



Reduced Loadability of Countersunk Socket Head Cap Screws

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Fasteners with reduced loadability have the material properties in accordance with an appropriate standard but are unable to achieve full tensile capacity due to geometry. Countersunk (Flat) Socket Head Cap Screws and Button Head Cap Screws have reduced loadability due to having a smaller stress area in the head than the stress area in the threads.

Standard bolts and screws are designed to yield and fail within the threaded part of the bolt shank. When these products are moderately overloaded the yielding and consequent extension of the fastener allows for the bending of steelwork before failure. Fasteners with reduced loadability fail within the head, meaning this yielding does not occur. Failures can be sudden and catastrophic. For this reason, these fasteners are not recommended for use in safety-critical connections where a standard cap screw should be used. Flat and button head socket screws are used for their aesthetic quality and not for critical loading.

Fasteners with reduced loadability can be identified by their head markings which are prefixed with a '0'. Experience teaches us that, in the Australian market, this is not always the case.

Marking symbols for fasteners with reduced loadability			
Property Class	8.8	10.9	12.9
Marking	08.8	010.9	012.9



Clamp Load, Bolt Strength and Fatigue

Clamp load is the tension that is induced in the bolt upon installation. For general engineering purposes this is typically between 60-80% of the bolt's yield strength. The design of bolted joints should ensure the applied (external) load does not exceed the total clamp load in the connection. Flat head socket screws have a tensile strength of 80% for the corresponding property class. This should be considered when using these products.

Tensile strength is not the only consideration. Flat and button head socket screws have a smaller internal drive than a standard socket head cap screw. This reduces the amount of torque that can be applied before either the drive bit breaks or the internal drive is damaged. Lower torque means a lower clamp load. For this reason, clamp load for flat and button head socket screws is recommended to be reduced to between 40-50% of the bolt's yield strength.

Hobson Engineering recommends tightening torques have a target bolt stress of 360MPa for PC 010.9 and 420MPa for 012.9; other suppliers should be using similar values. It is important for reduced bolt stress to be accounted for in the design as joints with applied loads that exceed this bolt stress will have a significantly reduced fatigue life.

The difference between clamp load and applied load is the most important consideration for fatigue life. If the higher clamp load of a stronger fastener is not utilised then a harder, more brittle fastener will experience the same cyclic loading. Cycles to failure may increase with higher strength materials but this delays the failure as opposed to avoiding it.

Hydrogen Embrittlement and Stress Corrosion Cracking

High strength bolts provide the benefit of higher clamp loads and stronger joints but bring with them the risks of bolt embrittlement (most commonly hydrogen embrittlement (H.E.)) and stress corrosion cracking. Property Class 10.9 products carry a low risk of hydrogen embrittlement as susceptibility is considered for materials with a hardness above 390HV. Property class 12.9 are much more prone to these issues. Even for applications where the applied load is small compared to the strength of the bolt, the environment and effects of corrosion should always be considered for all PC 12.9 products.

Australian Market

Most products on the market are not clearly defined as correct head markings are often omitted. Most socket screws with reduced loadability supplied to Europe (metric market) are now PC 010.9 and manufacturers are therefore producing larger quantities of these products. When buying cheap metric PC 12.9 flat head socket screws it is important to be aware of the true nature of the purchase, very likely a 010.9 product.

True PC 012.9 products will come at a premium. In most applications there is little benefit to using such a high strength product in place of a standard socket screw. When choosing bolting products, the strongest isn't always the most appropriate, especially in the case of countersunk socket heads. Before selecting a 12.9 or 012.9 product, consider whether the increase in strength is needed and the inherent risks associated with their use.

Case in Point

Hobson Engineering recently helped a customer who was experiencing issues with PC 012.9 flat socket heads in the automotive industry. The customer complained that bolts were failing after install, sometimes within hours. The first thought was that this must be a case of hydrogen embrittlement. However, the bolts failing were plain finish and had come from different factories.

Analysis of the failed bolts showed intergranular cracking, indicative of hydrogen embrittlement. However, extensive lab testing did not reveal H.E. from the product out of the box. All other mechanical properties of the socket screw were within the limits of the product standard.

It is difficult to provide a definitive answer on the cause of these failures, but bolt stress, environment and material grade all played a role. Despite this, a solution was found. Since changing the specification from PC 012.9 flat head socket screws to PC 010.9 no more failures have been reported.