

Calculation of a thin-walled member signature curve using GBTUL

A (very) quick tutorial

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June 2020

General notes

- GBTUL can be freely downloaded from <https://sites.fct.unl.pt/gbt>
- It is based on Generalised Beam Theory, meaning that the solution is expressed in terms of meaningful *cross-section deformation modes* (axial, flexural, torsional, distortional, local-plate, shear, etc.).
- The program has a lot of features, but only the most basic ones are explained in this tutorial, to obtain the signature curve of a lipped channel under uniform compression.
- All output is saved in a folder inside the program installation folder:
GBTUL/GBT/Output_Files

1. The “cross-section analysis” separator

Load/save file features

Specify material properties (in this case only material #1 is specified)

Coordinates of the cross-section *natural* nodes (folds and edges)

Definition of each wall properties

The units must be consistent

The screenshot shows the GBTUL software interface with the 'Cross-Section Analysis' tab selected. The interface is divided into several sections:

- Material Properties:** A table with columns for #Material, Exx, Ess, vxs, vsx, Gxs, and ρ . The first row is highlighted with material #1 and properties: Exx=210, Ess=210, vxs=0.3, vsx=0.3, Gxs=80.77, $\rho=7.85E-12$.
- Natural Nodes:** A table with columns for #Node, Y, and Z. The first row is highlighted with node #1 at Y=90, Z=112.
- Walls and Intermediate Nodes:** A table with columns for #Wall, #Node1, #Node2, #Material, IntermediateNodes, and Thickness. The first row is highlighted with wall #1 connecting nodes 1 and 2.
- Length-Distributed Elastic Supports and Additional Masses:** Two empty tables for distributed supports along longitudinal edges and strips.
- Cross-Section Geometry:** A plot showing a rectangular cross-section with nodes 1, 2, 3, 4, 5, and 6. Node 1 is at the top-right corner, 2 is at the top-left, 3 is at the bottom-left, 4 is at the bottom-right, 5 is at the bottom-right, and 6 is at the top-right.
- Plot Options:** A list of checkboxes for 'Natural Nodes', 'Walls', 'Materials', 'Intermediate Nodes', 'Wall Segments', and 'Y-Z Coordinate System'. 'Natural Nodes' is checked.
- Cross-Section Templates:** A row of four templates: 'C/U' (channel), 'Rack' (Z-section), 'Zed' (Z-section), and 'I/T' (I-section).
- Next Button:** A button labeled 'Next' at the bottom right.

