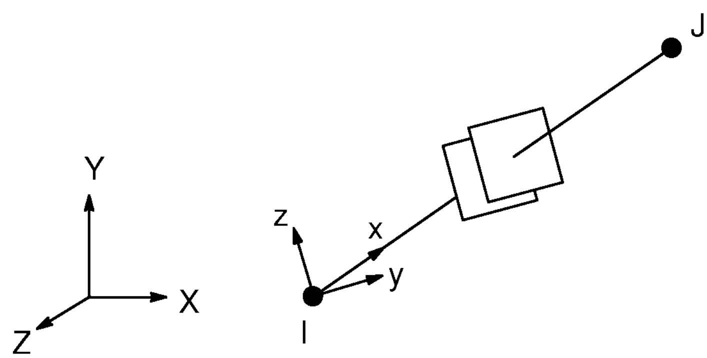
14.52 CONTAC52 — 3–D Point–to–Point Contact



Matrix or Vector	Geometry	Shape Functions	Integration Points
Stiffness Matrix	Normal Direction	None	None
	Sliding Direction	None	None

Load Type	Distribution
Element Temperature	None – average used for material property evaluation
Nodal Temperature	None – average used for material property evaluation

14.52.1 Other Applicable Sections

Section 14.12 has many aspects also valid for CONTAC52, including normal and sliding force determinations, rigid Coulomb friction (KEYOPT(1) = 1), and the force–deflection relationship shown in Figure 14.12–1.

14.52.2 Element Matrices

CONTAC52 may have one of three conditions: closed and stuck, closed and sliding, or open.

If the element is closed and stuck, the element stiffness matrix (in element coordinates) is:

$$[K_\ell] = \begin{bmatrix} k_n & 0 & 0 & -k_n & 0 & 0 \\ 0 & k_s & 0 & 0 & -k_s & 0 \\ 0 & 0 & k_s & 0 & 0 & -k_s \\ -k_n & 0 & 0 & k_n & 0 & 0 \\ 0 & -k_s & 0 & 0 & k_s & 0 \\ 0 & 0 & -k_s & 0 & 0 & k_s \end{bmatrix} \qquad (14.52\text{–}1)$$

where: k_n = normal stiffness (input quantity KN on **R** command)

k_s = sticking stiffness (input quantity KS on **R** command)

The Newton–Raphson load vector is:

$$\{F_\ell^{nr}\} = \begin{Bmatrix} F_n \\ F_{sy} \\ F_{sz} \\ -F_n \\ -F_{sy} \\ -F_{sz} \end{Bmatrix} \qquad (14.52\text{–}2)$$

where: F_n = normal force across gap (from previous iteration)

F_s = sticking force across gap (from previous iteration)

If the element is closed and sliding in both directions, the element stiffness matrix (in element coordinates) is:

$$[K_\ell] = \begin{bmatrix} k_n & 0 & 0 & -k_n & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ -k_n & 0 & 0 & k_n & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \end{bmatrix} \qquad (14.52\text{–}3)$$

and the Newton–Raphson load vector is the same as in equation (14.52–2). For details on the unsymmetric option (KEYOPT(11) = 1), see Section 14.12.2

If the element is open, there is no stiffness matrix or load vector.

14.52.3 Orientation of Element

For both small and large deformation analysis, the orientation of the element is unchanged. The element is oriented so that the normal force is in line with the original position of the two nodes.