*DEFINE_FRICTION_ORIENTATION

Purpose: This keyword allows for definition of different coefficients of friction (COF) in specific directions, specified using a vector and angles in degree. In addition, COF can be scaled according to the amount of pressure generated in the contact interface. This feature is intended for use with FORMING_ONE_WAY type of contacts.

Card 1	1	2	3	4	5	6	7	8
Variable	PID	LCID	LCIDP	V1	V2	V3		
Type	I	I	I	F	F	F		
Default	none	0	0	0.0	0.0	0.0		

VARIABLE	DESCRIPTION
PID	Part ID to which directional and pressure-sensitive COF is to be applied. See *PART.
LCID	ID of the load curve defining COF vs. orientation in degree.
LCIDP	ID of the load curve defining COF scale factor vs. pressure.
V1	Vector components of vector V defining zero-degree (rolling) direction.
V2	Vector components of vector V defining zero-degree (rolling) direction.
V3	Vector components of vector V defining zero-degree (rolling) direction.

The assumption:

Load curves LCID and LCIDP are not extrapolated beyond what are defined. It is recommended that the definition is specified for the complete range of angle and pressure expected. One edge of all elements on the sheet metal blank must align initially with the vector defined by V1, V2, and V3.

Application example:

The following is a partial keyword input of using this feature to define directional frictions and pressure-sensitive COF scale factor.

```
*DEFINE_FRICTION_ORIENTATION
$      PID      LCID     LCIDP        V1        V2        V3
         1        15        16       1.0        0.        0.
```

```
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$ define COF vs. orientation angle
*DEFINE_CURVE
15
0.0, 0.3
90.0, 0.0
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$ define COF scale factor vs. pressure
*DEFINE_CURVE
16
0.1, 0.3
0.2, 0.3
0.3, 0.3
0.4, 0.2
0.5, 0.5
0.6, 0.4
```

Referring to Figure 0-1, a deformable blank is clamped with 1000N of force between two rigid plates and is pulled along the direction of X-axis for 90 mm using displacement control. Initial and final positions of the blank are shown in Figure 0-2. The normal force is recovered from RCFORC file, as shown in Figure 0-3, which agrees with what is applied. Frictional force (pulling force) in X-direction is plotted as 89N, shown in Figure 0-4. A hand calculation from the input verifies this result:

1000N x 0.3 (x-dir. COF) x 0.3 (COF scale factor at 0.27 pressure) = 90N.

The interface pressure can be output from an LS-DYNA run when 'S=filename' is included in the command line. The binary output can be viewed from LS-PrePost4.0.

The element directions are automatically aligned with the vector V. The left side of Figure 0-5 shows the element directions of the incoming sheet blank. The keyword will re-orient the element directions based on the vector V specified, which has the component of [1.0, 0.0, 0.0] in this case. The re-oriented element directions for the blank are shown on the right side of the Figure.

Following the numeric directions provided in Figure 0-6, LS-PrePost4.0 can be used to check the element directions of a sheet blank.

This feature is generally developed for use with FORMING_ONE_WAY type of contact in SMP. However, this keyword can be used in combination with *CONTACT_FORMING_ONE_WAY _SURFACE TO_SURFACE_ORTHO_FRICTION, and in fact, it can only be used in this manner if running MPP. In this combination, the variables LCID and LCIDP are overridden by friction factor input in ORTHO_FRICTION, while the vector [V1, V2, V3] defines the first orthogonal direction. It furthermore allows the convenience of SSID and MSID in *CONTACT being input as part set IDs (when SSTYP/MSTYP=2), in which case the segments sets necessary for ORTHO_FRICTION are generated automatically with orientation according to the vectors defined by [V1, V2, V3]. The part set ID input option is typically used by metal forming users. A detailed keyword example is shown in Figure 0-7.

Revision information:

This feature is available in LS-DYNA Revision 60275 and later releases for SMP. It works with MPP with one way forming type of contact with ORTHO_FRICTION starting from Rev 73226. In addition, it works with SMOOTH contact option starting from Revision 69631.

