Darbury Lifting Lug Program

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Lifting Lug Calculator

Version 2.0.1.2
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Installation Procedure

Please consult the “Darbury Installation Document” for the procedure to install the Lifting Lug program from the Darbury Consulting website on to the local machine’s hard disc.

Note: Please uninstall any previous release of this program before installing the latest version. This can be achieved by using the “Start > Control Panel” function within Windows.

Darbury Lifting Lug Program

This program calculates the stresses on steel lifting lugs side lifting lugs & lifting eyes when a known load is put upon them. The user enters the physical dimensions of the lug, the material it is made from & the method of lifting, then the program calculates whether the lug dimensions entered are within the safe limits of the material selected. The program prints off the calculations, including the equations from 1st principles, for professional engineer approval on a project. The program has been written to be as simplistic to the user as possible, requiring minimal typing to perform the calculation.

Input Requirements

To use the program, the following input data must be available:

1. Which type of lifting device is to be calculated.
2. The method of lifting the overall package or unit.
3. The physical dimensions of the lifting lug being calculated.
4. The load exerted on the lug, the shackle pin size & the method of lifting.
5. The method of connection to the baseframe, whether fully welded or bolted. (Note: This version is a welded connection type only).
6. The material used in the construction of the lug / eye.
7. The safety factor to be used for the calculations.

Program Limitations

At the current revision, the following details some of the current limitations & the areas to be addressed in future revisions of the program:

- Units are SI Metric at this release of the program; i.e. length = mm, weight = kg
- The current version of the program does not calculate the stress on a bolted lifting lug connection type. Future versions of the program will calculate the following:
  - Maximum shear load on the bolts due to the moment
  - Maximum shear load on the bolts due to direct force
  - Total shear load per bolt
Program Revision History

<table>
<thead>
<tr>
<th>Version</th>
<th>Date</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>V1.0</td>
<td>January 2010</td>
<td>Initial release of the program</td>
</tr>
<tr>
<td>V2.0</td>
<td>December 2010</td>
<td>Added the following items:</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- The “Lug Type” screen</td>
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<tr>
<td></td>
<td></td>
<td>- The “Material” screen</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- More materials to select from.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Ability to add materials not in the pre-defined selection list.</td>
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<tr>
<td></td>
<td></td>
<td>- Ability to select either Yield or Ultimate stress of the material for the</td>
</tr>
<tr>
<td></td>
<td></td>
<td>safety factor calculations.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Welded side lifting lugs</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Welded lifting eyes</td>
</tr>
</tbody>
</table>
How to Use the Program

When the program is first run, a splash screen will be shown to confirm the current version. The user does not do anything at this time, but after a few seconds, the screen will change to the license screen. This screen will show the user what the current state of the license for this particular machine is; either not licensed, in a trial period or a permanent license. Please refer to the “Darbury Installation Document” for the method of changing the current license state. The main screen for the program is as follows:

The program uses a multiple tab control which means that to progress through the lifting lug calculation application, the user must select the relevant tab at the top of the control to select the individual pages. If the machine has not been licensed, then the remaining tabs are inaccessible to the user. Only by having a valid license, whether a trial or a permanent license, can the calculations be run & printed. If a license has been granted for the v1.0 release of this program, a new license file will need to be requested. Please follow the information & directions contained within the document, “Darbury Installation Document” to be found on the Darbury website.
The “Lug Type” Tab

The first tab that needs to be completed is the “Lug Type” tab; when it is selected it is as shown below:

It is here that the user selects the type of lug to be calculated. The types are as follows:

- Vertical Lifting Lug: This is a welded lug that is normally found on the outside of packaged units or baseframes.
- Side Lifting Lug: This is a welded lug that is also found on the exterior of a packaged unit or a baseframe, but is normally perpendicular to the frame.
- Lifting Eye: This is a welded eye that is connected to the top of a vessel, cylinder or component.

The user can either select the pictorial representation of the relevant type, or can select the radio buttons under the pictures. As the user selects the type required, the program then changes the remaining tabs to reflect the individual dimensions & attributes each type contains.
Note: At this version, only welded lugs / eyes are available. In a future release, the bolted connection options will be available.

The “Lifting Case” Tab

Next, the “Lifting Case” tab is selected to determine the lifting method of the entire package.

The user will select the lifting method that best describes the reality of how the complete package will be lifted. A description of the individual lifting methods is as follows:

- **Lift Case 1** – This is where either spreader beams are selected to ensure that as near vertical forces are imposed on the lugs / eyes during the lift, or where the forces are parallel to the outside of the packaged unit or baseframe producing only vertical forces during the lift.
- **Lift Case 2** – The 2-point lift produces forces that give bending moments on the lugs / eyes.
- **Lift Case 3** – The worst case scenario in which a single point lift gives bending moments on the lugs / eyes in multiple planes.
If the user is unsure of the lifting method to be used in the field, it is suggested that the “Lifting Case 3” be selected as this is the worst case scenario for lifting.

The “Material” Tab

The “Material” tab is selected next.

