CUSTOMER SUPPORT NOTE

Obtaining Section Forces and Moments from a 3D Solid Model

Note Number:	**CSN/LUSAS/1031**

This support note is issued as a guideline only.

LUSAS

Forge House, 66 High Street, Kingston upon Thames, Surrey, KT1 1HN, UK
Tel: +44 (0)20 8541 1999 Fax: +44 (0)20 8549 9399
Email: info@lusas.com www.lusas.com

Table of Contents

1. Introduction

This support note explains how to use the *Section Through 3D* feature to obtain section forces and moments from 3D models meshed with solid (continuum) elements.

2. Description

The *Section Through 3D* feature (Utilities > Section Through 3D) enables users to create planar slices through 3D models meshed with solid elements. It provides two key capabilities:

- Visualisation of results on the generated sections. Results are computed at pseudo-nodes located at the intersections of the slicing planes and element edges, using linear interpolation of nodal values.
- Calculation of stress resultants (forces and moments). Stress resultants are obtained by integrating stresses.

The *Section Through 3D* feature enables users to create slice-sections at arbitrary positions within the model. Using the cursor, users can define horizontal or vertical slices in the *View* window. Slices can be generated in any plane by rotating the model to the desired orientation before slicing.

By default, the location of an arbitrary slice through a model is not saved with the model. However, when creating a slice, an option to generate an annotation polygon is available. This polygon defines the location and orientation of the cutting plane and is saved with the model. Annotation polygons can be re-selected when the model is reloaded to view results at the same location. Additionally, slices can be created using surfaces that define the orientation of the cutting plane. This option is particularly useful when the desired slice plane does not align with the global coordinate axes.

3. Illustrative Example

A 10-metre-long cantilever with a rectangular cross-section (1 m x 0.5 m) is subjected to a uniformly distributed load (5 kN/m), which generates bending moments and shear forces. The structure is meshed with 3D hexahedral elements (HX8M), as shown in Figure 1. The objective is to calculate the bending moment and shear force at a cross-section located 1 metre from the fixed support using the *Section Through 3D* facility.

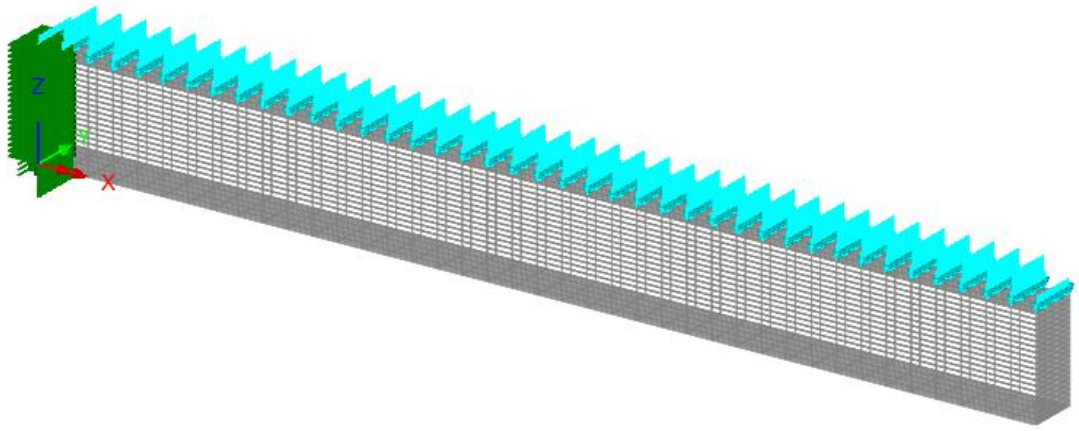


Figure 1 – 3D solid model of cantilever.

Before creating a slice, the model view must be oriented as shown in Figure 2, because the slice will be created in a plane perpendicular to the screen. It is also important to ensure that only the volumes and associated meshes intended for slicing are visible.

