

CUSTOMER SUPPORT NOTE

Section Property Calculator with a Mixed Material Section

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This support note is issued as a guideline only.

Introduction

The Arbitrary Section Property Calculator (ASPC) computes the section properties of any open or closed section defined in the XY plane. Sections are created within LUSAS Modeller either as a single regular or irregular surface, or as a group of surfaces. The calculator will compute the area, moments of inertia, torsional constant and shear areas of the section. This is achieved by meshing the surface using triangular elements and using the Membrane Analogy (also known as the “soap bubble” analogy), which involves a (thermal) field analysis performed by LUSAS Solver. Using the Arbitrary Section Property Calculator will automatically change the Modeller user interface to Thermal.

The procedure is straightforward for sections consisting of a single material type; this note provides guidance on using the ASPC with sections consisting of two or more materials (composite sections).

1. Description

When assigning a material property to a feature in LUSAS only one property can be used and so if a mixed material section is being modelled then the geometric property must be created such that the material that is not being used, is somehow represented by the material that *is* being used.

To calculate the geometric properties for a section containing mixed materials the following should be undertaken:

1. Generate the cross-section as normal and run the ASPC on the section in the standard manner. Do not assign any material to the model for this first run.

Add a new Isotropic Field Material using the “Attributes > Material > Isotropic > Thermal tab...” menu option and in V15.2 onwards set

Thermal Conductivity, $\mathbf{K} = \mathbf{E2/E1}$

in the isotropic field properties, where:

E1 is the Young’s modulus for the material to be used in the structural analysis model and

E2 is for the material to be represented.

Important Note: In V14 you should use the inverse of these ratios, i.e. E1/E2

These calculated properties will take into account the modular ratios.

2. Assign the newly defined properties to the surface of the material to be represented.

3. Re-run the Section Calculator to get the revised section properties in which the modular ratio is considered.

A common occurrence of this situation is a pre-cast beam with an in situ slab. The following example shows the principles of the above procedure.

Create a new model with units of “N mm t C s” and Analysis category 2D Inplane. Open the Precast Beam Section generator using “Tools > Section Property Calculator > Precast Section...” menu options. The Precast Beam Section generator produces 2D cross-sectional models of widely available pre-cast concrete beams.

The section to be considered will be a Y8 beam where the concrete cube strength, $f_{cu} = 50 \text{ N/mm}^2$, and Young’s Modulus $E_c = 34 \text{ kN/mm}^2$.

The slab will have properties of

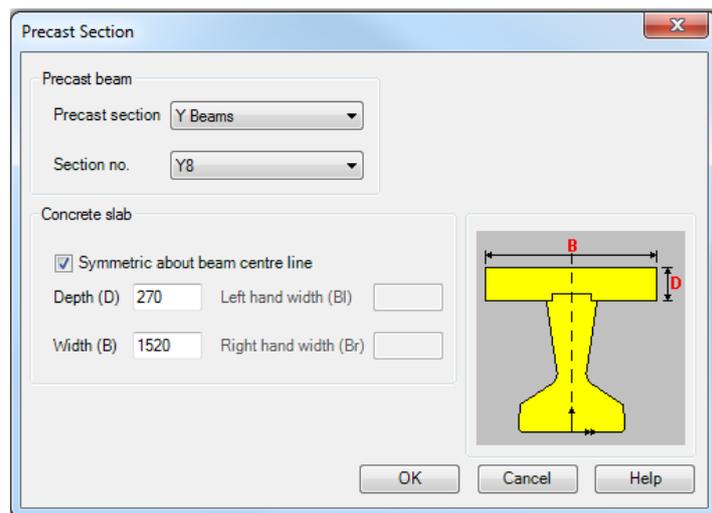
$f_{cu} = 40 \text{ N/mm}^2$ and $E_c = 31 \text{ kN/mm}^2$.

For this example the elastic moduli for the concrete given in Table 3 of BS5400: Part 4 are the secant values appropriate to a stress of approximately one third of the cube strength.

Since the pre-cast and in situ concrete strengths do not differ by more than 10 N/mm^2 , clause 7.4.1 of BS5400: Part 4 permits a modular ratio of 1.0 to be used. However, in this example a more accurate value will be calculated taking the different concrete stiffnesses into account.

Select a Y8 beam section with a symmetrical slab 270 mm deep and 1520 mm wide and press OK, which will generate the required section. Then run the Arbitrary Section Property Calculator via “Tools > Section Property Calculator > Arbitrary Section...”

Using the defaults analyse the section to give the section properties (including the torsional constant and shear areas) for a homogeneous material section. Click “Close” after this initial analysis and add a new Isotropic Field Material using the “Attributes > Material > Thermal > Isotropic...” menu option.



Using the above calculations, as we will assign “beam” properties to the structural analysis model, in V15.2 onwards $K = 0.912$ (note in V14 these will be K and $C = 1.097$).

Enter this value, leaving the rest as zero. Name this material “Concrete Slab” and press OK. Select the original “Unit Conductivity” material attribute and rename this to “Concrete Beam”. This original material has K value of 1.0. Select the slab surface and assign the “Concrete Slab” material. This will overwrite the “Concrete Beam” that was originally assigned to all surfaces.

Open the ASPC using the “Tools > Section Property Calculator > Arbitrary Section...” menu option. Click the apply button to accept the defaults and the section will be re-analysed. However, this time, the modular ratio of the materials will be considered. The resulting section properties can be stored in a local or network section library for future use. To use the section properties in a model select the appropriate library from the options available before clicking the “Apply” button.