



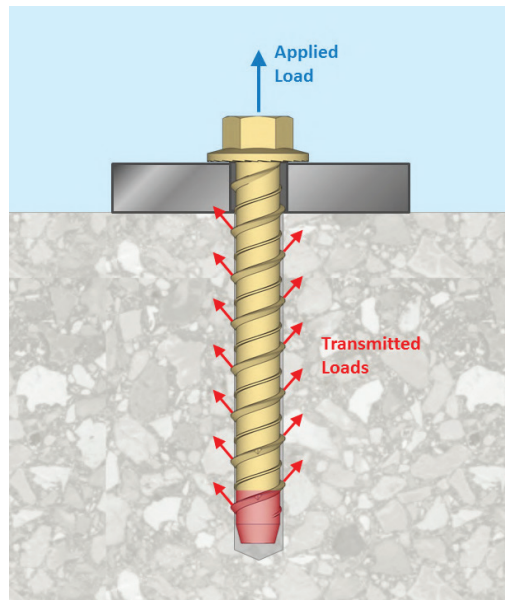
XBolt® Tech Guide - Screw Anchor Performance 101

Why use a screw anchor?

Screw anchors are used in medium duty applications that normally require faster installation time, close concrete edge distance, close anchor spacing and removability of anchor.

Screw anchors work by tapping the drilled hole and mechanically locking to the concrete. When the anchor is loaded in tension (as shown on the right), the threads become force transmitters from the anchor body to the concrete. Obviously, a screw anchor makes use of keying and interlocking, thus, enabling its usability in close anchor spacing and edge distance applications.

Screw anchor performance qualification can be divided into two, namely, (1) Ease of installation and (2) Load Bearing performance

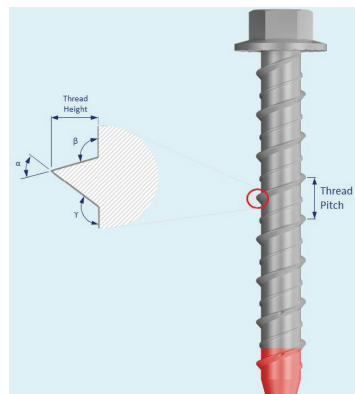


Ease in installation



Assuming that the drilled hole is within the acceptable dimensions, the ease of installation is influenced by a number of factors. The top two main influencers are thread pitch+profile and steel strength + hardness.

1. Thread pitch & profile – Thread pitch defines how quickly a screw anchor taps the concrete and drives into the hole. Obviously, the wider the pitch, the faster it drives and vice versa. The thread pitch also defines how much concrete there is in between threads, and will be discussed in further detail in the next section of this document. The thread profile defines how the tapping process will occur. The higher the thread height, the more energy needed to tap the hole.



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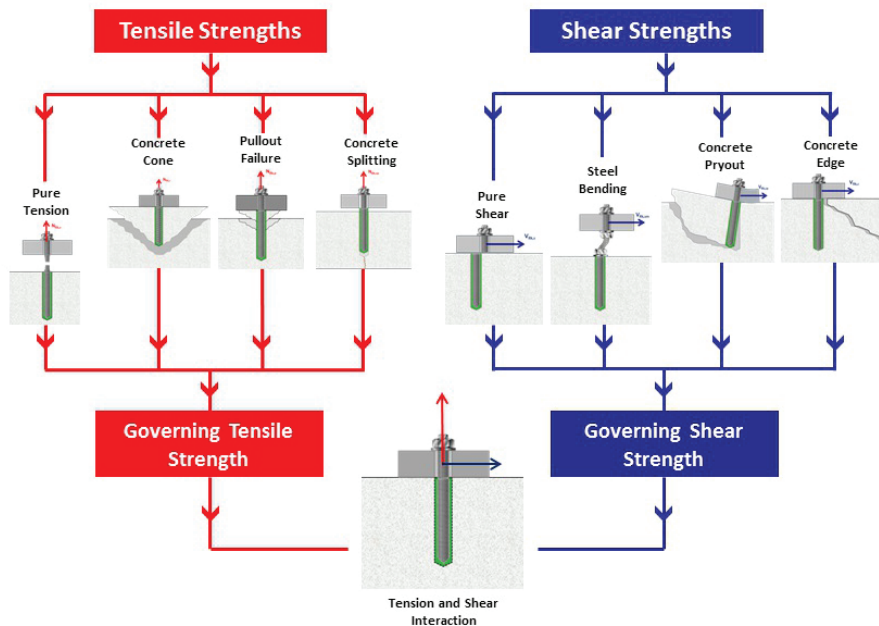
2. Steel Strength & Hardness – Driving a screw anchor into concrete requires significant torque application. Steel strength directly influences the ability of the screw anchor to resist potential torsional failure/warping as a result of the driving process. The higher the steel strength, the higher is its ability to resist any torsion related failure. The case and core hardness is equally important because the tapping process depends highly on the threads hardness/toughness. Concrete is very abrasive and can easily eat up the thread if it is not hard enough, as shown on the right. When the thread gets “eaten up”, the driving process becomes very hard and in most cases, does not drive-in at all. On the other side of the hardness spectrum, it cannot be too hard because of the possibility of the brittle chipping off of the thread during the driving process. This balance in material strength and hardness must be established in conjunction with the thread pitch and profile.