Several cross-section geometry templates are available here

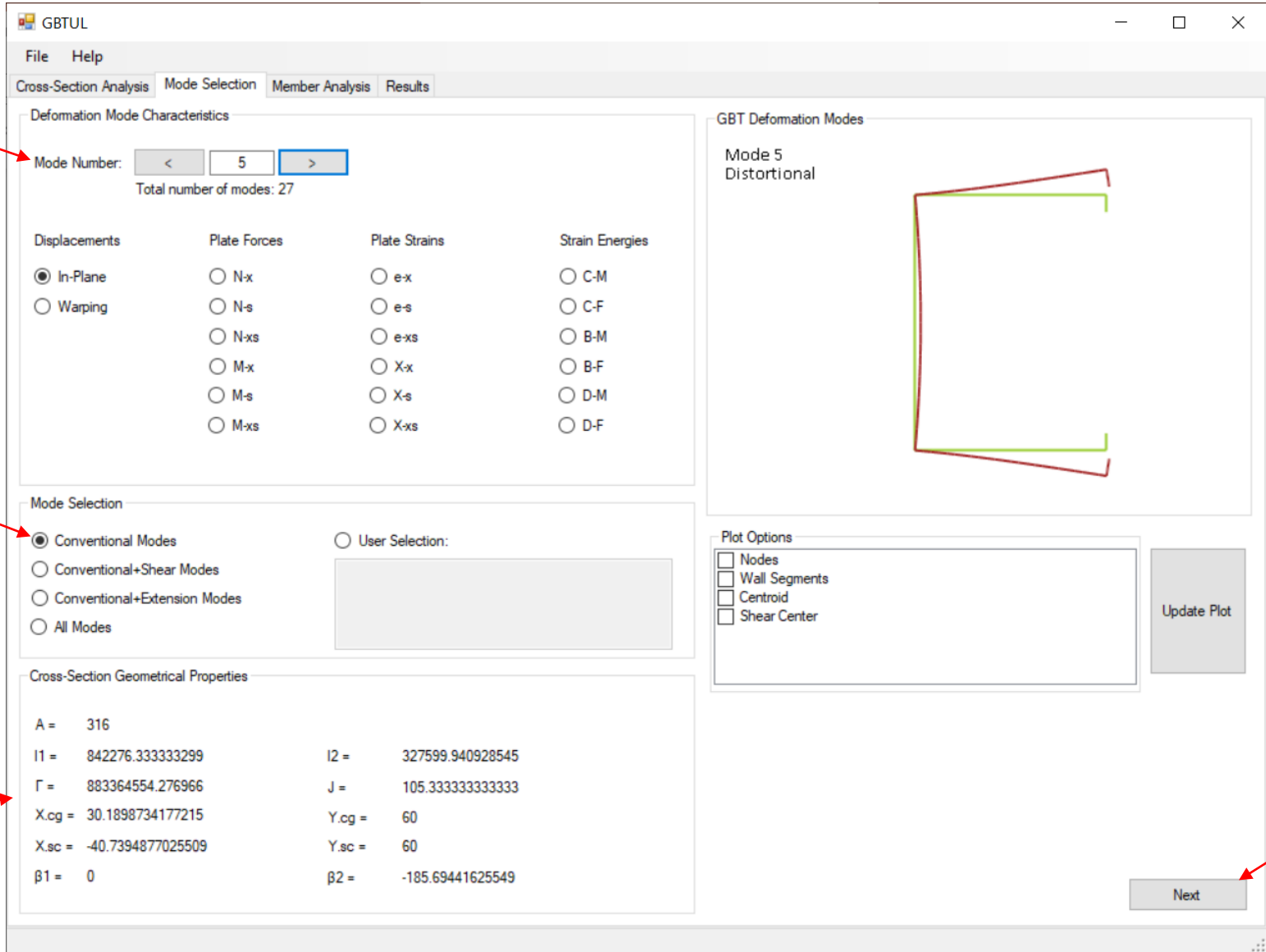
Once finished, click “Next”

2. The “mode selection” separator

Select the deformation mode to be displayed

Define the modes used in the analysis (typically only the conventional modes are necessary)

Cross-section properties (consistent units)



Once finished, click “Next”

