Line and area springs

Test Problem

Name:	Line and area springs
Description:	This test problem demonstrates and validates the application of line and area springs.
Program:	SAP2000
Version:	12.0.0
Model ID:	na

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Overview

When line or area springs are assigned to an object, SAP2000 generates equivalent joint springs at each node created during auto-meshing. Joint-spring stiffness is determined from tributary area and the line- or area-spring stiffness which is assigned to the object. As a result, joint springs which support interior joints are stiffer than those at corner joints. Since contact pressure is proportional to joint-spring deformation and the displacement of those joints to which springs are attached, users may obtain contact pressure through the product of spring-stiffness constant and displacement, available for output in both graphic and tabular format.

Example model

The example model, attached for reference, contains two area objects (2m x 2m and 1m x 1m), each auto-meshed into four area objects, two frame objects (2m and 1m), each auto-meshed into two frame objects, and one point object. A link (LIN1) is assigned to the area objects as an area spring, to the frame objects as a line spring, and to the point object as a joint link.

Link stiffness is defined as follows:

- 1kN/m when used as a joint link

- 1kN/m/m when used as a line spring

- 1kN/m/m^2 when used as an area spring

The values specified for Factors For Line, Area, and Solid Springs, available on the Link/Support Property Data menu, are explained in Figure 1:

Figure 1 - Link and support property data

The SPRING-LOAD load case applies a unit load to objects, including 1kN/m^2 for the area objects, 1kN/m for the frame objects, and 1kN for the point object. UZ displacement of 1m at all joints indicates consistency between applied loading and assigned stiffness.

The stiffness of automatically created internal springs could be indirectly determined by dividing joint reaction by its displacement. These values are available in the output tables. Here, internally created joints are preceded with a tilda (~).

Model screenshots and results
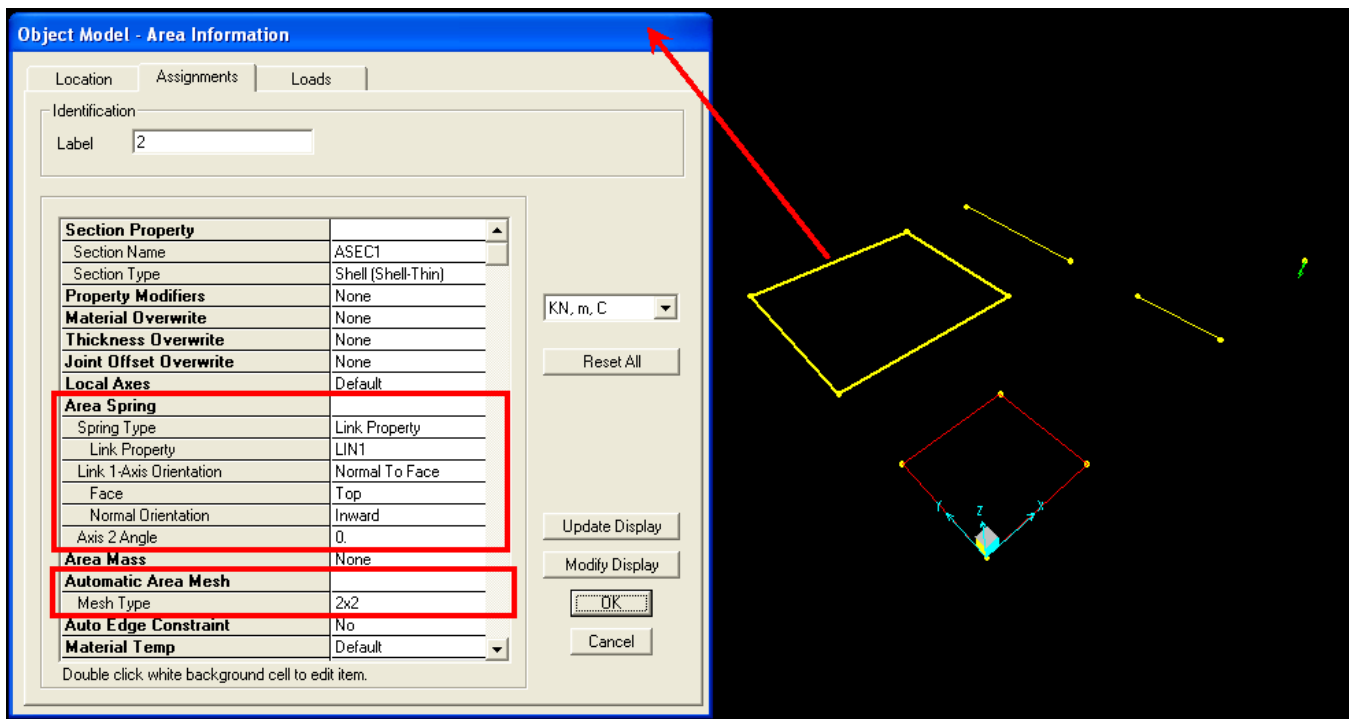
Area-spring and auto-mesh assignment

