

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/m² 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:

Link/Support Property Data

Link/Support Type: Linear

Property Name: LIN1 Set Default Name

Property Notes: Modify/Show...

Total Mass and Weight

Mass: 0. Rotational Inertia 1: 0.

Weight: 0. Rotational Inertia 2: 0.

Rotational Inertia 3: 0.

Factors For Line, Area and Solid Springs

Property is Defined for This Length In a Line Spring: 1

Property is Defined for This Area In Area and Solid Springs: 1

Directional Properties

Direction	Fixed	Properties
<input checked="" type="checkbox"/> U1	<input type="checkbox"/>	Modify/Show for All...
<input checked="" type="checkbox"/> U2	<input checked="" type="checkbox"/>	
<input checked="" type="checkbox"/> U3	<input checked="" type="checkbox"/>	
<input checked="" type="checkbox"/> R1	<input checked="" type="checkbox"/>	
<input checked="" type="checkbox"/> R2	<input checked="" type="checkbox"/>	
<input checked="" type="checkbox"/> R3	<input checked="" type="checkbox"/>	

Fix All Clear All

P-Delta Parameters

Advanced...

OK Cancel

X2.99 Y9.69 Z0.00 GLOBAL KN, m, C

For this entry, the line spring stiffness is entered in $\text{kN/m}/(1 \text{ m})$ units

For this entry, the area spring stiffness is entered in $\text{kN/m}/(1 \text{ m}^2)$ units

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 tilde (~).

Model screenshots and results

Area-spring and auto-mesh assignment

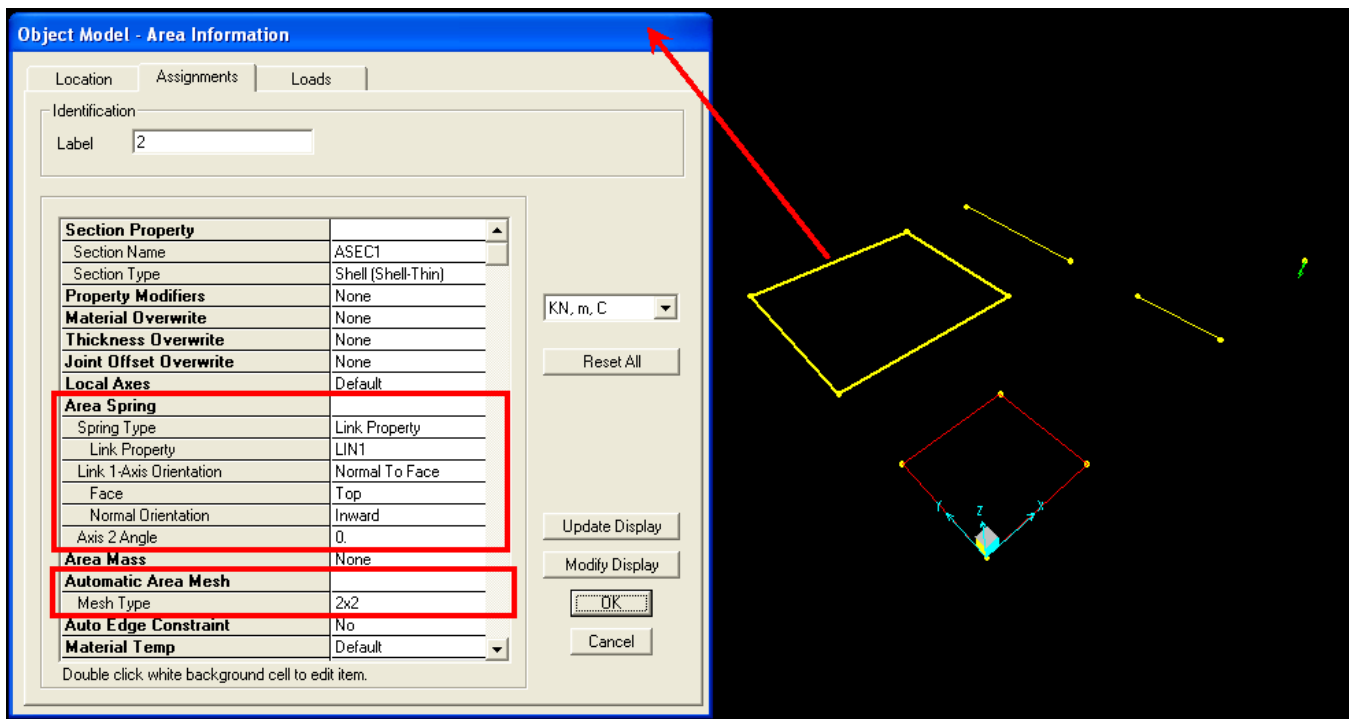


Figure 2 - Area-spring and auto-mesh assignment

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:

