*RIGIDWALL

Two keywords are used in this section to define rigid surfaces:

*RIGIDWALL_GEOMETRIC*_OPTION_{OPTION}_{OPTION}}_{OPTION}*

*RIGIDWALL_PLANAR*_{OPTION}_{OPTION}_{OPTION}*

The RIGIDWALL option provides a simple way of treating contact between a rigid surface and nodal points of a deformable body, called tracked nodes. Tracked nodes which belong to rigid parts are not, in general, checked for contact with only one exception. The RIGIDWALL_PLANAR option may be used with nodal points of rigid bodies if the planar wall defined by this option is fixed in space and the RWPNAL parameter is set to a positive nonzero value on the control card, *CONTROL_CONTACT.

When the rigid wall defined in this section moves with a prescribed motion, the equations of rigid body mechanics are not involved. For a general rigid body treatment with arbitrary surfaces and motion, refer to the *CONTACT_ENTITY definition. The *CONTACT_ENTITY option is for treating contact between rigid and deformable surfaces only.

Energy dissipated due to rigidwalls (sometimes called stonewall energy or rigid wall energy) is computed only if the parameter RWEN is set to 2 in *CONTROL_ENERGY.

The following keyword causes the forces acting on a rigid wall to be computed:

*RIGIDWALL_FORCE_TRANSDUCER

*RIGIDWALL_FORCE_TRANSDUCER

Purpose: Define a force transducer for a rigid wall. The output of the transducer is written to the rwforc file.

Card 1	1	2	3	4	5	6	7	8
Variable	TID	RWID						
Type	I	I						
Default	none	none						

VARIABLE	DESCRIPTION
TID	Transducer ID.
RWID	Rigid wall ID.

Card 2	1	2	3	4	5	6	7	8
Variable	HEADING							
Type	C							
Default	none							
Remarks	1							

VARIABLE	DESCRIPTION
HEADING	Description for force transducer

Node Set Cards. For each node set add one card. This input ends at the next keyword ("*") card.

Card 3	1	2	3	4	5	6	7	8
Variable	NSID							
Type	I							
Default	none							

VARIABLE	DESCRIPTION
NSID	Node set ID.

Remarks:

1. **Reporting for Node Set.** The forces acting on rigid wall RWID are reported separately for each NSID.

2. **Segment Option for Rigid Walls.** For rigid walls using the segment option, the forces acting on each segment are reported separately for each NSID.

RIGIDWALL_GEOMETRIC_*SHAPE_{OPTION}_{OPTION}_{OPTION}

RIGIDWALL_GEOMETRIC_*SHAPE is a family of keywords all sharing a common set of data cards and option flags. The available shape variants are:

*RIGIDWALL_GEOMETRIC_FLAT

*RIGIDWALL_GEOMETRIC_PRISM

*RIGIDWALL_GEOMETRIC_CYLINDER

*RIGIDWALL_GEOMETRIC_SPHERE

If prescribed motion is desired an additional option is available:

MOTION

One of the shape types **[FLAT, PRISM, CYLINDER, SPHERE]** must be specified, followed by the optional definition of **MOTION**, both on the same line with ***RIGIDWALL_GEOMETRIC.** If an ID number is specified, the additional option is available:

ID

If active, the ID card is the first card following the keyword. To view the rigid wall, the option:

DISPLAY

is available. With this option a rigid body is automatically defined which represents the shape, the physical position of the wall, and follows the walls motion if the MOTION option is active. Additional input is optional if DISPLAY is active.

For the CYLINDER and SPHERE, the option:

INTERIOR

is available. Nodes are confined to the interior of these geometric forms.

For the CYLINDER, the option:

DEFORM

is available. With this option you can rotate and change the shape of the cylinder.

The order of the *OPTIONS* is arbitrary, that is, LS-DYNA will read *RIGIDWALL_GEOMETRIC_*SHAPE*_MOTION_DISPLAY the same as *RIGIDWALL_GEOMETRIC_*SHAPE*_DISPLAY_MOTION. However, the data cards have a strict order as indicated in the Card Summary.

Purpose: Define a rigid wall with an analytically described form. Four forms are possible. A prescribed motion is optional. For general rigid bodies with arbitrary surfaces and motion, refer to the *CONTACT_ENTITY definition. This option is for treating contact between rigid and deformable surfaces only.

Card Summary:

Card Sets. For each rigid wall include one set of the following data cards. This input ends at the next keyword ("*") card.

Card ID. First data card of the card set if the ID keyword option is used in the keyword name. Otherwise Card 1 is the first data card.

RWID	HEADING

Card 1. This card is required.

