SINbeam design software

Please be patient as the software opens.

Users are invited to accept the terms of use. Acceptance is required for te software to open.

General use

The software is launched automatically by opening the Excel file. After use, the software may be re-launched by using the command button, or Ctrl+k.

As the SINbeam software opens, all other Excel workbooks are closed, to avoid conflict. The software and intermediate input screens are closed using the appropriate button – use of the red "x" is generally disabled.

Beam data may be saved as a .sinb file. Existing designs may be loaded. Only the input data is saved, not the analysis or results.

As a beam design is progressed from new, additional tabs become visible.

Overview

Generally the beam is assessed at intervals of 1/100 span. Bending moments and shears are calculated at these intervals to plot the results.

Deflections are calculated at 1/10 span intervals, by a process of product integration of the actual bending moment diagram with the bending moment diagram for a unit load at the point of interest. The inertia at that location (every 1/100 span) is used in the calculation to account for tapered beams.

Shear deflection is also determined by considering every 1/100 of the span.

Design verification follows BS EN 1993-1-5. In contrast to the Zeman guidance, this program also assesses the flanges for shear lag, in accordance with BS EN 1993-1-5.

Flanges are verified between points of restraint – which may be independently specified for each flange. The web is verified for global and (optionally) local buckling.

Clicking "next", "calculate" or "done" as appropriate is recommended, as this triggers updates and calculation routines.

File saving and loading from file

Files may be saved – with an automatic .sinb file extension. There is no need to save after each page. For the first save, a name will be needed; for subsequent saves, the file is overwritten. "Save as" may be used to save with a different name.

The current file path and name is shown at the bottom left of the screen.

C:\Users\dgb\Desktop\Sinbeam files\example23.sinb
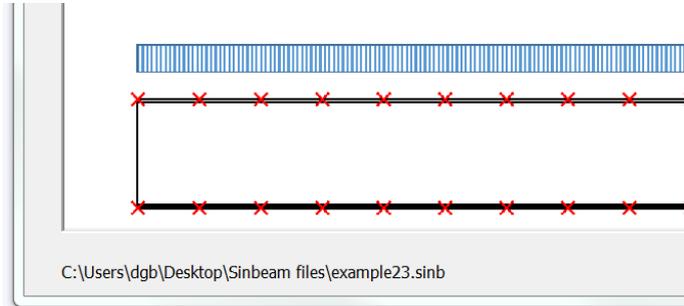
General details

The data input here will appear in the output (not the notes)

Localisation

UK, Irish or any user-defined values can be selected. If user-defined values are selected, they will be reported in the output. User-defined values may be changed. The initial set of user-defined values
are the core Eurocode values. The user may define any values, within the user-defined values – there are no limitations.

According to the Irish NA to EN 1993-1-1, steel strengths may be taken from Table 3.1 or the product Standard. For Ireland, the strengths from Table 3.1 have been implemented in the software (no reduction in strength at 16 mm).

If expression 6.10a and 6.10b are selected, the psi value defaults to 0.7, though other values may be selected. The psi value is applied to <u>every</u> type of variable load, as the program does not know what type of variable load has been input, merely that it is a variable action.

If psi is set to 1.0, expression 6.10a will govern.

Defaults

On opening the software, certain defaults are set, which may be changed. The defaults include choices on the localisation pane and an initial beam geometry.

Beam

The section will re-draw after any of the drop down boxes are updated (and de-selected) or the "refresh" button is clicked.

Note that shortening the span after loads and restraints have been entered will cause problems, so changing the span during a beam design should be avoided.
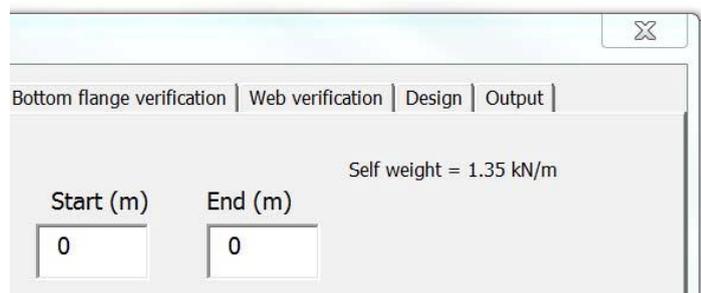
Loading

Loads may be input as characteristic loads, or ultimate loads. No further factors are applied

to ultimate loads.

Loads may be UDL, partial UDL, point loads, end moments and an axial force.

