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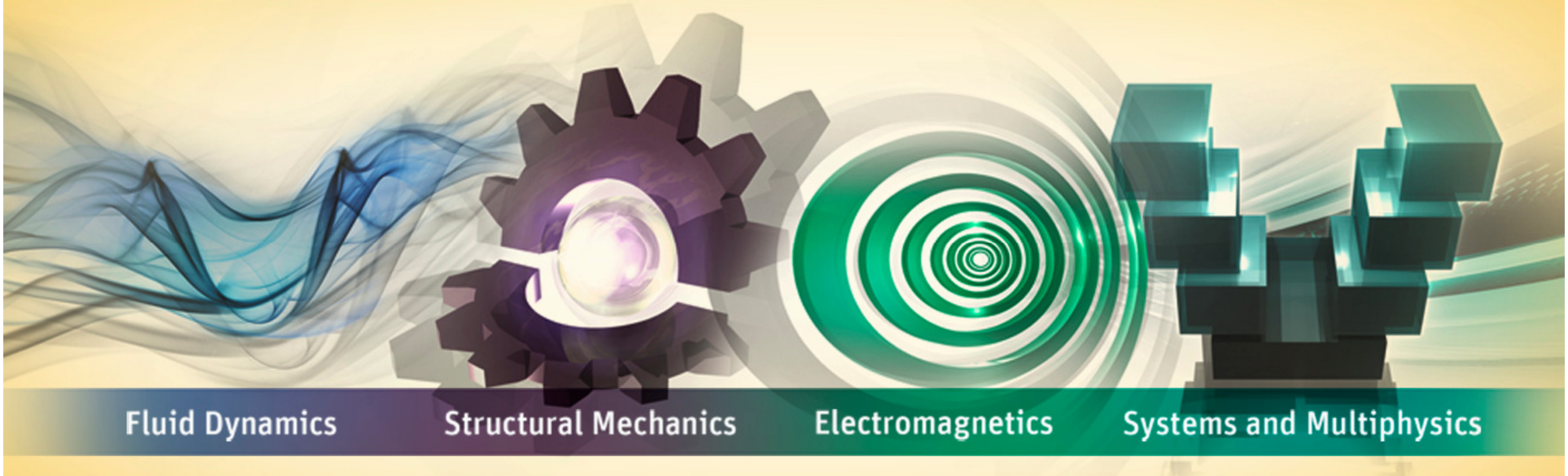
Elastic Foundation Stiffness



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Elastic Foundation Stiffness (EFS)

The “Elastic Foundation Stiffness” (EFS) or “Elastic Support” is a way of specifying a spring stiffness per unit area that only acts in the direction normal to the face of the element

- **In Mechanical APDL (MAPDL), elastic foundation stiffness is available with surface effect elements SURF153 and SURF154**
- **In Workbench (WB) Mechanical, the Elastic Support can be scoped on any 3D face**

This boundary condition is analogous to a convection boundary condition in heat transfer analyses, where the film coefficient “h” plays a role similar to EFS

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Elastic Foundation Stiffness (EFS)

EFS is part of the stiffness matrix and is described in the ANSYS Help system in the following location:

// Theory Reference // 14. Element Library // 14.154. SURF154 - 3-D Structural Surface Effect

The stiffness matrix is:

$$[K_e^f] = \text{element foundation stiffness matrix}$$
$$= k^f \int_A \{N_z\}\{N_z\}^T dA$$

where:

k^f = foundation stiffness (input as EFS on R command)

A = area of element

$\{N_z\}$ = vector of shape functions representing motions normal to the surface

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Elastic Foundation Stiffness (EFS)

When the surface is planar, and the loading acts normal to the direction, the expected displacement at the location of EFS is straightforward to calculate:

$$x_{efs} = \frac{F}{k_{efs}}$$

$$= \frac{F}{EFS \cdot Area}$$

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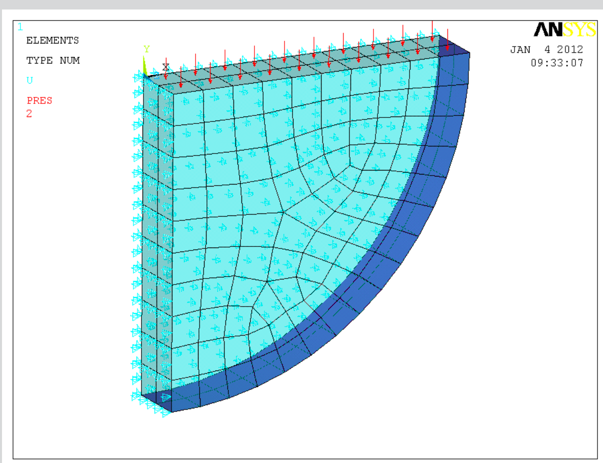
Elastic Foundation Stiffness (EFS)

For non-planar geometry, the user should be aware of a $\cos^2\theta$ term present (N_z term shown in earlier slide, taken from ANSYS Theory Reference)

$$k_{efs} = EFS\int \cos^2\theta dA$$

For example, consider the quarter cylinder shown below:



$$k_{efs} = EFS\int_0^{\pi/2}\cos^2\theta\cdot r\cdot h\cdot d\theta$$

$$= EFS\cdot r\cdot h\left[\frac{\theta}{2}+\frac{1}{4}\sin(2\theta)\right]_0^{\pi/2}$$

$$= EFS\cdot r\cdot h\frac{\pi}{4}$$

Elastic Foundation Stiffness (EFS)

For non-planar geometry, the resulting stiffness using EFS is not based on the projected area. Instead, as shown in the previous slide, the integral must be evaluated to determine the actual stiffness.

These calculations are done automatically for the user by the MAPDL solver. However, for the user who wants a given total stiffness, the previous slide should help in calculating an appropriate value of EFS to input into the program.

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