Concrete strength also plays a major role on the ease of screw anchor installation. The higher the concrete compressive strength, the higher the energy needed to tap the hole.

Load Bearing Performance

The load bearing performance qualification of post-installed anchors, including screw anchors, as contained in international standards like EOTA (European Organization of Technical Approvals) and ACI (American Concrete Institute) is illustrated below.



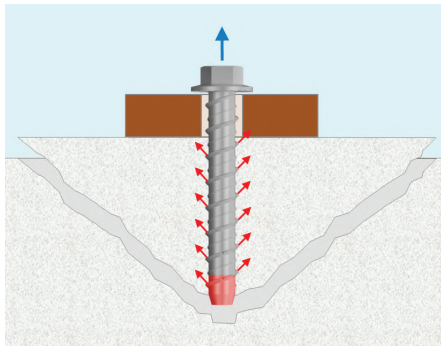
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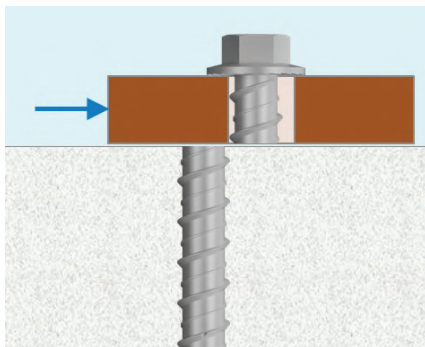
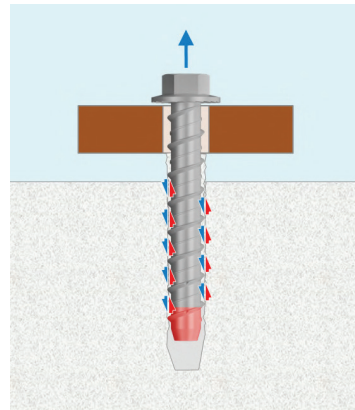
The “*qualified load bearing performance*” of the anchor is achieved by considering all the probable failure modes in steel and concrete. The critical failure mode becomes governing.

Steel Strength in Pure Tension– This is the tensile load resistance of the anchor material itself. This is where steel class/grade matters a lot. Strength classes 10.9, 12.9 and the likes are evaluated in detail. Indirectly incorporated here is the probability of thread stripping as well which is highly unlikely. The embedments and applications by which screw anchors are used usually result in concrete failure first before steel. Concrete cone failure and/or pullout failure occurs first before any steel yielding, even at Steel Strength Class 8.8.



Concrete Cone Strength – Cone strength is dictated by the compressive strength of the concrete and the effective embedment of the anchor. To make the concrete cone happen, the engagement of the thread to the concrete is of importance. If the steel material is good enough, then cone failure will happen first before thread stripping or shank failure, as shown on the left.

Pullout strength – pullout failure occurs when the concrete around the anchor shears off when load is applied. If the steel material is strong enough, concrete shearing off will happen first before thread stripping or shank failure. Worth noting is how thread pitch/profile affect the pullout strength of the anchor. A narrow pitch will mean that there is less concrete in between threads and if the thread profile is not well designed, the concrete’s brittle behavior during the screw installation process can lead to a significant drop in the anchor’s pullout performance.



Shear Steel Strength – Similar in principle to tensile steel strength, it is the shear load resistance of the anchor material itself. The strength class of the steel and effective cross sectional area decisive. Strength classes 10.9, 12.9 and the likes are evaluated in detail. Steel strength becomes most important in applications where the anchor is far from any concrete edge or steel failure in shear is the expected failure mode.

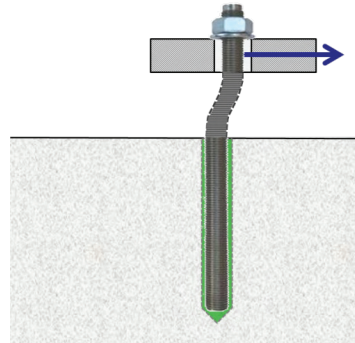
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Bending Strength – Although not often for screw anchor applications, shank bending occurs when the shear resistance offered by the concrete is not closely opposite the applied shear load. This may happen if the fixture is at a significant distance concrete surface (as shown on the right) or the material between the fixture and the concrete surface is relatively thick and “soft”. The bending strength is dependent on the diameter size of the screw anchor, its stiffness and the material strength of the anchor.