NSID	NSIDEX	BOXID	BIRTH	DEATH			

Card 2. This card is required.

XT	YT	ZT	XH	YH	ZH	FRIC	

Card 3a. This card is included only for the FLAT shape.

XHEV	YHEV	ZHEV	LENL	LENM			

Card 3b. This card is included only for the PRISM shape.

XHEV	YHEV	ZHEV	LENL	LENM	LENP		

Card 3c. This card is included only for the CYLINDER shape.

RADCYL	LENCYL	NSEGS					

Card 3c.1. NSEGS instances of this card are included only for the CYLINDER shape.

VL	HEIGHT						

Card 3c.2. This card is included only for the CYLINDER shape with DEFORM option.

XP	YP	ZP	NL	NARC	NR		

Card 3c.3. This card is included only for the CYLINDER shape with DEFORM option.

LCIDR	LCIDA	LCIDB	LCIDG				

Card 3d. This card is included only for the SPHERE shape.

RADSPH							

Card 4. This card is required if the MOTION keyword option is used.

LCID	OPT	VX	VY	VZ			

Card 5. This card is read only if the DISPLAY keyword option is used. It is optional and may be omitted unless more than one card set is being read in; if more than one card set is being used, then at least a blank line must be included for all, but the last card set. If not input, the defaults will be used.

PID	RO	E	PR				

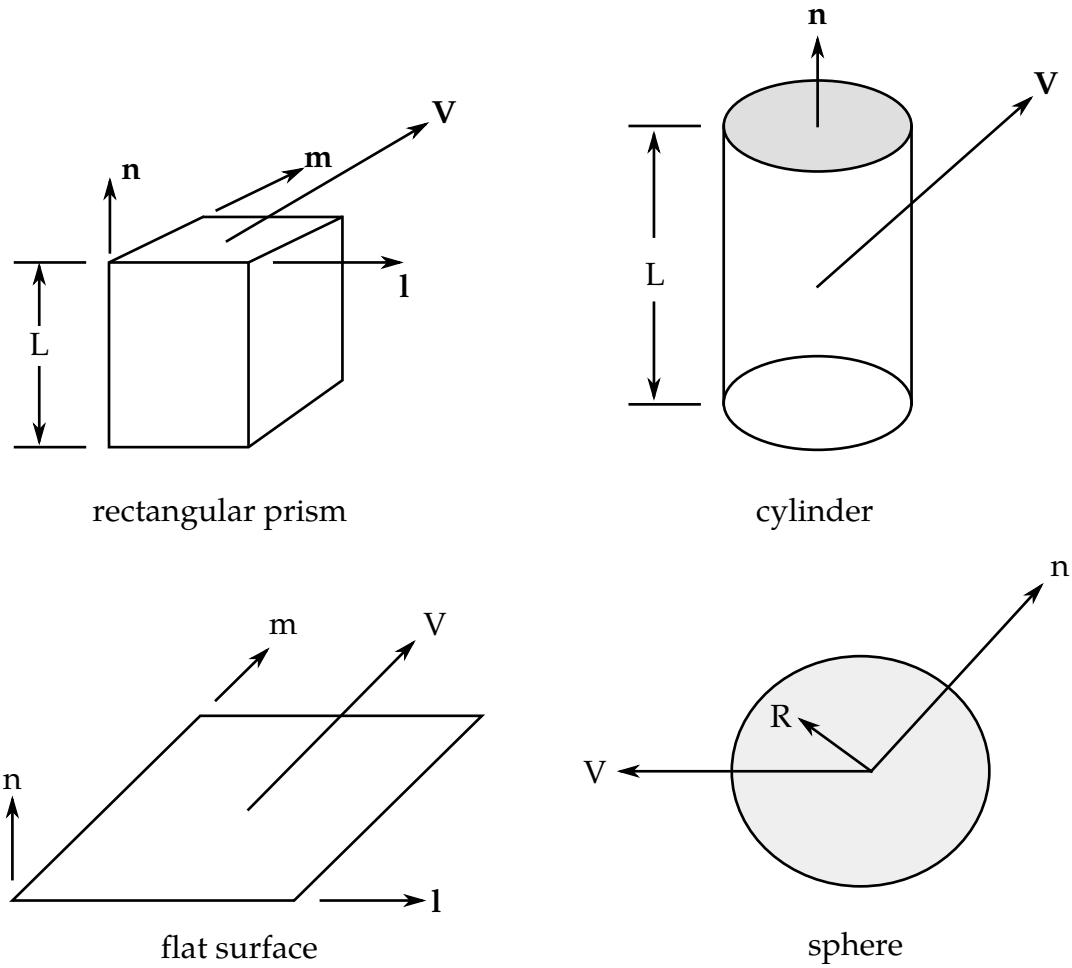

Figure 40-1. Vector **n** determines the orientation of the rigidwall. By including the MOTION option, motion of the rigidwall can be prescribed in any direction **V** as defined by variables VX, VY, VZ.