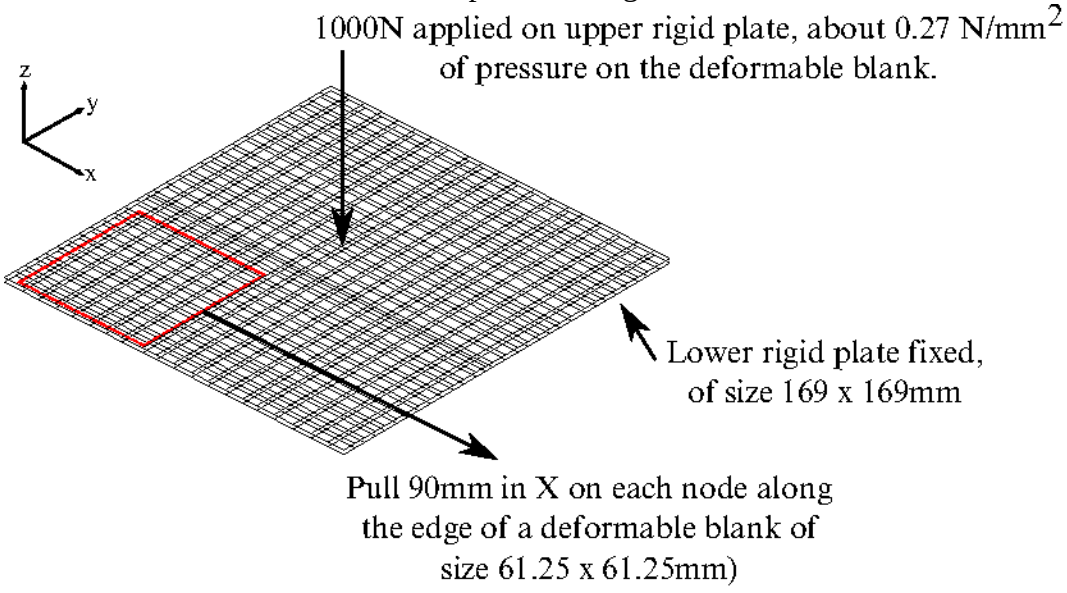

Figure [0-1]. Boundary and loading conditions of a small test model.

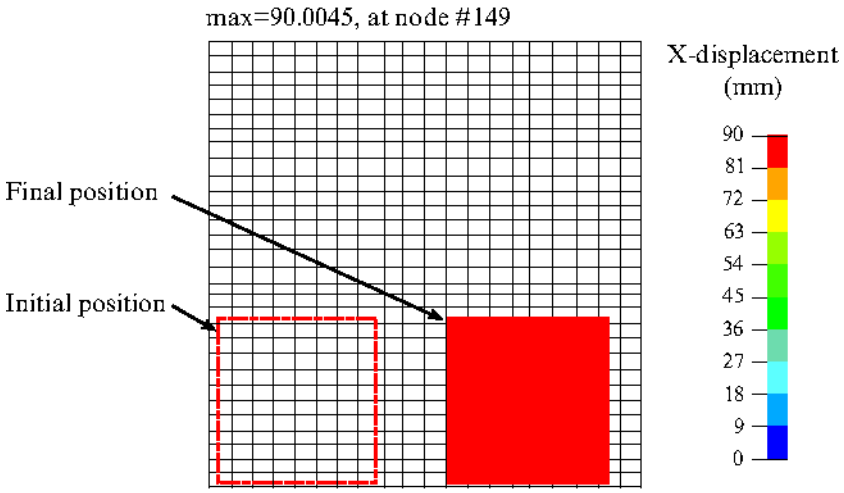

Figure [0-2]. Initial and final position of the blank.

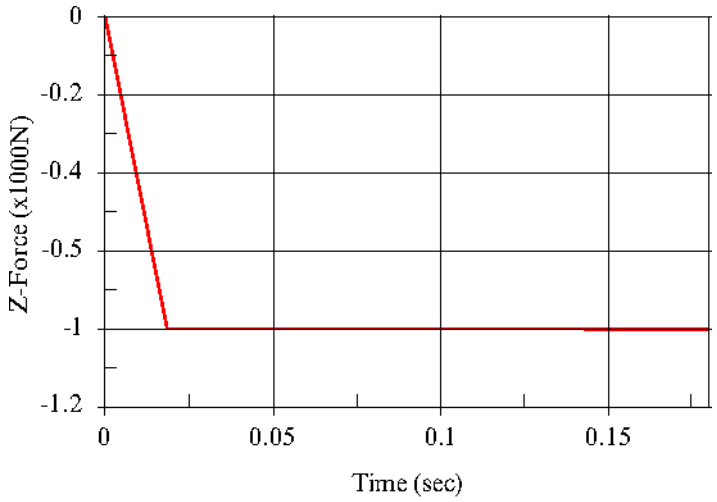

Figure [0-3]. Normal force from RCFORC file.