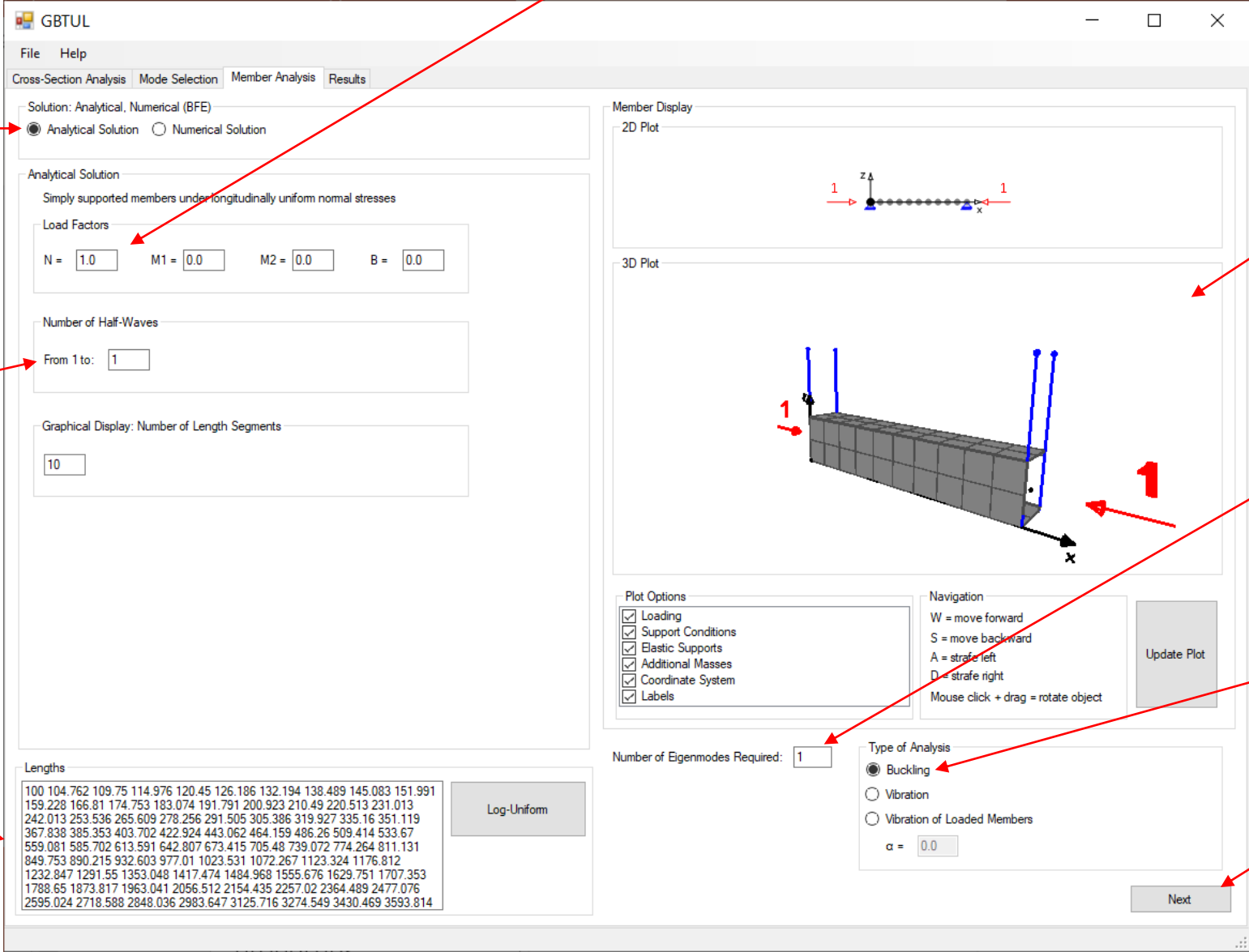
3. The “member analysis” separator

For the signature curve, the solution is designated “analytical”, as exact mode amplitude functions are used. Finite elements can be also used.

For the signature curve, a single half-wave applies.

Provide the half-wavelengths here (the “log-uniform” button helps)

Uniform compression



This window is interactive

Only the first bifurcation mode is calculated

The buckling solution is requested

Once finished, click “Next”

4. The “results” separator

The signature curve

2D plot for the cross-section location indicated

Interactive 3D plot

The screenshot shows the GBTUL software interface with the following components:

- Member Length and Eigenmode Required:** Length slider set to 533.67, Eigenmode slider set to 1.
- Deformed Configuration:** Cross-Section slider set to x/L = 0.000.
- 2D Plot:** In-Plane Displacements selected.
- 3D Plot:** Deformed Configuration selected.
- Plot Options:** Scales set to Log, Limits set to 10-10000, Show All Curves checked.
- Buckling/Vibration Curves:** A line graph showing a peak at approximately 10^3. A red dot marks a point on the curve.
- Results of the buckling analysis of the member with L=533.67 (Mode 1):**
 - Buckling Load: $P_b = 18.263043$
 - Modal participations (%) of the most important GBT modes:

P5=96.72	P7=2.51	P9=0.75	Other=0.02
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- GBT Modal Participation Diagram:** A stacked area chart showing the percentage contribution of 11 modes across the load range. Mode 5 (green) is the dominant mode at lower loads, while Mode 7 (dark green) becomes dominant at higher loads.

Most significant deformation mode participations

Modal decomposition graph

Final notes

- An extensive list of GBT bibliography by our group can be found at <https://sites.fct.unl.pt/gbt>
- To cite GBTUL please use
 - Bebiano, R., Camotim, D., Gonçalves, R., “GBTUL 2.0 – a second-generation code for the GBT-based buckling and vibration analysis of thin-walled members”, Thin-Walled Structures, 124, 235-253, 2018.