Data Card Definitions:

ID Card. Additional card for ID keyword option. This heading is picked up by some of the peripheral LS-DYNA codes to aid in post-processing.

Card ID	1	2	3	4	5	6	7	8
Variable	RWID	HEADING						
Type	I	A70						

VARIABLE	DESCRIPTION
RWID	Rigid wall ID. This must be a unique number.
HEADING	Rigid wall descriptor. It is suggested that unique descriptions be used. This field can be left undefined.

Card 1	1	2	3	4	5	6	7	8
Variable	NSID	NSIDEX	BOXID	BIRTH	DEATH			
Type	I	I	I	F	F			
Default	{all}	{∅}	{∅}	0.	10^{20}			

VARIABLE	DESCRIPTION
NSID	Nodal set ID containing tracked nodes; see *SET_NODE_*OPTION*: EQ.0: All nodes are tracked with respect to the rigid wall.
NSIDEX	Nodal set ID containing nodes exempted as tracked nodes; see *SET_NODE_*OPTION*.
BOXID	If defined, only nodes in box are included as tracked nodes for the rigid wall.
BIRTH	Birth time of rigid wall. The time values of the load curves that control the motion of the wall are offset by the birth time.

VARIABLE	DESCRIPTION
DEATH	Death time of rigid wall. At this time the wall is deleted from the calculation. If dynamic relaxation is active at the beginning of the calculation and if BIRTH = 0.0, the death time is ignored during the dynamic relaxation.

Card 2	1	2	3	4	5	6	7	8
Variable	XT	YT	ZT	XH	YH	ZH	FRIC	
Type	F	F	F	F	F	F	F	
Default	0.	0.	0.	0.	0.	0.	0.	

VARIABLE	DESCRIPTION
XT	x-coordinate of tail of any outward drawn normal vector, **n**, originating on wall (tail) and terminating in space (head); see Figure 40-1.
YT	y-coordinate of tail of normal vector **n**
ZT	z-coordinate of tail of normal vector **n**
XH	x-coordinate of head of normal vector **n**
YH	y-coordinate of head of normal vector **n**
ZH	z-coordinate of head of normal vector **n**
FRIC	Coulomb friction coefficient, except as noted below: EQ.0.0: Frictionless sliding when in contact EQ.1.0: No sliding when in contact

Flat Rigidwall Card. Card 3 for FLAT keyword option. A plane with a finite size or with an infinite size can be defined; see Figure 40-1. The vector **m** is computed as the vector cross product **n** × **l**. The origin, which is the tail (the start) of the normal vector, is the corner point of the finite size plane.

Card 3a	1	2	3	4	5	6	7	8
Variable	XHEV	YHEV	ZHEV	LENL	LENM			
Type	F	F	F	F	F			
Default	0.	0.	0.	infinity	infinity			

VARIABLE	DESCRIPTION
XHEV	x-coordinate of head of edge vector **l**; see Figure 40-1.
YHEV	y-coordinate of head of edge vector **l**
ZHEV	z-coordinate of head of edge vector **l**
LENL	Length of **l** edge. A zero value defines an infinite size plane.
LENM	Length of **m** edge. A zero value defines an infinite size plane.

Prismatic Rigidwall Card. Required card for PRISM keyword option that is input after Card 2. The description of the definition of a plane with finite size is enhanced by an additional length in the direction negative to **n**; see Figure 40-1.

Card 3b	1	2	3	4	5	6	7	8
Variable	XHEV	YHEV	ZHEV	LENL	LENM	LENP		
Type	F	F	F	F	F	F		
Default	none	0.	0.	infinity	infinity	infinity		

VARIABLE	DESCRIPTION
XHEV	x-coordinate of head of edge vector **l**, see Figure 40-1.
YHEV	y-coordinate of head of edge vector **l**

VARIABLE	DESCRIPTION
ZHEV	z-coordinate of head of edge vector **l**
LENL	Length of **l** edge. A zero value defines an infinite size plane.
LENM	Length of **m** edge. A zero value defines an infinite size plane.
LENP	Length of prism in the direction negative to **n**; see Figure 40-1.

Cylindrical Rigidwall Card. Required card for CYLINDER keyword option that is input after Card 2. The tail of **n** specifies the top plane of the cylinder. The length is defined in the direction negative to **n**. See Figure 40-1.

