

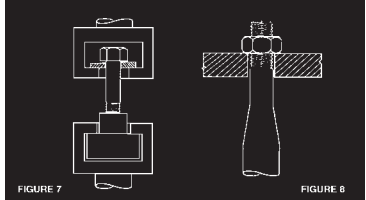
The normal tensile properties of metals; tensile strength, proof stress, 0.2% yield stress, elongation, reduction of area; are determined on machined test pieces. While these properties and testing methods can be applied to bolt materials, it is the usual practice to test bolts in their full size to more adequately reproduce the conditions under which they will be used in service.

This procedure of tensile testing bolts in their full size is recognised and adopted by many standardising bodies, including the International Organisation for Standardisation (ISO), British Standards Institution, Standards Association of Australia, American Society for Testing and Materials (ASTM) and Society of Automotive Engineers (SAE).

The bolt is screwed into a tapped attachment (Figure 7) with six full threads exposed between the face of the attachment and the unthreaded shank. The bolt head is initially supported on a parallel collar for the proof load test, and a tapered or wedge collar for the second stage when it is broken in tension.

In this test, the bolt load is calculated from the tensile strength of the material, and the Tensile Stress Area of the thread. The Tensile Stress Area is the area calculated from the mean of the minor and pitch diameters of the thread. Tensile Stress Areas for common sizes and thread forms will be found in Tables 5-11.

The test, as indicated above, is carried out in two stages:



**(1) Proof Load Test.** This consists of applying a proof load (derived from a “proof load” stress) with the bolt head supported on a parallel collar. The bolt length is measured accurately before and after application of the proof load. It is required that the bolt shall not have permanently extended. A 0.0005” or 12.5 micrometers allowance is made for errors of measurements. This test provides a guide to the load to which the bolt will behave elastically.

**(2) Wedge Tensile Test.** The bolt is assembled as described previously but with the head supported on a tapered wedge collar. The angle of the wedge is varied for bolt diameter and grade, and for bolts with short or no plain shank length, but in most cases for bolts up to 1” or 20mm diameter it is 10°. The bolt is loaded until it fractures, and the breaking load must be above the specified minimum. The load is calculated from the tensile strength of the material and the Tensile Stress Area of the thread.

The test requires that, in addition to meeting the specified minimum breaking load, fracture must occur in the thread or plain shank with no fracture of the head shank junction. The bolt head must, therefore, be capable of

conforming with the required wedge taper angle without fracturing at its junction with the shank. This latter requirement provides a very practical test for ductility.

Where the capacity of available testing equipment does not permit testing of bolts in full size, a hardness test is carried out. This is performed on a cross section through the bolt thread at a distance of 1 x diameter from the end.

### **(3) Proof Load Test for Nuts.**

The preferred method of testing nuts follows that of bolts in adoption of a test in full size to measure the load which the nut will carry without its thread stripping. This is also referred to as a Proof Load Test and it was traditional for the nut "Proof Load Stress" to be the same as the specified minimum tensile strength of the mating bolt. This "rule of thumb" still applies for products to the older standards such as BSW commercial and unified high

tensile precision nuts. Metric nuts to AS 1112 - 1980 were designed with greater knowledge of bolt/nut assembly behaviour to satisfy the functional requirement that they could be used to tighten (by torque), a mating bolt of the same strength class up to its actual (not specification minimum) yield stress without the assembly failing by thread stripping. To satisfy this design requirement both the thickness/diameter ratio and proof load stress were increased and now vary with diameter.

The nut is assembled on a hardened, threaded mandrel (Figure 8) and the proof load applied in an axial direction. The nut must withstand this load without failure by stripping or rupture, and be removable from the mandrel after the load is released.

Again, where nut proof loads exceed the capacity of available, it is usual to carry out hardness tests on the top or bottom face of the nut.