![Material Tab Image]

It is here that the user selects one of the pre-determined steel materials for the construction of the lug /eye or inserts the attributes for a new material definition. To use one of the pre-determined materials, the user selects the required item from the drop-down combo box. As the selection changes, the relevant attributes are changed in the “Tensile Strength” boxes on the right-hand side. The user then determines what safety factor is to be used for the calculations & also selects whether the safety factor is to be used against the 70% Yield or the Ultimate tensile strength of the selected material.
The pre-defined materials are:

- ASTM A36 Mild Steel
- ASTM A572-42 High Strength Low Alloy Steel
- ASTM A572-50 High Strength Low Alloy Steel
- ASTM A588 Corrosion Resistant High Strength Low Allow Steel
- BS-EN-S235JR Grade 40 Steel
- BS-EN-S275 Grade 43 Steel
- BS-EN-S355 Grade 50 Steel

Should the list of materials not contain the specific grade or type of steel required, (maybe another country’s standard, for example), then the user will complete the “Other” box with a description of the material that they would like to see on the printed calculation page. Next, the appropriate value for either the Yield or the Ultimate tensile strength of that material needs to be added to the boxes under the appropriate attribute & select a safety factor to be applied in the calculations as normal.

The “Dimensions” Tab

This tab is where the user will type in the relevant dimensions required to describe the exact lifting lug.
The user will insert the dimensions relevant to the calculation. The “Lifting Shakle” is important to select as this is the size of the shakle that will perform the lift in real life. If in doubt, the size to select is the next available shakle diameter larger than the lift weight.

**The “Calculations” Tab**

Once all the lifting conditions & dimensions have been inputted, the user will select the “Calculations” tab to process all the information. When first selected, the tab layout will show the following:
Press the “Calculate Lifting Lug Design Values” button & the program will go through the input data to ensure that it has enough information to complete the calculation. If there is anything missing or the user has not filled in the relevant text boxes, the program will advise that it cannot complete the process.

When the program has determined that the input information is sufficient, the program will calculate the stresses involved & show the relevant sections as below:
The results are shown graphically as a tick mark for the areas that are acceptable to the design conditions & the safe working limit, or as a cross where the calculation is outside the safe limit. From here, the user can print the calculations to the default printer. When the “Print Data” is pressed, the information at the top of the printed page can be changed. See the tutorial for more information.
Sample Tutorial

The centre of gravity on a packaged unit has been calculated & subsequently, each of the loads on the 3 lifting eyes has been determined. The unit has been calculated to have a maximum load on any one of the lifting eyes to 3500kg. The lift has been assumed to be case 3 as no other information is available at this time & this gives the worse case scenario.

*Note: the program calculates a single lifting lug / eye, not multiples contained on the packaged unit, baseframe or item.*

1. Start the program & select “Lifting Eye” from the “Lug Type” tab.
2. Select “Lifting Case 3” from the “Lifting Case” tab.
3. Select “ASTM A572-42 High Strength Low Alloy Steel” from the “Material” tab, choose the “Yield” option for tensile strength & leave the safety factor as “2”.
4. Next, select the “Dimensions” tab.
5. Add the information as per the table below:

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1 - Load imposed on a single lifting lug</td>
<td>3500</td>
<td>kg</td>
</tr>
<tr>
<td>R – Radius of the lug</td>
<td>50</td>
<td>mm</td>
</tr>
<tr>
<td>D – Diameter of the lifting lug hole</td>
<td>25</td>
<td>mm</td>
</tr>
<tr>
<td>T – Thickness of the lug</td>
<td>10</td>
<td>mm</td>
</tr>
<tr>
<td>Ø - Angle of the lift from the lug to the hoist</td>
<td>45</td>
<td>mm</td>
</tr>
<tr>
<td>f – Height of the lug above the steel frame</td>
<td>100</td>
<td>mm</td>
</tr>
<tr>
<td>Lifting Shakle SWL</td>
<td>4750</td>
<td>kg</td>
</tr>
</tbody>
</table>

6. Select the “Calculations” tab & press the “Calculate Lifting Lug Design Values” to perform the calculations.
7. As can be seen, the bearing stress & the bending stress have failed because the safety factor value against that material’s yield tensile strength has been exceeded.
8. To correct this, the lifting eye needs to be made from thicker material to allow for the bending moments that the lifting case will produce. To change the thickness, go back to the “Dimensions” tab & modify the “Thickness” value to be “20”.

![Darbury Lifting Lug Calculator](image)
9. Re-run the calculation & we will see whether the increased thickness in the lifting eye now conforms to the tensile strength of the material against the safety factor we have chosen.
10. As can be seen from the image above, the calculated stresses & moments are now within the safety limit we have set for this type of material.
11. Press the “Print Data” button & change the text boxes to include the contract details:
12. Press the “Print” button to send the calculation to the default printer.
13. The following shows the printed page of the end calculation:
Disclaimer

Whilst Darbury Consulting Ltd. has checked the operation & the results of the calculations within this program, it can accept no liability whatsoever for the incorrect use of the data. As with every engineering calculation program, it is the responsibility of the company using the routine to have the input data, the calculations & the result verified & approved for use by a professional engineer. Darbury has ensured that the printed results from this program are clear & have the first principle engineering calculations contained on the page making it even more efficient for the approval process to be followed. There is an approved box, a date box & a revision section on the printed page to ensure the calculations are as useful to a professional engineer as possible.