



Darbury COG – Centre of Gravity Program

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Darbury Consulting Ltd.
www.darbury.com

COG - Centre of Gravity Calculations

Version 1.1.4.0

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Installation Procedure

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

Darbury COG – Centre of Gravity Program

This program allows for the calculation of the 3D centre of gravity of simple point loads on either a baseframe or a contained area. It was written from a need to being able to calculate the centre of gravity on a baseframe refrigeration package so that the correct loading on the lifting lugs could be worked out & proved was safe for transportation. The program is written with a simple interface & gives a pictorial representation of the input data. The program will allow for a printed page to show the calculation for professional engineer approval on a project.

Input Requirements

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

1. The baseframe size or the containment area to be calculated
2. The number of point loads, their weight & the positional coordinates (XYZ) relative to the origin point of the baseframe (the lower-left baseframe vertex)

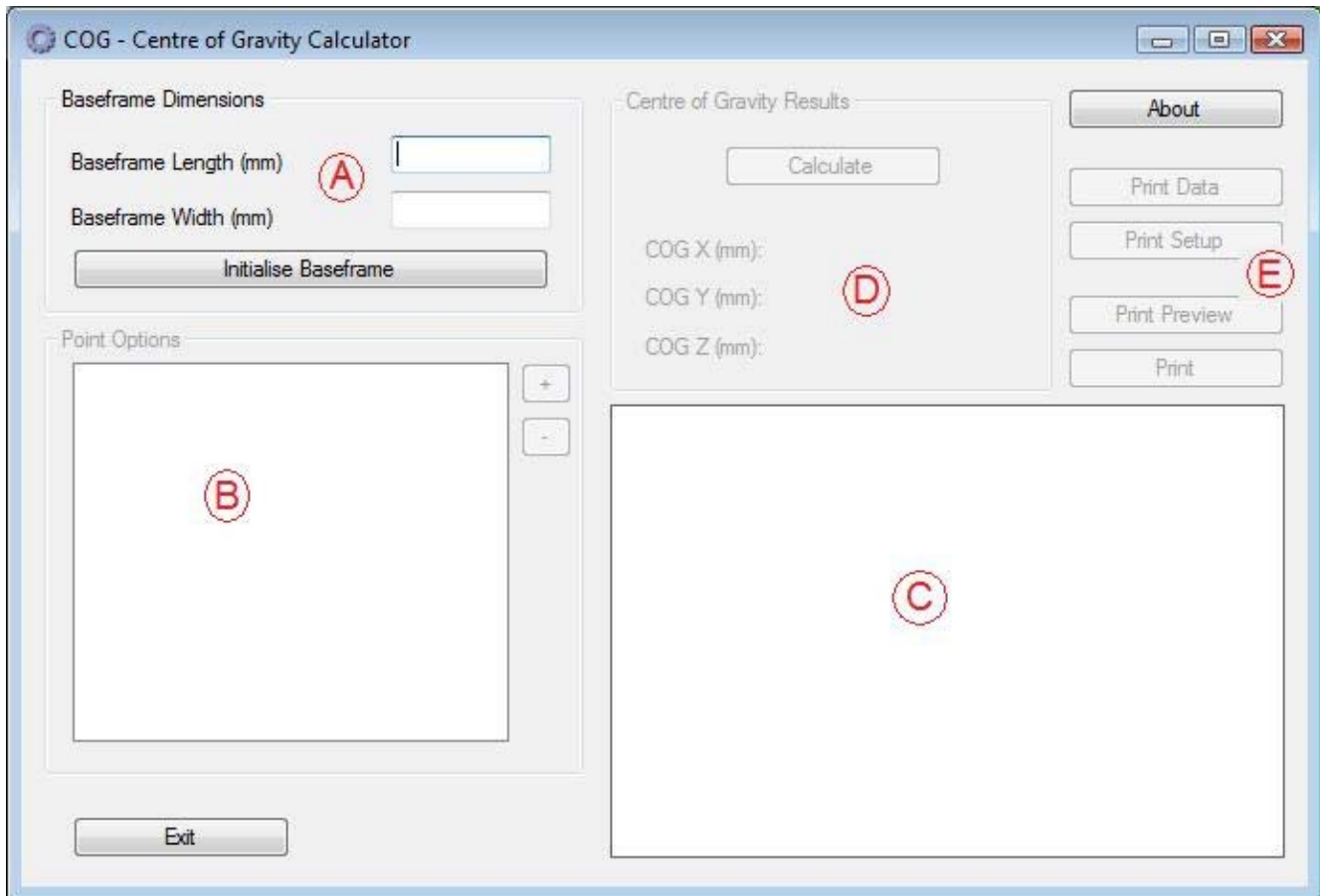
Program Limitations

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

- Units are SI Metric; i.e. length = mm, weight = kg
- The baseframe itself is not taken in to consideration. Some baseframes are not uniform in their fabrication & can offer slight changes to the overall centre of gravity calculation
- The Darbury logo cannot be changed on the printed page

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 disappear & the main screen will be shown. The main screen is divided in to separate sections:



- A = The baseframe size input area & where the graphics box is initialised
- B = The point load input list
- C = The graphics area representing the current input data
- D = The calculation button & results
- E = The printed page area

Section A