Card 3c	1	2	3	4	5	6	7	8
Variable	RADCYL	LENCYL	NSEGS					
Type	F	F	I					
Default	none	infinity	0					

VARIABLE	DESCRIPTION
RADCYL	Radius of cylinder
LENCYL	Length of cylinder; see Figure 40-1. Only if a value larger than zero is specified is a finite length assumed. For the DEFORM keyword option, the length of the cylinder must be finite.
NSEGS	Number of subsections along cylinder to output forces for post-processing. The force vector for each subsection is output to rwforc. This gives a better idea of the force distribution along the length of the cylinder.

NSEGS Card. For the CYLINDER option, NSEGS of this card must be input after Card 3c.

Card 3c.1	1	2	3	4	5	6	7	8
Variable	VL	HEIGHT						
Type	F	F						
Default	none	none						

VARIABLE	DESCRIPTION
VL	Distance from the top plane of the cylinder where the subsection begins.
HEIGHT	Section height. The subsection starts at VL and extends the length, HEIGHT, in the *negative* **n**-direction.

DEFORM Card 1. If the DEFORM option is used for the CYLINDER shape, this card must be input after Card 3c.1.

Card 3c.2	1	2	3	4	5	6	7	8
Variable	XP	YP	ZP	NL	NARC	NR		
Type	F	F	F	I	I	I		
Default	none	none	none	none	none	none		

VARIABLE	DESCRIPTION
XP, YP, ZP	Coordinates of a point in the local *xz*-plane of the local coordinate system for cylinder. See Remark 1.
NL	Number of auto-generated elements in the longitudinal direction. If DISPLAY option is not used, NL will be ignored. See Remark 2.
NARC	Number of auto-generated elements in the circumferential direction. If DISPLAY option is not used, NARC will be ignored.

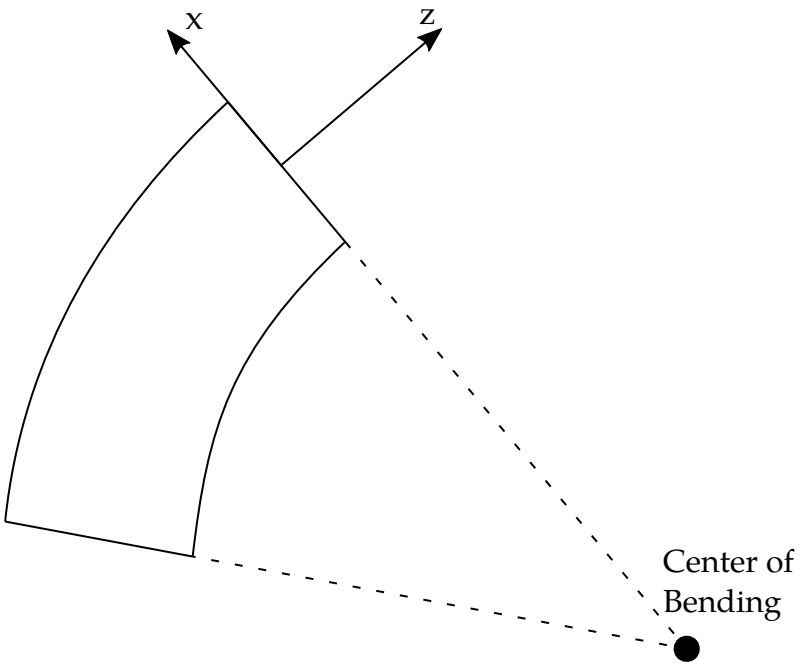

Figure 40-2. Example of cylinder bending for DEFORM keyword option

VARIABLE	DESCRIPTION
NR	Number of auto-generated elements in the radius direction. If DISPLAY option is not used, NR will be ignored.

DEFORM Card 2. If the DEFORM option is used for the CYLINDER shape, this card must be input after Card 3c.2.

Card 3c.3	1	2	3	4	5	6	7	8
Variable	LCIDR	LCIDA	LCIDB	LCIDG				
Type	I	I	I	I				
Default	0	0	0	0				

VARIABLE	DESCRIPTION
LCIDR	Load curve ID to describe the change of the radius over time
LCIDA	Load curve ID to specify the change of the rotation in radians about the local *x*-axis over time.

VARIABLE	DESCRIPTION
LCIDB	Load curve ID to describe the change of the bending curvature over time. Bending occurs in the local *xz*-plane with the center of the bending lying on the negative side of the local *x*-axis. See Figure 40-2.
LCIDG	Load curve ID to describe the change of the rotation in radians about the local *z*-axis over time.

