CUSTOMER SUPPORT NOTE

Slice Forces and Moments in Solid Models

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This support note is issued as a guideline only.



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1. Introduction

This support note explains how to use the *Section Through 3D* feature in LUSAS to extract forces and moments from slices cut directly through 3D models meshed with solid (continuum) elements.

2. Description

The Section Through 3D feature enables users to create slices through 3D models meshed with solid elements and visualise results on these slices. For slices through solid models, results are computed at pseudo-nodes, located at the intersections of the slices with element edges, through linear interpolation of nodal results. Stresses on the slices can be integrated over the cross-sectional area to determine resultant forces and moments.

The Section Through 3D feature (Utilities > Section Through 3D) 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 view 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 along its length. The structure is meshed with 3D hexahedral elements (HX8M), as shown in Figure 1. The task is to calculate the bending moment and shear force at a section 1 metre from the fixed support using the Section Through 3D facility.



Figure 1 – 3D solid model of cantilever.

Prior to creating a slice through the model, the model view should be oriented as required (see Figure 2), as the slice will be taken in a plane perpendicular to the current view orientation (into the screen). It is also essential to confirm that only the volumes and their underlying meshes intended for slicing are visible, or that these elements are the only ones displaying results.

In this example, a section through the 3D model is created at X = 1. In the dialog that appears, the grid size is set to 1 m, and a line parallel to the global Z-axis is drawn (see

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Figure 2). A parent group labelled *Slices* is automatically generated under 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 of the desired slice and selecting *Print Local Forces* (see Figure 3). The axes of the slice can be visualised by selecting *Draw Axes*, which helps in interpreting the results. Additionally, the properties of the section can be printed by selecting *Print Properties*.

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Figure 3 – How to obtain forces and moments for a selected 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 along the y-axis) and Mxx (bending moment about the x-axis). A hand calculation further confirms the accuracy of the results obtained from the facility:

Shear force = $5 \text{ kN/m} \times 9 \text{ m} = 45 \text{ kN}$

Bending moment = $0.5 \times (5 \text{ kN/m} \times (9 \text{ m})^2) = 202.5 \text{ kNm}$



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 for the slice created in this example. As expected, the top fibres are in tension, while the bottom fibres are in compression.

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Figure 5 – Displaying contour plots on slices.

Component (Averaged nodal): SX (Units: kN/m²)



Figure 6 – Display of SX contour plot on slice.

Consider a scenario where results are needed for one of the beams in the model shown in Figure 7, which features two identical beams positioned close to each other. If both beams are visible when the slice is cut, the slice will intersect both models. As illustrated in Figure 7, the slice axis is positioned between the two beams, indicating that the results will reflect the combined effects of both beams rather than those of a single beam.



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.
- It is essential to confirm that only the volumes and their underlying meshes intended for slicing are visible, or that these elements are the only ones displaying results.
- By default, the position of a slice is not saved with the model.
- Annotation polygons or surfaces can define slices. These are saved and can be reused later to obtain results at the same locations.

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.