The user will input the baseframe length & width values in the boxes provided & press the "Initialise Baseframe" button. This button then tells the program to firstly draw the rectangle representing the size on the graphics box (section C) & sets up the limits of the point load inputs. This means that if a user enters a distance value for X or Y of the each point load from the bottom left-hand corner of the baseframe, the program will verify that the point actually lies within the baseframe boundary.

Section B

Once a baseframe size has been initialised, the user then adds the point loads in to the system. Press the "+" button to show the "Point Information" dialog screen for inputting the information relative to the origin of the baseframe (the bottom left-hand corner).



Point Information

Point: 1

Load: 1000 kg

X: 1000 mm

Y: 1000 mm

Z: 1000 mm

Add Point Cancel

Once the desired values have been input, press the “Add Point” to return back to the main screen with the new point load added to the list. Press “Cancel” to return without saving the new point load.

Once on the main screen & various point loads have been entered, anyone can be removed from the list by selecting the relevant point load entry & then using the “-” button to remove it from the list altogether.

Section C

This part of the main screen is where a graphical representation of the baseframe & the point load positions will be drawn. There are no functions for the user to click on this part of the screen; it is purely a graphical representation of the current data.

Section D

Once a minimum of 1 point load has been added to the program, the “Calculate” button will be shown to the user. When this button is clicked, the program will work out the 3D centre of gravity, display an approximate position on the image on the screen in section C & will show the accurate X, Y & Z values in the text boxes below the button.

Section E

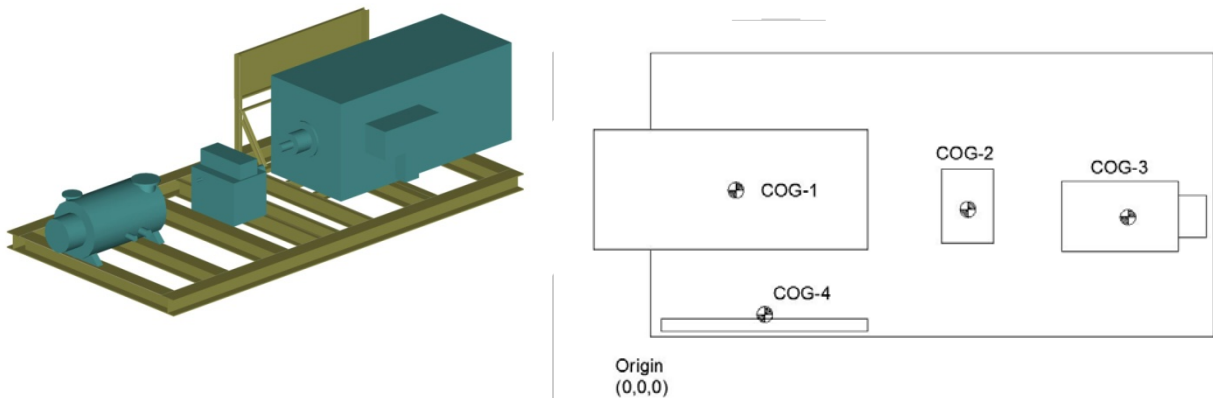
Once a valid calculation has been performed, the print buttons will then display for the user. Below is a description of each of the button’s functions:

- “Print Data” – this button allows the user to change some of the data on the printed sheet. Once pushed, a new dialog box will appear for user defined text strings that need to be printed.
- “Print Setup” – this button shows the standard Microsoft setup dialog box.
- “Print Preview” – allows for the standard Microsoft preview screen to be displayed, including zoom functions to see the page before it is sent to the printer.
- “Print” – prints the current calculation data to the default printer.



Sample Tutorial

The following describes a compressor packaged unit on a baseframe that needs to be lifted by a crane half-way through construction. The construction program demands that the major pieces of equipment are placed on the frame, then for it to be lifted to the pipe fabrication shop for the piping, instrumentation, electrical & controls to be added at a later date. The project manager needs to identify the position of the centre of gravity for this mid-build lift so that he can ensure the overhead crane already in-situ is safe for the job.



The input data is as follows for the sample baseframe above:

Item	Description	Weight (kg)	X (mm)	Y (mm)	Z (mm)
Baseframe			6500	3275	
COG-1	Motor	9500	1250	1700	750
COG-2	Gear box	750	3850	1600	400
COG-3	Compressor	2250	4800	1100	400
COG-4	Gauge board	50	1250	200	1500

The following is the complete procedure to calculate the centre of gravity for this example, with screen shots inserted to show what it should look like:

1. Start the program, from either "Start > All Programs > Darbury Consulting > COG" or from the desktop icon.
2. Enter the baseframe dimensions in section A, as outlined above, so that the length is 6500 & the width is 3275.
3. Press the "Initialise Baseframe" button to accept the dimensions & to prepare the graphics section C.
4. Press the "+" button in section B to add the first point load.



5. Add the number "1" in the "Point" text box, "9500" in the "Load", "1250" in the "X", "1700" in the "Y" & "750" in the "Z". The data should look like the following image:

Point Information

Point: 1

Load: 9500 kg

X: 1250 mm

Y: 1700 mm

Z: 750 mm

Add Point Cancel

6. Press the "Add Point" to accept the new point load.
7. Repeat for each of the remaining points as listed in the table above by using the "+" to eadd each load in turn.
8. Once completed, press the "Calculate" button in section D.
9. The completed calculation should look identical to the following image:

COG - Centre of Gravity Calculator

Baseframe Dimensions

Baseframe Length (mm): 6500

Baseframe Width (mm): 3275

Initialise Baseframe

Point Options

PT1 : L9500 : X1250 : Y1700 : Z750
PT2 : L750 : X3850 : Y1600 : Z400
PT3 : L2250 : X4800 : Y1100 : Z400
PT4 : L50 : X1250 : Y200 : Z1500

Centre of Gravity Results

Calculate

COG X (mm): 2041.83

COG Y (mm): 1580.48

COG Z (mm): 669.32

About

Print Data

Print Setup

Print Preview

Print

Exit

Diagram showing points PT1, PT2, PT3, PT4 and the Centre of Gravity (COG) relative to a baseframe.