Card 3d	1	2	3	4	5	6	7	8
Variable	RADSPH							
Type	F							
Default	0.							

VARIABLE	DESCRIPTION
RADSPH	Radius of sphere

Motion Card. Additional card for MOTION keyword option.

Card 4	1	2	3	4	5	6	7	8
Variable	LCID	OPT	VX	VY	VZ			
Type	I	I	F	F	F			
Default	none	0	none	none	none			

VARIABLE	DESCRIPTION
LCID	Rigidwall motion curve ID; see *DEFINE_CURVE.
OPT	Type of motion: EQ.0: velocity specified, EQ.1: displacement specified.

VARIABLE	DESCRIPTION
VX	x-direction cosine of velocity/displacement vector
VY	y-direction cosine of velocity/displacement vector
VZ	z-direction cosine of velocity/displacement vector

Display Card. Optional card for DISPLAY keyword option. If this card is omitted, default values are set. The values set here have no effect on the solution other than the PID appearing in the post-processing.

Card 5	1	2	3	4	5	6	7	8
Variable	PID	RO	E	PR				
Type	I	I	I	F				
Default	↓	10^{-9}	10^{-4}	0.3				

VARIABLE	DESCRIPTION
PID	Unique part ID for moving geometric rigid wall. If zero or left empty for default behavior, a part ID will be set that is larger than the maximum of all user defined part IDs.
RO	Density of rigid wall. The default is set to 10^{-9}.
E	Young's modulus. The default is set to 10^{-4}.
PR	Poisson's ratio. The default is set to 0.30.

Remarks:

1. **Local coordinate system of the cylinder.** When keyword option DEFORM is used, the deformations of the cylinder are based upon a local coordinate system. The origin of the coordinate system is (XT,YT,ZT). The local z-direction is aligned with vector **n**. The cross product of vector **n** with the vector that has its the tail at the origin and head at (XP,YP,ZP) gives the local y-axis. The direction of the local x-axis is the cross product of a vector on the local y-axis and vector **n**.

2. **Visualization of the cylinder with DEFORM option**. Elements generated by defining NL, NARC and NR are only for visualization. These elements are not used in analysis.

Example:

```
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$
$$$$   *RIGIDWALL_GEOMETRIC_SPHERE_MOTION
$
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$
$  Define a rigid sphere:
$     - with a radius of 8
$     - centered at (x,y,z) = (20,20,9)
$     - that moves in the negative z-direction with a specified displacement
$          given by a load curve (load curve: lcid = 5)
$     - which prevents all nodes within a specified box from penetrating the
$          sphere (box number: boxid = 3), these nodes can slide on the sphere
$          without friction
$
*RIGIDWALL_GEOMETRIC_SPHERE_MOTION
$...>....1....>....2....>....3....>....4....>....5....>....6....>....7....>....8
$     nsid    nsidex     boxid
                             3
$
$       xt        yt        zt        xh        yh        zh      fric
      20.0      20.0       9.0      20.0      20.0       0.0       0.0
$
$   radsph
       8.0
$
$     lcid       opt        vx        vy        vz
         5         1       0.0       0.0      -1.0
$
$
*DEFINE_BOX
$    boxid       xmn       xmx       ymn       ymx       zmn       zmx
         3       0.0      40.0       0.0      40.0      -1.0       1.0
$
$
*DEFINE_CURVE
$     lcid      sidr      scla      sclo      offa      offo
         5
$           abscissa            ordinate
                 0.0                 0.0
              0.0005                15.0
$
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
```

***RIGIDWALL_PLANAR**_{OPTION}_{OPTION}_{OPTION}

Available options include:

<BLANK>

ORTHO

FINITE

MOVING

FORCES

The ordering of the input below as specified in the Card Summary must be observed, but the ordering of the options in the keyword name is unimportant. For example, both *RIGIDWALL_PLANAR_ORTHO_FINITE and *RIGIDWALL_PLANAR_FINITE_ORTHO are valid and have the same effect. The ORTHO option does not apply if the MOVING option is used.

An ID number may be assigned to the rigid wall using the following option:

ID

If this option is active, the ID card is the first card following the keyword.

Display of a non-moving, planar rigid wall is on by default (see SKIPRWG in *CONTROL_CONTACT). The option

DISPLAY

is available for display of moving rigid walls. With this option active, a rigid body is automatically created which represents the shape of the rigid wall and tracks its position without need for additional input. The part ID of the rigid body defaults to RWID if the ID option is active and RWID is a unique ID within the set of all part IDs.