The indicative graphics update when "calculate" is clicked and are scaled horizontally. The graphics show point loads, end moments and axial loads in the same way, with no discrimination between positive and negative values – simply that a load is applied.

Note that the self weight is calculated and reported on this screen. This self weight is included in the permanent actions.

Bottom flange verification	Web verification	Design	Output

Self weight = 1.35 kN/m

Start (m)	End (m)
0	0

Analysis results

A selection of bending moment, shear force or deflection is made from the drop down. If changes are made to the loading, say, clicking "refresh" is necessary to renew the graphics (or selecting a different graphic and returning).

The deflection graphic shows the deflection limit previously entered.

Variable load deflection (SLS) or unfactored total load deflection can be displayed. Whichever deflection graphic is currently displayed will appear in the output, but not both. In the output, all deflections are reported – but only the current graphic is presented.

If "ultimate loads" had been selected on the previous screen, the deflections are shown for these ultimate loads. These deflections would not normally be used, as they are not SLS.

Restraints

Restraints may be added, moved or deleted from both flanges, or fully restrained selected, which removes all intermediate restraints.

Clicking "done" is recommended, which will update the graphics and run other routines.

Flange verification

The same verifications are used for both flanges. Under conventional "gravity" loading, the effect of an axial force and end moments mean that either flange force in a particular position along the beam may be tension or compression.

The flanges are verified between restraints. The most onerous utilisation is reported at the top of

the screen, and the initial design data displayed is for the most onerous segment, not (for example) the first segment. Data for other segments can viewed by selecting the row in the table and clicking "display detail".

Each segment is assessed to determine if the segment is in compression, or tension, or if both compression and tension exist within the segment length.

Segments wholly in compression

For each segment, the bending moment at the end of the segment and at ¼ points within the segment is calculated, so that the C_1 factor and the k_c factor may be calculated. The expression for non-linear bending moment diagrams provided in *New Steel Construction* of Nov/Dec 2013 is used to calculate C_1.

The resistance of the flange is calculated in accordance with clause 6.3.2.4 of EN 1993-1-1. The axial load in a flange is calculated in proportion to the flange area, assuming all the axial load is carried in the flanges.

Segments wholly in tension

The resistance is based on the effective area (if relevant) and design strength

Segments partially in tension and partially in compression

The resistance of the segment assuming the maximum compression is applied over the whole length of the segment is calculated. The resistance of the segment in tension is also calculated. The utilisation for each situation is calculated, and the most onerous reported.

This approach can be conservative if compression is only present over a short length of the segment, so the software reports the position where compression becomes tension, and invites the user to provide a restraint at that point. This will have the effect of constraining the compression to a shorter segment length.

Web verification

The web is verified in accordance with EN 1993-1-5 Anned D. Local buckling may be included or not. SCI recommend that it is included, unless there is compelling evidence otherwise.

Note the shear verification is carried out at points equal to 1/100 of the span. The first and last points are at 1/100 and 99/100 of the span. At the ends, there will be stiffening from the end connections, so this is reasonable. The shear reaction at the ends of the beam is reported in the output.

Design

The web and both flanges may be designed, starting at the lowest weight possible. The web depth is not varied. Once a satisfactory solution is found, the routine ends and reports the solution.

If no satisfactory solution is found, the user is invited to change the beam design (a deeper section,

or additional restraints, or increased steel strength).

The width of the flanges may be fixed, to force one or both flanges to be identical to the other, even if it is not an optimised design for weight.

"Recheck all" simply runs through the three design routines so may be used to design each element with one click.

There may be a small jump in the utilisation values, especially if the flange sizes have changed from the initial design. This is because the axial load is shared in proportion to the flange areas – so the initial checks assume the "original" flange areas, and the designed values may be different, meaning a slightly different distribution of force.

Clicking "recheck all" again should stabilise the values.

The individual tabs (beam, flanges and web) should have the updated dimensions and verification results, if the "design" routines have identified a satisfactory solution.

Properties

Beam properties are calculated once the beam dimensions have been input and "next" clicked. Running any of the "design" routines updates the properties.

The web is not included in the calculated properties of inertia, radius of gyration or cross sectional area.

Output

Two output reports are provided – beam properties and a design report. Once the user exits to the output, the software is no longer running, but may be re-launched. It is recommended that users save the data file before exiting to the output.

The beam design report is a comprehensive report of the input, user choices, analysis results and design verifications (if these have been completed). Graphics of the bending moment, shear force and deflection are included. The deflection graphic reflects the last choice selected in the software (i.e. variable loads or total loads)

Users should select the print area and page breaks in the normal way, and may print as required.