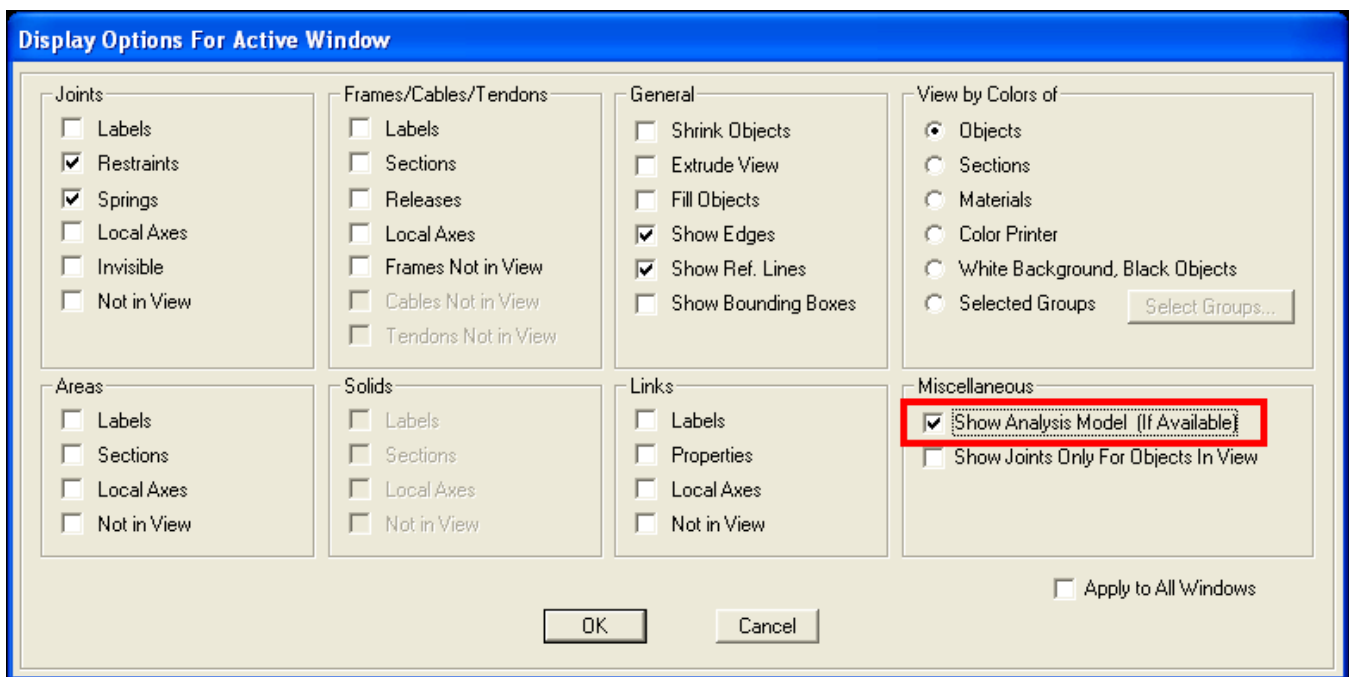


Figure 3 - Show analysis model

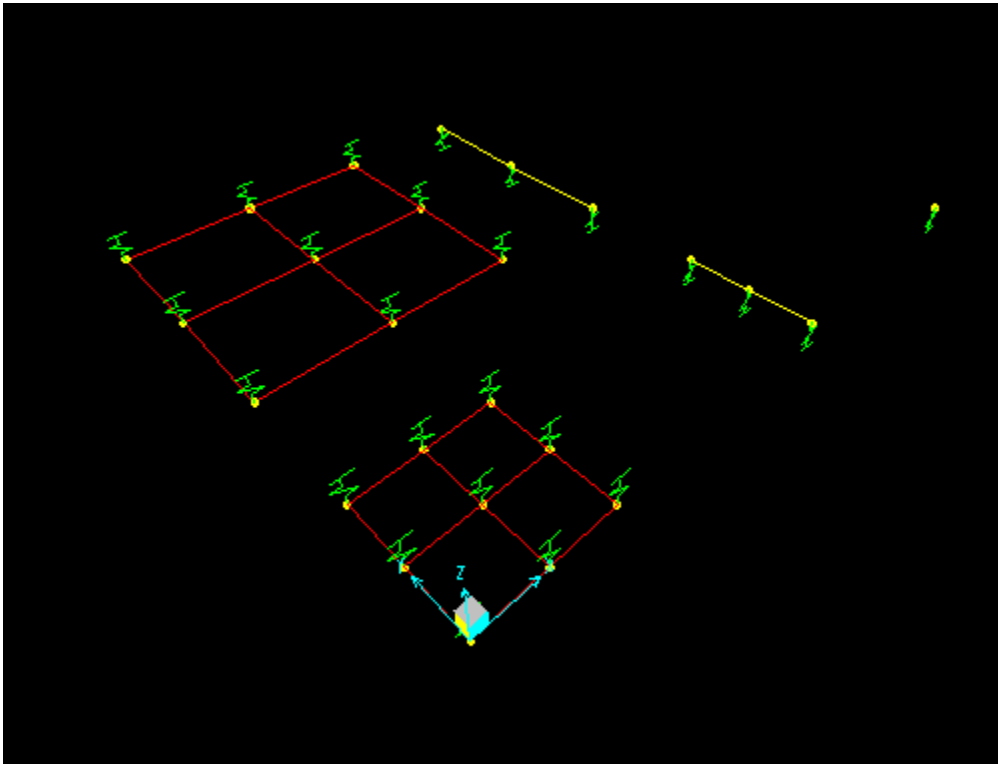


Figure 4 - Equivalent joint springs

Attachments

- [SAP2000 V12.0.0 model](#) (zipped .SDB file)