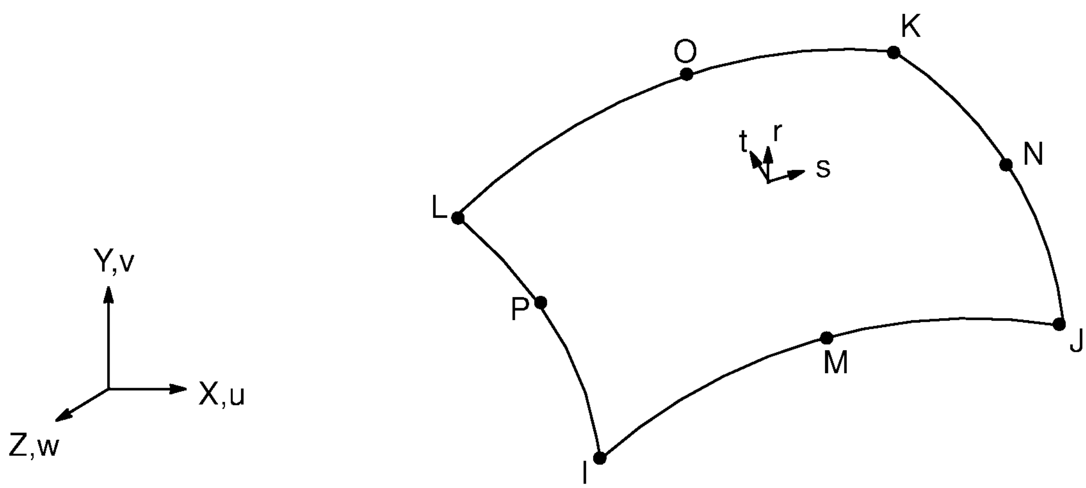
14.150 SHELL150 — 8–Node Structural Shell p–Element



Matrix or Vector	Geometry	Geometric Shape Functions	Solution Shape Functions	Integration Points
Stiffness Matrix	Quad	Equations (12.5.14–1), (12.5.14–2), and (12.5.14–3)	Polynomial variable in order from 2 to 8	Thru–the–thickness: 2 In–plane: Variable
	Triangle	Equations (12.5.5–1), (12.5.5–2), and (12.5.5–3)	Polynomial variable in order from 2 to 8	Thru–the–thickness:2 In–plane: Variable
Thermal and Inertial Load Vector	Same as stiffness matrix		Polynomial variable in order from 2 to 8	Same as stiffness matrix

Matrix or Vector	Geometry	Geometric Shape Functions	Solution Shape Functions	Integration Points
Transverse Pressure Load Vector	Quad	Equation (12.5.10–3)	Polynomial variable in order from 2 to 8	Variable
	Triangle	Equation (12.5.2–3)	Polynomial variable in order from 2 to 8	Variable
Edge Pressure Load Vector	Same as in–plane stiffness matrix, specialized to the edge		Polynomial variable in order from 2 to 8	Variable

Load Type	Distribution
Element Temperature	Linear thru thickness, bilinear in plane of element
Nodal Temperature	Constant thru thickness, bilinear in plane of element
Pressure	Bilinear across plane of element, linear along each edge

Reference: Ahmad (1), Cook(5), Szabo and Babuska(192)

14.150.1 Other Applicable Sections

Chapter 2 describes the derivation of structural element matrices and load vectors as well as stress evaluations.

14.150.2 Assumptions and Restrictions

Normals to the centerplane are assumed to remain straight after deformation, but not necessarily normal to the centerplane.

Each pair of integration points (in the r direction) is assumed to have the same element (material) orientation.

There is no significant stiffness associated with rotation about the element r axis.

This element uses a lumped (translation only) inertial load vector.

14.150.3 Stress–Strain Relationships

The material property matrix [D] for the element is:

$$[D] = \begin{bmatrix} BE_x & B\nu_{xy}E_x & 0 & 0 & 0 & 0 \\ B\nu_{xy}E_x & BE_y & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & G_{xy} & 0 & 0 \\ 0 & 0 & 0 & 0 & \frac{G_{yz}}{f} & 0 \\ 0 & 0 & 0 & 0 & 0 & \frac{G_{xz}}{f} \end{bmatrix} \qquad (14.150\text{–}1)$$

where:

$B = \dfrac{E_y}{E_y - (\nu_{xy})^2 E_x}$

E_x = Young's modulus in element x direction (input as EX on **MP** command)

ν_{xy} = Poisson's ratio in element x–y plane (input as NUXY on **MP** command)

G_{xy} = shear modulus in element x–y plane (input as GXY on **MP** command)

$f = \begin{Bmatrix} 1.2 \\ 1.0 + .2\dfrac{A}{25t^2} \end{Bmatrix}$, whichever is greater

A = element area (in s–t plane)

t = average thickness

The above definition of f is designed to avoid shear locking.