In this example, a slice through the 3D model is created at X = 1. In the *Section Through 3D* dialog, the grid size is set to 1 m, and a line parallel to the global Z-axis is drawn (see Figure 2). A parent group labelled *Slices* is automatically generated in the *Groups* tab, with each slice assigned a sequentially numbered subgroup.

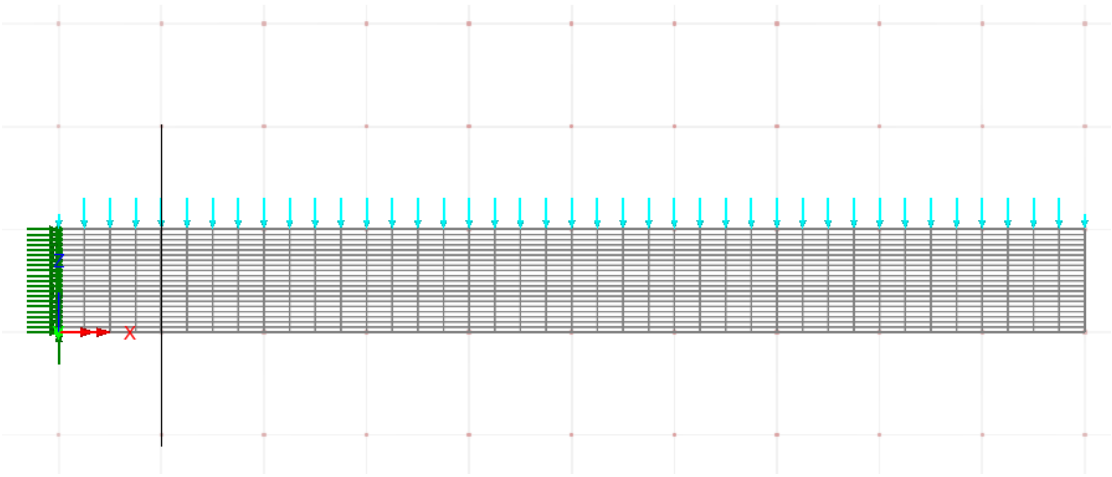


Figure 2 – Cutting a slice 1 metre from support.

Section forces and moments can be obtained by right-clicking on the subgroup corresponding to the section of interest and selecting *Print Local Forces* (see Figure 3). The axes of the slice can be visualised by selecting *Draw Axes*. Additionally, the properties of the section can be displayed by selecting *Print Properties*.

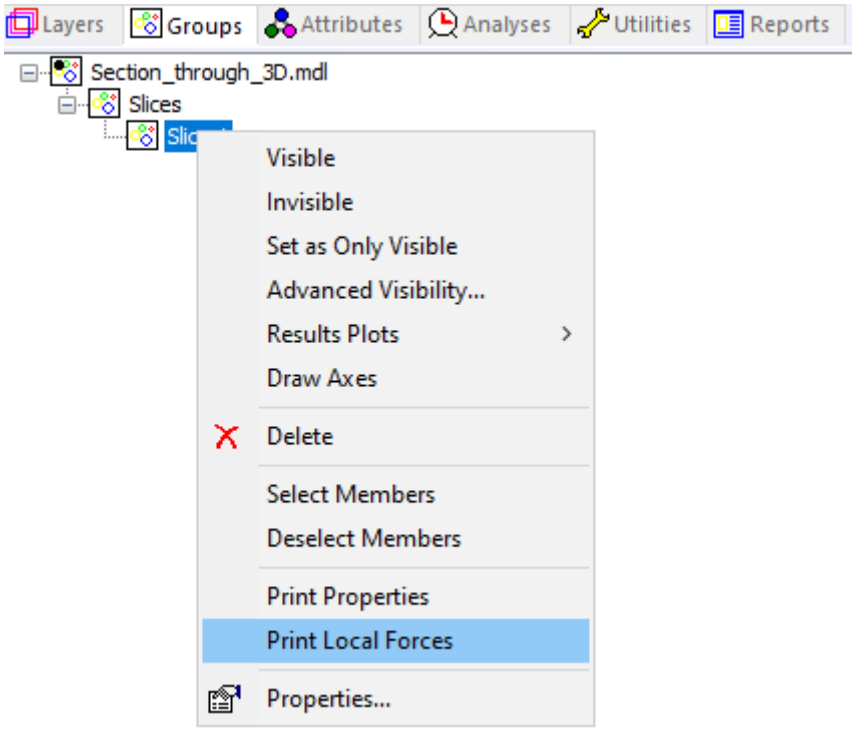
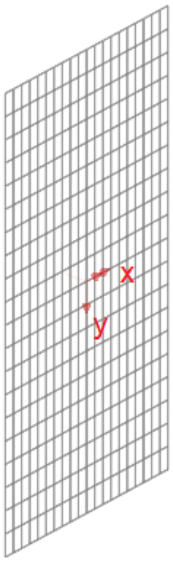


