical data

Angle from Perpendicular	Installed Tension		Angle from Perpendicular	Installed Tension
0	13,030 lbs	-	26,780 lbs	-
10	10,280 lbs	21.1%	25,690 lbs	4.1%
20	5,230 lbs	59.8%	25,060 lbs	6.4"
30	3,280 lbs	74.8%	23,050 lbs	13.9%

Results from lab testing conducted at Stelco.

Legal disclaimer

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