Figure 2 - Area-spring and auto-mesh assignment

Equivalent joint springs

The software automatically creates equivalent joint springs which represent those line and area springs which are assigned to an object. These joint springs are displayed through View > Set Display Options > Show Analysis Model, as shown in Figures 3 and 4:
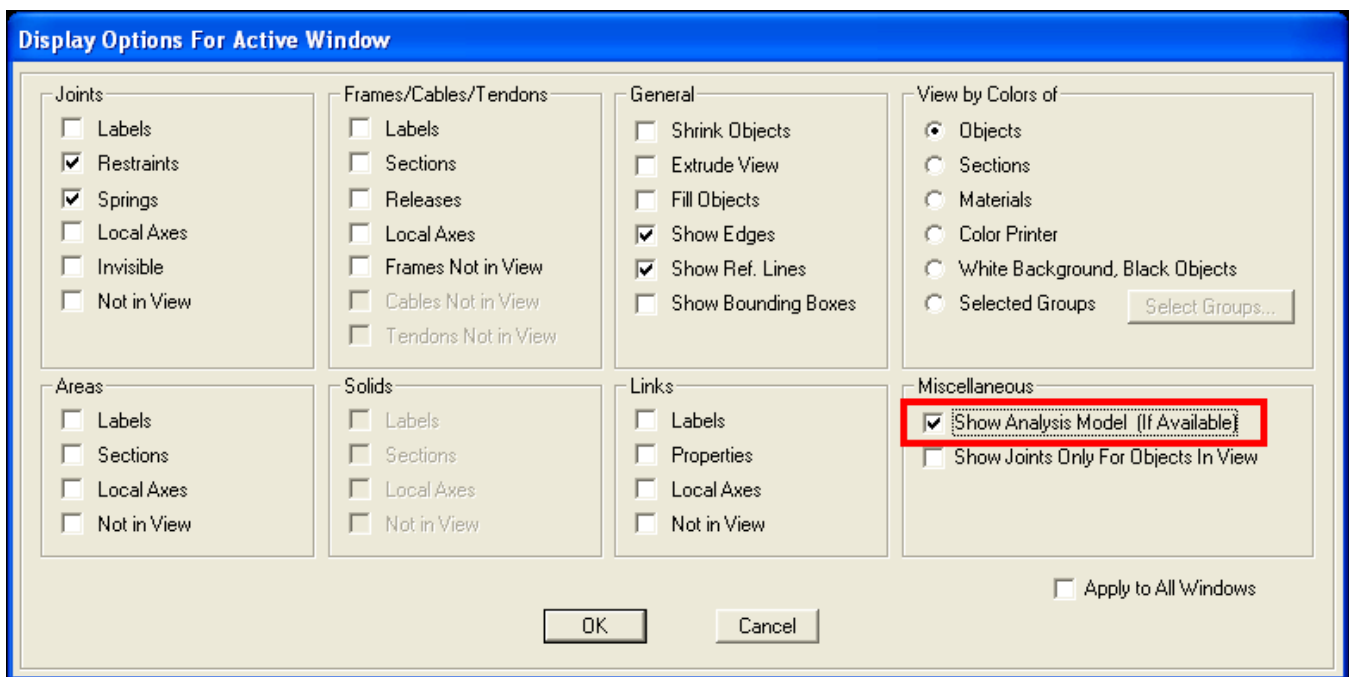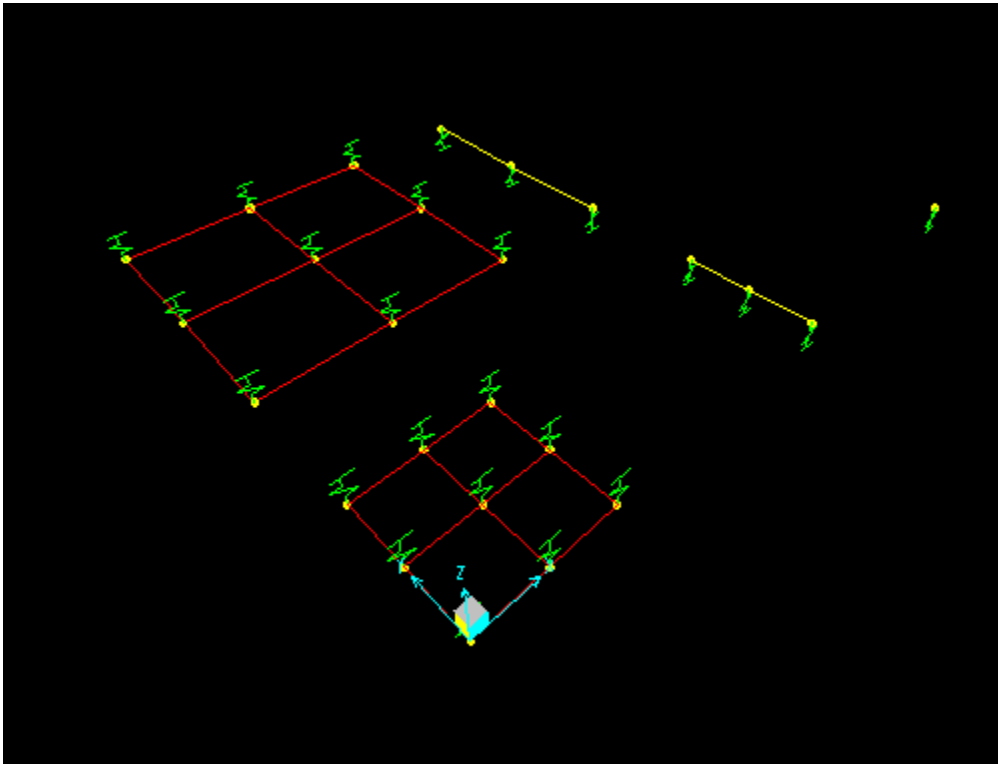

Figure 3 - Show analysis model

Figure 4 - Equivalent joint springs

Attachments

- SAP2000 V12.0.0 model (zipped .SDB file)