Figure 3 – How to obtain forces and moments for a slice.

The results are presented in a table format (see Figure 4). As expected, all forces and moments are very small, except for Fy (shear force in the y-direction) and Mxx (bending moment about the x-axis). The following hand calculation confirms the accuracy of the results obtained using the facility:

Shear force = 5 kN/m x 9 m = 45 kN

Bending moment = 0.5 x (5 kN/m x (9 m)^2) = 202.5 kNm



	Fx on slice ▲	Fy on slice	Fz on slice	Mxx about slice x axis	Myy about slice y axis	Mzz about slice z axis
1	3.91446E-9	-45.0	0.600808E-9	-202.58	-24.5958E-9	0.356896E-9

Figure 4 – Slice axes and results.

Contour plots can also be generated on slices by selecting the *Display on slice(s)* option, as shown in Figure 5. Figure 6 shows the SX contour plot on the slice defined in this example. As expected, the top fibres are in tension, while the bottom fibres are in compression.

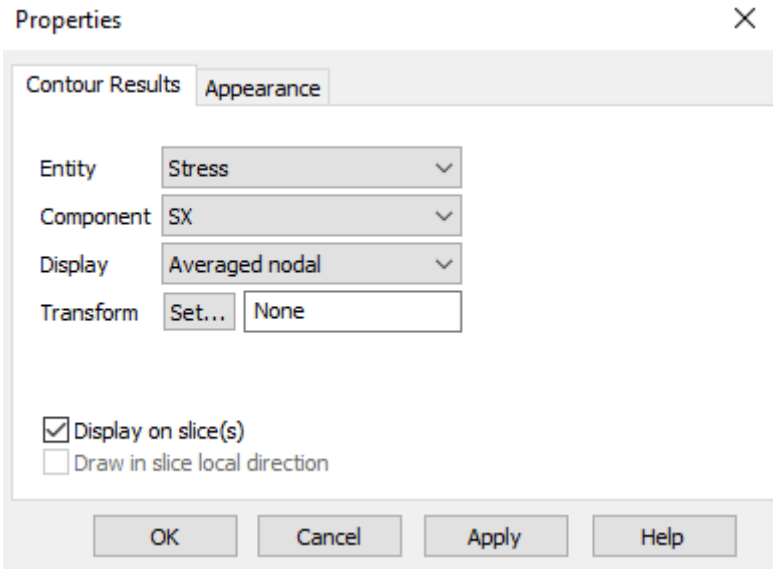


Figure 5 – Displaying contour plots on slices.