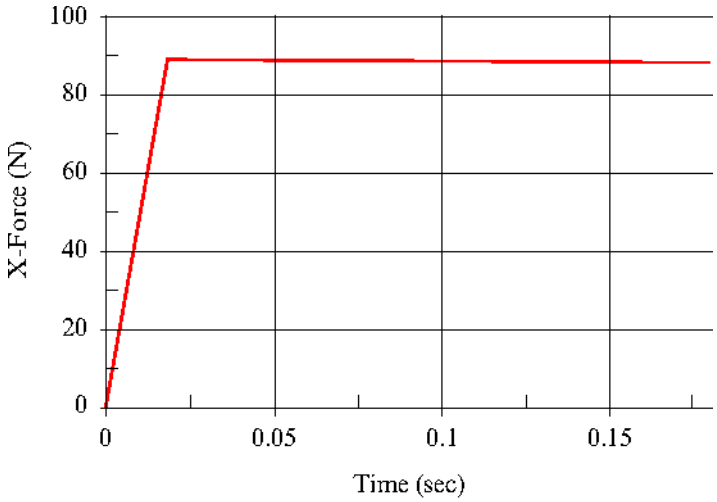

Figure [0-4]. Pulling force (frictional force) from RCFORC file.

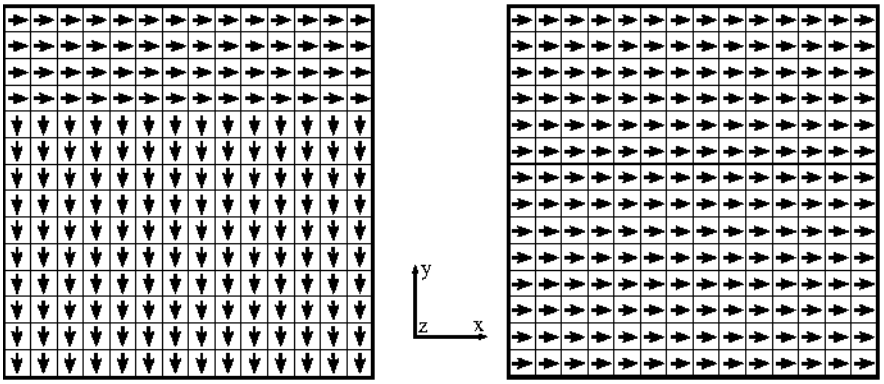

Figure [0-5]. Element directions (N1-N2) of an incoming sheet blank (left) and directions after re-orientation.