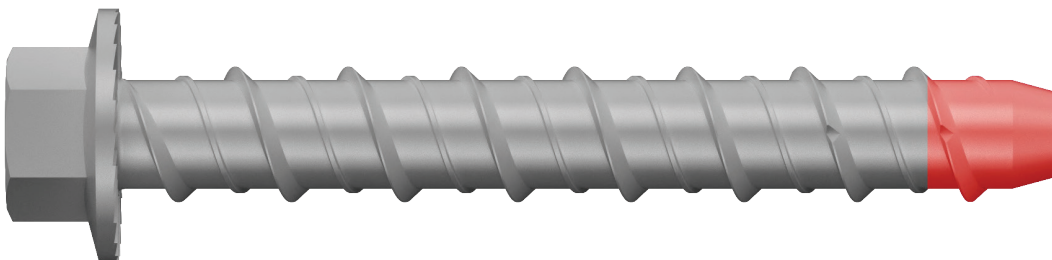


Concrete Edge Strength – For anchors near a concrete edge, failure occurs when the concrete resisting the shear load gives in. For this to happen, the material strength must be good enough to transfer the shear forces from the fastened material to the concrete.

Pryout Strength – Pryout usually happens when the embedded anchor is stiff enough to pry the concrete opposite the direction of shear load. This normally occurs when the anchor embedment is relatively shallow and stiff enough to cause the concrete to fail before it undergoes bending. In screw anchor applications today, more emphasis is given to the anchor’s qualified tensile performance.

XBolt® Development

In the **latest** XBolt®, careful attention was given to “ease of installation” and “load bearing performance”. The new design gives impressive ease in installation and once installed, delivers reliable load bearing performance.



Testing shows the reliable performance of the latest XBolt®. Pullout testing revealed that there is optimum thread engagement to concrete and that the engaged thread length was optimally utilized - thanks to the case hardened steel.



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Bolt Tension | Anti-Vibration | Product Reliability | Traceability

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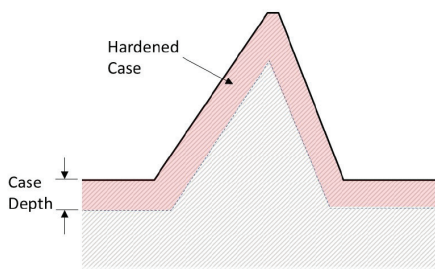
Material Specification

The latest XBolt® is made of high strength carbon steel that is hardened to ensure effective tapping of the concrete hole.

Material Class: C10B21

Ultimate Steel Strength: 1 200 N/mm²

To ensure that the XBolt® is hard enough on the outside to resist unwanted wear and strong enough to effectively transmit the loads to the concrete, the hardness of the XBolt® comes in two folds - **case hardness** and **core hardness**. The case hardness ensures that the XBolt® can handle the abrasiveness of the concrete without the thread chipping off and has a specified thickness or case depth at which it transitions to the specified core hardness, as shown in the thread cutout illustration below.

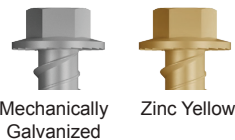


The core hardness, together with the rated steel strength gives the anchor the required ductility of the anchor connection.

XBolt®

Serrated flange head for better fixture grip.

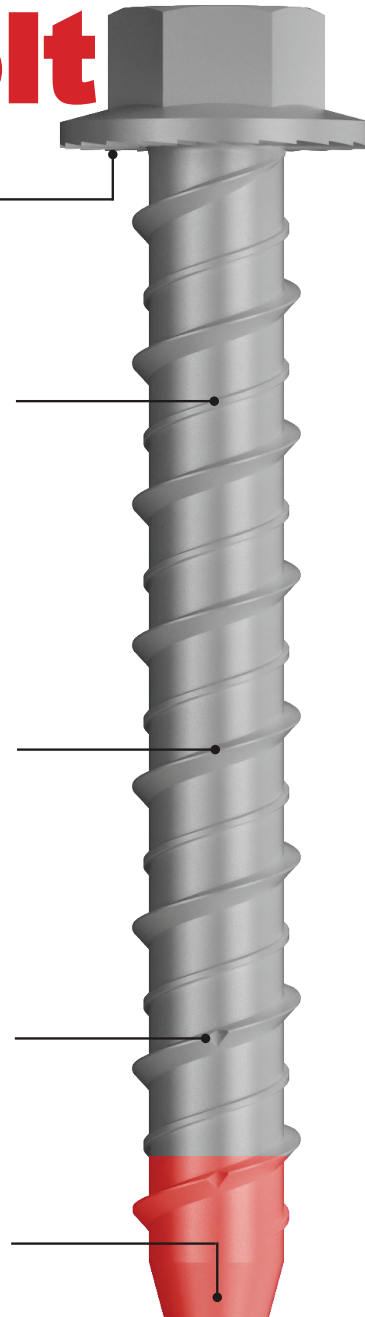
Heat treated carbon steel for secured concrete tapping



Optimized thread profile and pitch, for easy installation and reliable performance.

Thread indentations for better concrete tapping.

Tapered end for easier insertion to the hole.



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With the latest thread design thread design and its hardened steel body. The XBolt® is capable of reliably delivering optimum performance while being easy and quick to install.

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