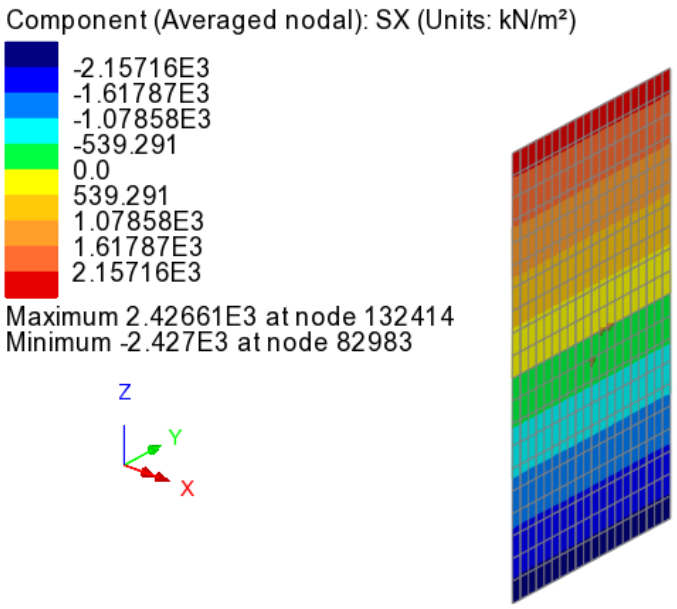


Figure 6 – Display of SX contour plot on slice.

Consider the model shown in Figure 7, which comprises two identical beams positioned close to each other. When the *Section Through 3D* facility is used while both beams are visible, two slices are generated, and the slice axes are positioned between the two beams. Consequently, the resulting effects include the contributions from both beams. If the effects of one beam only are required, the other beam must be hidden before using the *Section Through 3D* facility.

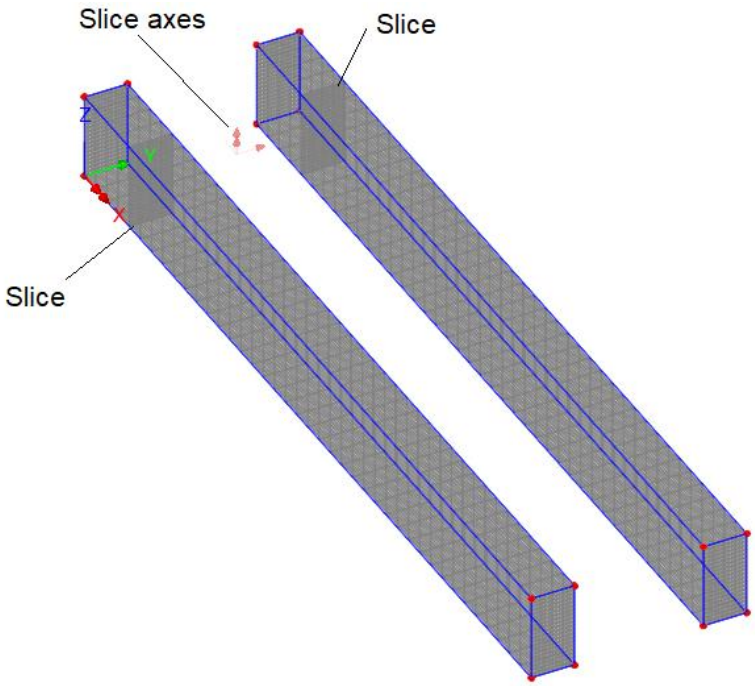


Figure 7 – Creating a slice in a model with two beams.

Please note that this method does not slice line (beam/bar) or surface (shell) elements. If such elements are present, they must be made invisible and sliced separately. To obtain results for slices through beam and/or shell elements, use the *Slice Resultants Beams/Shells* tool (Utilities > Slice Resultants Beams/Shells).

4. Summary

Section Through 3D facility:

1. **Usage:**
   - This tool is designed for three-dimensional models meshed with solid elements.
   - It enables the creation of slices at arbitrary locations within the model.
   - Slices are created in planes perpendicular to the screen.
   - It is important to ensure that only the volumes and associated meshes intended for slicing are visible when defining a slice.
   - By default, slice positions are not stored with the model.
   - Slices can also be defined using annotation polygons or surfaces, which are saved with the model and can be reused to obtain results.
2. **Outputs:**
   - Forces and moments.
   - Section properties.
   - Contour plots on slices.

If you have any doubts or require specific advice for your type of analysis, please contact the LUSAS Technical Support team at support@lusas.com.