Purpose: Define planar rigid walls with either finite (FINITE) or infinite size. Orthotropic friction can be defined (ORTHO). Also, the plane can possess a mass and an initial velocity (MOVING); otherwise, the wall is assumed to be stationary. The FORCES option allows the specification of segments on the rigid walls on which the contact forces are computed. For a more physical reaction related to the force as function of time curve, the SOFT value on the FORCES card can be specified.

Card Summary:

Card Sets. For each rigid wall matching the specified keyword options include one set of the following data cards. This input ends at the next keyword ("*") card.

Card ID. This card is included if the ID keyword option is used.

ID							

Card 1. This card is required.

NSID	NSIDEX	BOXID	OFFSET	BIRTH	DEATH	RWKSF	

Card 2. This card is required.

XT	YT	ZT	XH	YH	ZH	FRIC	WVEL

Card 3. This card is included if the ORTHO option is used.

SFRICA	SFRICB	DFRICA	DFRICB	DECAYA	DECAYB		

Card 4. This card is included if the ORTHO option is used.

NODE1	NODE2	D1	D2	D3			

Card 5. This card is included if the FINITE option is used.

XHEV	YHEV	ZHEV	LENL	LENM			

Card 6. This card is included if the MOVING option is used.

MASS	V0						

Card 7. This card is included if the FORCES option is used.

SOFT	SSID	N1	N2	N3	N4		

Data Card Definitions:

ID. Card. Additional card for ID keyword option.

Card ID	1	2	3	4	5	6	7	8
Variable	RWID							
Type	I							
Default	none							

VARIABLE	DESCRIPTION
RWID	Rigid wall ID. Up to 8 characters can be used.

Card 1	1	2	3	4	5	6	7	8
Variable	NSID	NSIDEX	BOXID	OFFSET	BIRTH	DEATH	RWKSF	
Type	I	I	I	F	F	F	F	
Default	all nodes	{∅}	{∅}	0.	0.	10^{20}	1.0	

VARIABLE	DESCRIPTION
NSID	Nodal set ID containing tracked nodes; see *SET_NODE: EQ.0: All nodes are tracked for interacting with the rigid wall.
NSIDEX	Nodal set ID containing nodes that are exempted as tracked nodes; see *SET_NODE.
BOXID	All nodes in box are included as tracked nodes for interacting with the rigid wall; see *DEFINE_BOX. If options NSID or NSIDEX are active, then only the subset of nodes activated by these options are checked to see if they are within the box.
OFFSET	All nodes within a normal offset distance, OFFSET, to the rigid wall are included as tracked nodes for the rigid wall. If options NSID, NSIDEX, or BOXID are active, then only the subset of nodes activated by these options are checked to see if they are within the offset distance.
BIRTH	Birth time of rigid wall. The time values of the load curves that control the motion of the wall are offset by the birth time.
DEATH	Death time of rigid wall. At this time the wall is deleted from the calculation. If dynamic relaxation is active at the beginning of the calculation and BIRTH = 0.0, the death time is ignored during the dynamic relaxation.
RWKSF	Stiffness scaling factor. If RWKSF is also specified in *CONTROL_CONTACT, the stiffness is scaled by the product of the two values.

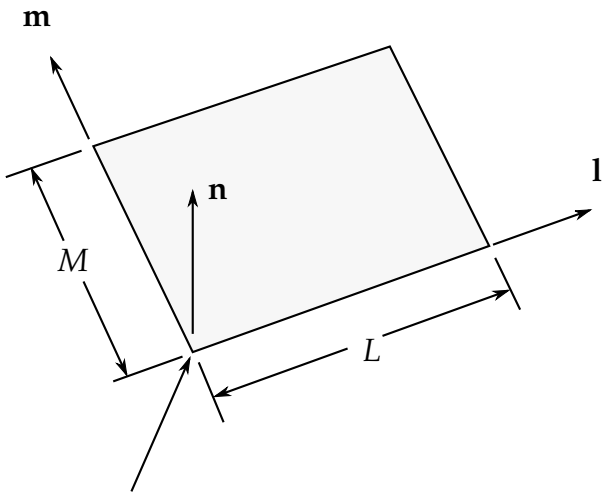

Figure 40-3. Vector **n** is normal to the rigidwall. An optional vector **l** can be defined such that **m** = **n** × **l**. The extent of the rigidwall is limited by defining L (LENL) and M (LENM). A zero value for either of these lengths indicates that the rigidwall is infinite in that direction.

Card 2	1	2	3	4	5	6	7	8
Variable	XT	YT	ZT	XH	YH	ZH	FRIC	WVEL
Type	F	F	F	F	F	F	F	F
Default	0.	0.	0.	0.	0.	0.	0.	0.