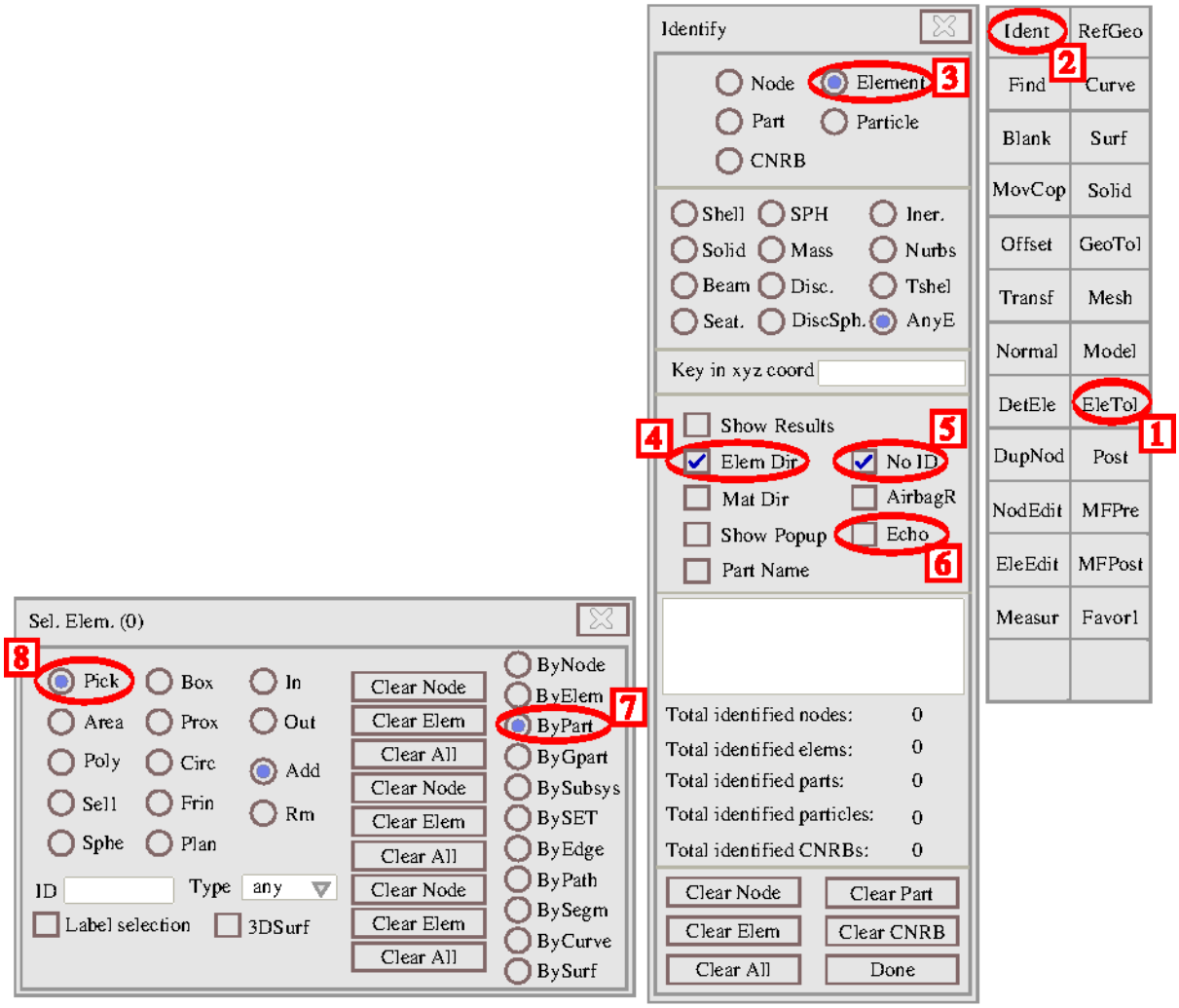

Figure [0-6]. Checking element directions (N1-N2) by part using LS-PrePost4.0.

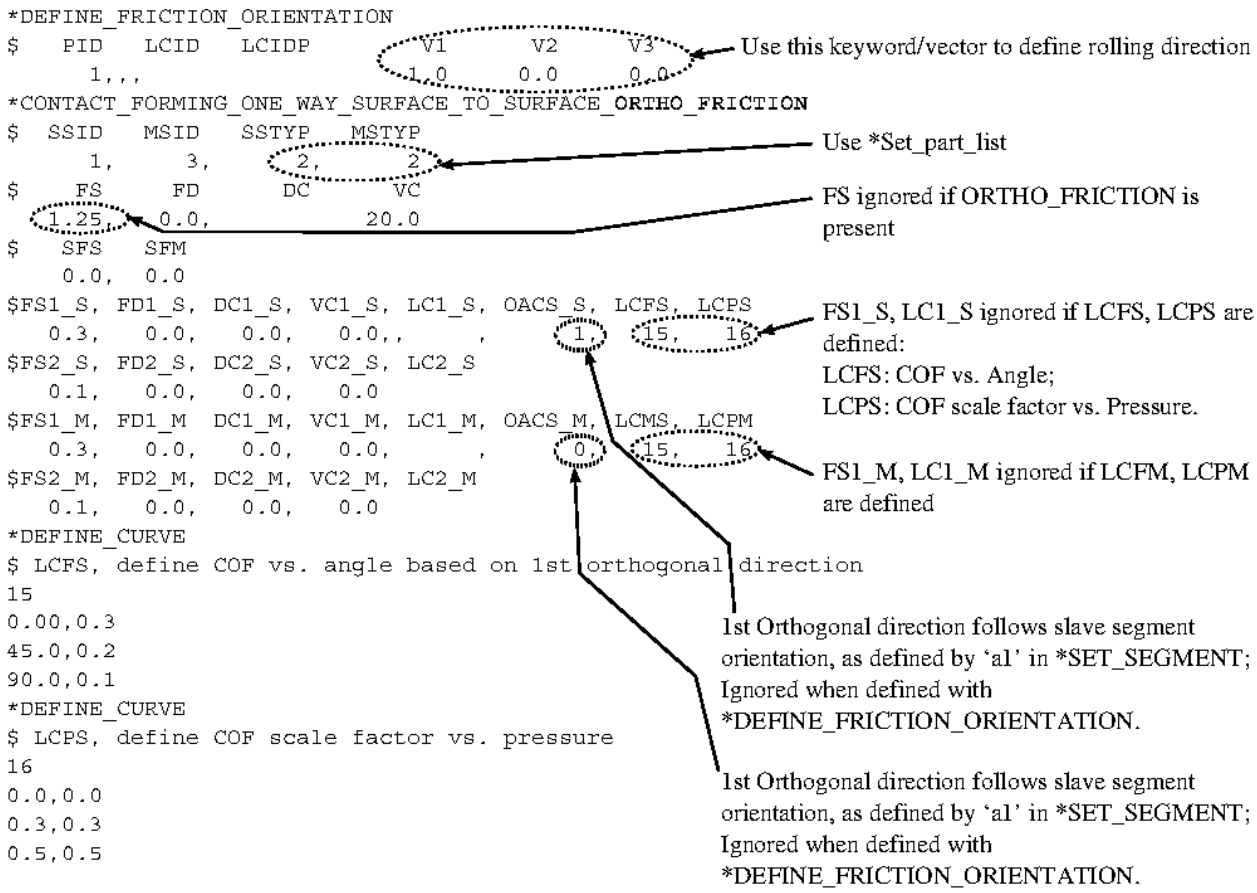

Figure [0-7]. Use of this keyword with _ORTHO_FRICTION for MPP.