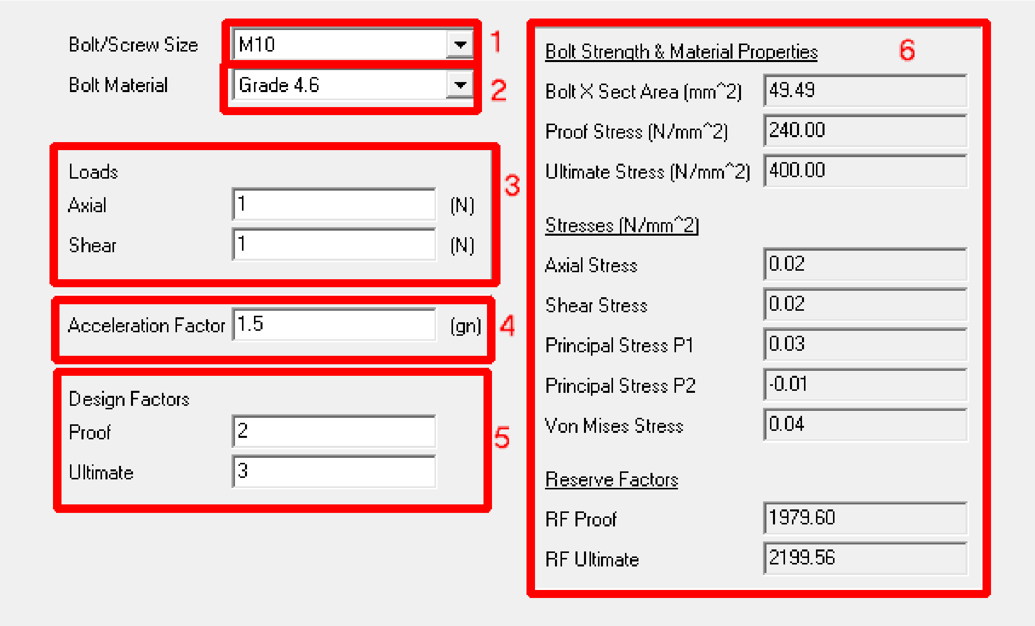
Help File for Bolt Stress Calculation Program.

This program is a simple calculator to allow you to easily work out if a bolt is overloaded. The order of operation is as below:



1. Select the bolt/screw size.
2. Select the bolt/screw material. If not known, assume Grade 4.6.
3. Input the axial and shear loads. This may be calculated using the Bolt Group analysis program.
4. Enter the acceleration factor in gravities.
   For statically loaded objects, 1.0 or 1.1 will probably be adequate.
   For light duty cycle items, 1.3.
   For medium duty cycle items, 1.5 may be appropriate.
   For heavy duty cycle items use 2.0.
   For lifting equipment, use 1.0.
   For Road/Rail/Sea Transport, use 2.0
   For Air Transport, use factors for the specific aircraft.
5. Enter the Design Factors.
   For most items, the Proof Factor should be 2.0, and Ultimate Factor 3.0.
   For items subject to wear and tear over a long life, Proof Factor should be 3.0, and Ultimate Factor 4.0
   For Lifting Equipment, the Proof Factor must be at least 4.0, and the Ultimate Factor must be at least 6.0.
6. As you change the data, the stresses and reserve factors will update. What you are aiming for is for both the RF Proof (Reserve Factor for permanent deformation) and RF Ultimate (Breaking Reserve Factor) to be at least 1.00. If either is less than 1.00, change the bolt diameter or material. The remaining stresses calculated are for stress reports where evidence needs to be given that the calculations are safe.
7. Pressing the 'Copy Calcs' button copies an image of the program window to clipboard. It's done this way to include all applicable information as one easy to handle image rather than lots of lines of text that may need individual formatting.

To increase the range of bolt sizes available to the program, edit 'BoltData.csv' in the program directory with a text editor. The format is given in the first line of the file.

To increase the range of bolt materials available to the program, edit 'BoltMaterial.csv' in the program directory with a text editor. The format is given in the first line of the file.

Sometimes, after editing, there may be a problem with first bolt size/material name being strange. This is due to the text editor not saving the .csv file in ‘UTF8’ format. If you could find a way of saving it in that format, please do so.

Background Information

The supplied data for the M series bolts & screws (M4 to M36) is based on the minimum minor diameter of Medium Fit (6H/6g) Coarse Screws & Bolts to BS 3692. This is slightly pessimistic (between 10% & 21% depending on thread size), as BS 3692 gives a stress area that includes a contribution from the peak of the thread at any slice through the screw. The pessimism of the area is a hidden additional margin of safety. If you need to use it, it’s probably better to use a larger diameter bolt.

The supplied material data is based on the method of naming materials for carbon steel bolts (grade 4.6 = 400 N/mm^2 minimum failure strength (f_{tu}), Yield Stress (f_{ty}) = 60% f_{tu} = 240 N/mm^2). For stainless steel bolts, the material strength is the minimum permitted strength from BS 6105.

Note: The calculations assume standard strength nut engagement and do not take into account stripping of threads in the socket or bolt through very small amounts of engagement or large disparities between socket and bolt strength. If you are going to do something unusual, there’s probably a good reason why it’s not often done, please analyse the particular case properly.

The calculations have been verified as being the commonly used ones by two stress engineers (the program author and one other), and the results have been verified by checking 10 existing analyses where hand calculations were used to derive the initial results. All stresses and reserve factors were found to be identical.

The calculation formulae are:

$$\text{Axial Stress } (\sigma_{axial}) = \frac{\text{Axial Force}}{\text{Cross Sectional Area}}$$

$$\text{Shear Stress } (\tau) = \frac{\text{Shear Force}}{\text{Cross Sectional Area}}$$

$$\text{P1 Principal Stress} = \sigma_{axial}/2 + \sqrt{((\sigma_{axial}/2)^2 + \tau^2)}$$

$$\text{P2 Principal Stress} = \sigma_{axial}/2 - \sqrt{((\sigma_{axial}/2)^2 + \tau^2)}$$

$$\text{Von Mises Stress } (\sigma_{vm}) = \sqrt{(P1^2 + P2^2 - P1 * P2)}$$

$$\text{RF Proof} = \frac{f_{ty}}{\sigma_{vm} \text{ x Accn Factor x Proof Design Factor}}$$

$$\text{RF Ultimate} = \frac{f_{tu}}{\sigma_{vm} \text{ x Accn Factor x Ultimate Design Factor}}$$

If you need the ‘Safety Margin’, then it is simply calculated as:

Safety Margin, Proof = RF Proof – 1.00

Safety Margin, Ultimate = RF Ultimate – 1.00