VARIABLE	DESCRIPTION
XT	*x*-coordinate of tail of any outward drawn normal vector, **n**, originating on wall (tail) and terminating in space (head), see Figure 40-3.
YT	*y*-coordinate of tail of normal vector **n**
ZT	*z*-coordinate of tail of normal vector **n**
XH	*x*-coordinate of head of normal vector **n**
YH	*y*-coordinate of head of normal vector **n**

VARIABLE	DESCRIPTION
ZH	z-coordinate of head of normal vector **n**
FRIC	Coulomb friction coefficient except as noted below: EQ.0.0: frictionless sliding after contact, EQ.1.0: no sliding after contact, EQ.2.0: node is welded after contact with frictionless sliding. Welding occurs if and only if the normal value of the impact velocity exceeds the critical value specified by WVEL. EQ.3.0: node is welded after contact with no sliding. Welding occurs if and only if the normal value of the impact velocity exceeds the critical value specified by WVEL. In summary, FRIC could be any positive value. Three special values of FRIC trigger special treatments as follows:
WVEL	Critical normal velocity at which nodes weld to wall (FRIC = 2 or 3).

FRIC	1.0	2.0	3.0
Bouncing back from wall	allowed	not allowed	not allowed
Sliding on wall	not allowed	allowed	not allowed

Orthotropic Friction Card 1. Additional card for ORTHO keyword option. See Figure 40-4 for the definition of orthotropic friction.

Card 3	1	2	3	4	5	6	7	8
Variable	SFRICA	SFRICB	DFRICA	DFRICB	DECAYA	DECAYB		
Type	F	F	F	F	F	F		
Default	0.	0.	0.	0.	0.	0.		

Orthotropic Friction Card 2. Additional card for ORTHO keyword option. See Figure 40-4 for the definition of orthotropic friction.

Card 4	1	2	3	4	5	6	7	8
Variable	NODE1	NODE2	D1	D2	D3			
Type	I	I	F	F	F			
Default	0	0	0.	0.	0.			

VARIABLE	DESCRIPTION
SFRICA	Static friction coefficient in local a-direction, μ_{sa}; see Figure 40-4 and Remark 1.
SFRICB	Static friction coefficient in local b-direction, μ_{sb}
DFRICA	Dynamic friction coefficient in local a-direction, μ_{ka}
DFRICB	Dynamic friction coefficient in local b-direction, μ_{kb}
DECAYA	Decay constant in local a-direction, d_{ya}
DECAYB	Decay constant in local b-direction, d_{yb}
NODE1	Node 1, alternative to definition of vector **d** using components below. See Figure 40-4. With the node definition, the direction changes if the nodal pair rotates. See Remark 2.
NODE2	Node 2
D1	d_1, x-component of vector, alternative to definition with nodes above. See Figure 40-4. This vector is fixed as a function of time. See Remark 2.
D2	d_2, y-component of vector
D3	d_3, z-component of vector

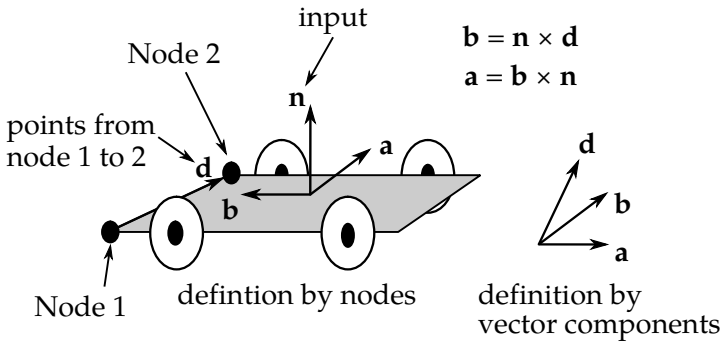

Figure 40-4. Definition of orthotropic friction vectors. The two methods of defining the vector, **d**, are shown. If vector **d** is defined by nodes 1 and 2, the local coordinate system may rotate with the body which contains the nodes; otherwise, **d** is fixed in space, thus on the rigid wall, and the local system is stationary.

Finite Wall Size Card. Additional card for FINITE keyword option. See Figure 40-4 for the definition of orthotropic friction. See Figure 40-3. The ***m*** vector is computed as the vector cross product $\boldsymbol{m} = \boldsymbol{n} \times \boldsymbol{l}$. The origin, the tail of the normal vector, is taken as the corner point of the finite size plane.