10. Press the "Print" button & the following page should be sent to your default printer:

Centre of Gravity Calculations v1.1 <small>Written by Dave Bradbury, Darbury Consulting Ltd. (c) 2010 All rights reserved.</small>		Darbury Consulting Ltd. <small>http://www.darbury.com/products/cog.html</small>																										
Contract: Sample Tutorial		Rev:	Approved:																									
		Date:																										
<p><u>Calculation Inputs</u></p> <table border="1" style="width: 100%; border-collapse: collapse; text-align: center;"> <thead> <tr> <th style="padding: 5px;">Point No.</th> <th style="padding: 5px;">Load (kg)</th> <th style="padding: 5px;">X (mm)</th> <th style="padding: 5px;">Y (mm)</th> <th style="padding: 5px;">Z (mm)</th> </tr> </thead> <tbody> <tr> <td style="padding: 5px;">PT1</td> <td style="padding: 5px;">9500</td> <td style="padding: 5px;">1250</td> <td style="padding: 5px;">1700</td> <td style="padding: 5px;">750</td> </tr> <tr> <td style="padding: 5px;">PT2</td> <td style="padding: 5px;">750</td> <td style="padding: 5px;">3850</td> <td style="padding: 5px;">1600</td> <td style="padding: 5px;">400</td> </tr> <tr> <td style="padding: 5px;">PT3</td> <td style="padding: 5px;">2250</td> <td style="padding: 5px;">4800</td> <td style="padding: 5px;">1100</td> <td style="padding: 5px;">400</td> </tr> <tr> <td style="padding: 5px;">PT4</td> <td style="padding: 5px;">50</td> <td style="padding: 5px;">1250</td> <td style="padding: 5px;">200</td> <td style="padding: 5px;">1500</td> </tr> </tbody> </table> <p style="margin-top: 10px;">All dimensions are from the baseframe origin, the bottom-left hand corner</p> <p style="margin-top: 20px;"><u>Baseframe Dimension Inputs</u></p> <p>Baseframe Length - 6500 mm Baseframe Width - 3275 mm</p> <p style="margin-top: 10px;"><u>Calculation Results</u></p> <p>COG X - 2041.83 mm COG Y - 1580.48 mm COG Z - 669.32 mm</p> <p style="font-size: small;">NOTE: Centre of Gravity (COG) calculated on point loads only; i.e. the baseframe is not considered.</p>				Point No.	Load (kg)	X (mm)	Y (mm)	Z (mm)	PT1	9500	1250	1700	750	PT2	750	3850	1600	400	PT3	2250	4800	1100	400	PT4	50	1250	200	1500
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<p style="text-align: center;"><u>Calculation Dimensions</u></p>		<p style="text-align: center;"><u>Calculation Principles</u></p> $\text{COG X} = \frac{(P1 * X1) + (P2 * X2) + (P3 * X3)}{P1 + P2 + P3}$ $\text{COG Y} = \frac{(P1 * Y1) + (P2 * Y2) + (P3 * Y3)}{P1 + P2 + P3}$ $\text{COG Z} = \frac{(P1 * Z1) + (P2 * Z2) + (P3 * Z3)}{P1 + P2 + P3}$ <p style="font-size: x-small;">Where: P1 = Point Load 1, P2 = Point Load 2, P3 = Point Load 3, etc</p>																										

Disclaimer: As with any engineering software, all calculations should be verified & signed off by a Professional Engineer as fit for use. Darbury Consulting Ltd. accepts no liability for these calculations should they not be approved & signed by a Professional Engineer.



Calculation Principles

The calculation principles are listed below & are located on the printed output from the program.

For the 4 point calculation as per the tutorial above:

$$\text{COG about X} = ((P1 * X1) + (P2 * X2) + (P3 * X3) + (P4 * X4)) / (P1 + P2 + P3 + P4)$$

$$\text{COG about Y} = ((P1 * Y1) + (P2 * Y2) + (P3 * Y3) + (P4 * Y4)) / (P1 + P2 + P3 + P4)$$

$$\text{COG about Z} = ((P1 * Z1) + (P2 * Z2) + (P3 * Z3) + (P4 * Z4)) / (P1 + P2 + P3 + P4)$$

Where:

P1 = Point Load 1 (kg)

P2 = Point Load 2 (kg)

X1 = X dimension from origin (0,0,0) for Point Load 1

Y2 = Y dimension from origin (0,0,0) for Point Load 2

Z3 = Z dimension from origin (0,0,0) for Point Load 3

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.