Card 5	1	2	3	4	5	6	7	8
Variable	XHEV	YHEV	ZHEV	LENL	LENM			
Type	F	F	F	F	F			
Default	0.	0.	0.	infinity	infinity			

VARIABLE	DESCRIPTION
XHEV	x-coordinate of head of edge vector ***l***, see Figure 40-3.
YHEV	y-coordinate of head of edge vector ***l***
ZHEV	z-coordinate of head of edge vector ***l***
LENL	Length of ***l*** edge
LENM	Length of ***m*** edge

Moving Wall Card. Additional card for MOVING keyword option. Note: The MOVING option is *not* compatible with the ORTHO option.

Card 6	1	2	3	4	5	6	7	8
Variable	MASS	V0						
Type	F	F						
Default	none	0.						

VARIABLE	DESCRIPTION
MASS	Total mass of rigidwall
V0	Initial velocity of rigidwall in direction of defining vector, **n**

Forces Card. Additional card for FORCES keyword option. This option allows the force distribution to be monitored on the plane. Also four points can be defined for visualization of the rigid wall. A shell or membrane element must be defined with these four points as the connectivity for viewing in LS-PREPOST.

Card 7	1	2	3	4	5	6	7	8
Variable	SOFT	SSID	N1	N2	N3	N4		
Type	I	I	I	I	I	I		
Default	0	{∅}	no node	no node	no node	no node		

VARIABLE	DESCRIPTION
SOFT	Number of cycles to zero relative velocity to reduce force spike
SSID	Segment set ID for defining areas for force output; see *SET_SEGMENT and Remark 3 below.
N1-N4	Optional node for visualization. See Remark 4.

Remarks:

1. **Orthotropic Coefficients of Friction.** The coefficients of friction are defined in terms of the static, dynamic and decay coefficients and the relative velocities in the local a and b-directions as

$$\mu_a = \mu_{ka} + (\mu_{sa} - \mu_{ka})e^{-d_{va}|V_{\text{relative},a}|}$$
$$\mu_b = \mu_{kb} + (\mu_{sb} - \mu_{kb})e^{-d_{vb}|V_{\text{relative},b}|}$$

2. **Modeling Rolling Objects.** Orthotropic rigid walls can be used to model rolling objects on rigid walls where the frictional forces are substantially higher in a direction transverse to the rolling direction. To use this option, define a vector **d** to determine the local frictional directions by:

$$\mathbf{b} = \mathbf{n} \times \mathbf{d}, \qquad \mathbf{a} = \mathbf{b} \times \mathbf{n}$$

where **n** is the normal vector to the rigid wall. If **d** is in the plane of the rigid wall, then **a** is identical to **d**.

3. **Resultant Forces.** The segment set defines areas for computing resultant forces. These segments translate with the moving rigidwall and allow the force distribution to be determined. The resultant forces are written in file rwforc.

4. **Visualization with LS-PrePost.** These four nodes are for visualizing the movement of the wall, that is, they move with the wall. To view the wall in LS-PREPOST a single shell element with these four nodes as its connectivity need to be defined. The single element must be deformable (non-rigid) or else the segment will be treated as a rigid body and the nodes will have their motion modified independently of the rigidwall.

Example:

```
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$
$$$$   *RIGIDWALL_PLANAR_MOVING_FORCES
$
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
$
$  Define a moving planar rigid wall:
$     - that is parallel to the y-z plane starting at x = 250 mm
$     - with an initial velocity of 8.94 mm/ms in the negative z-direction
$     - that has a mass of 800 kg
$     - which prevents all nodes in the model from penetrating the wall
$     - with a friction coefficient for nodes sliding along the wall of 0.1
$     - track the motion of the wall by creating a node (numbered 99999)
$         at the tail of the wall and assigning the node to move with the wall
$
*RIGIDWALL_PLANAR_MOVING_FORCES
$...>....1....>....2....>....3....>....4....>....5....>....6....>....7....>....8
$     nsid    nsidex     boxid
         0         0         0
$
$       xt        yt        zt        xh        yh        zh      fric
```

```
     250.0       0.0       0.0       0.0       0.0       0.0       0.1
$
$  SW mass    SW vel
    800.00      8.94
$
$     soft      ssid     node1     node2     node3     node4
         0         0     99999
$
$
*NODE
$
$...>....1....>....2....>....3....>....4....>....5....>....6....>....7....>....8
$    nid               x               y               z      tc      rc
   99999           250.0             0.0             0.0       0       0
$
$
*DATABASE_HISTORY_NODE
$   Define nodes that output into nodout
$      id1       id2       id3
$...>....1....>....2....>....3....>....4....>....5....>....6....>....7....>....8
     99999
$
*DATABASE_NODOUT
$       dt
       0.1
$
$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$$
```