28.1.4 Three-dimensional solid element library

Products: Abaqus/Standard Abaqus/Explicit Abaqus/CAE

References

- "Solid (continuum) elements," Section 28.1.1
- *SOLID SECTION

Overview

This section provides a reference to the three-dimensional solid elements available in Abaqus/Standard and Abaqus/Explicit.

Element types

Stress/displacement elements

C3D4	4-node linear tetrahedron
C3D4H(S)	4-node linear tetrahedron, hybrid with linear pressure
C3D6(S)	6-node linear triangular prism
C3D6(E)	6-node linear triangular prism, reduced integration with hourglass control
C3D6H(S)	6-node linear triangular prism, hybrid with constant pressure
C3D8	8-node linear brick
C3D8H(S)	8-node linear brick, hybrid with constant pressure
C3D8I	8-node linear brick, incompatible modes
C3D8IH(S)	8-node linear brick, incompatible modes, hybrid with linear pressure
C3D8R	8-node linear brick, reduced integration with hourglass control
C3D8RH(S)	8-node linear brick, reduced integration with hourglass control, hybrid with constant pressure
C3D10(S)	10-node quadratic tetrahedron
C3D10H(S)	10-node quadratic tetrahedron, hybrid with constant pressure
C3D10I(S)	10-node general-purpose quadratic tetrahedron, improved surface stress visualization
C3D10M	10-node modified tetrahedron, with hourglass control
C3D10MH(S)	10-node modified tetrahedron, with hourglass control, hybrid with linear pressure
C3D15(S)	15-node quadratic triangular prism
C3D15H(S)	15-node quadratic triangular prism, hybrid with linear pressure

C3D20$^{(S)}$	20-node quadratic brick
C3D20H$^{(S)}$	20-node quadratic brick, hybrid with linear pressure
C3D20R$^{(S)}$	20-node quadratic brick, reduced integration
C3D20RH$^{(S)}$	20-node quadratic brick, reduced integration, hybrid with linear pressure

Active degrees of freedom

1, 2, 3

Additional solution variables

The constant pressure hybrid elements have one additional variable relating to pressure, and the linear pressure hybrid elements have four additional variables relating to pressure.

Element types C3D8I and C3D8IH have thirteen additional variables relating to the incompatible modes.

Element types C3D10M and C3D10MH have three additional displacement variables.

Stress/displacement variable node elements

C3D15V$^{(S)}$	15 to 18-node triangular prism
C3D15VH$^{(S)}$	15 to 18-node triangular prism, hybrid with linear pressure
C3D27$^{(S)}$	21 to 27-node brick
C3D27H$^{(S)}$	21 to 27-node brick, hybrid with linear pressure
C3D27R$^{(S)}$	21 to 27-node brick, reduced integration
C3D27RH$^{(S)}$	21 to 27-node brick, reduced integration, hybrid with linear pressure

Active degrees of freedom

1, 2, 3

Additional solution variables

The hybrid elements have four additional variables relating to pressure.

Coupled temperature-displacement elements

C3D4T	4-node linear displacement and temperature
C3D6T$^{(S)}$	6-node linear displacement and temperature
C3D6T$^{(E)}$	6-node linear displacement and temperature, reduced integration with hourglass control
C3D8T	8-node trilinear displacement and temperature
C3D8HT$^{(S)}$	8-node trilinear displacement and temperature, hybrid with constant pressure
C3D8RT	8-node trilinear displacement and temperature, reduced integration with hourglass control

C3D8RHT(S)	8-node trilinear displacement and temperature, reduced integration with hourglass control, hybrid with constant pressure
C3D10MT	10-node modified displacement and temperature tetrahedron, with hourglass control
C3D10MHT(S)	10-node modified displacement and temperature tetrahedron, with hourglass control, hybrid with linear pressure
C3D20T(S)	20-node triquadratic displacement, trilinear temperature
C3D20HT(S)	20-node triquadratic displacement, trilinear temperature, hybrid with linear pressure
C3D20RT(S)	20-node triquadratic displacement, trilinear temperature, reduced integration
C3D20RHT(S)	20-node triquadratic displacement, trilinear temperature, reduced integration, hybrid with linear pressure

Active degrees of freedom

1, 2, 3, 11 at corner nodes

1, 2, 3 at midside nodes of second-order elements in Abaqus/Standard

1, 2, 3, 11 at midside nodes of modified displacement and temperature elements in Abaqus/Standard

Additional solution variables

The constant pressure hybrid element has one additional variable relating to pressure, and the linear pressure hybrid elements have four additional variables relating to pressure.

Element types C3D10MT and C3D10MHT have three additional displacement variables and one additional temperature variable.

Coupled thermal-electrical-structural elements

Q3D4(S)	4-node linear displacement, electric potential and temperature
Q3D6(S)	6-node linear displacement, electric potential and temperature
Q3D8(S)	8-node trilinear displacement, electric potential and temperature
Q3D8H(S)	8-node trilinear displacement, electric potential and temperature, hybrid with constant pressure
Q3D8R(S)	8-node trilinear displacement, electric potential and temperature, reduced integration with hourglass control
Q3D8RH(S)	8-node trilinear displacement, electric potential and temperature, reduced integration with hourglass control, hybrid with constant pressure
Q3D10M(S)	10-node modified displacement, electric potential and temperature tetrahedron, with hourglass control

Q3D10MH(S)	10-node modified displacement, electric potential and temperature tetrahedron, with hourglass control, hybrid with linear pressure
Q3D20(S)	20-node triquadratic displacement, trilinear electric potential and trilinear temperature
Q3D20H(S)	20-node triquadratic displacement, trilinear electric potential, trilinear temperature, hybrid with linear pressure
Q3D20R(S)	20-node triquadratic displacement, trilinear electric potential, trilinear temperature, reduced integration
Q3D20RH(S)	20-node triquadratic displacement, trilinear electric potential, trilinear temperature, reduced integration, hybrid with linear pressure

Active degrees of freedom

1, 2, 3, 9, 11 at corner nodes

1, 2, 3 at midside nodes of second-order elements in Abaqus/Standard

1, 2, 3, 9, 11 at midside nodes of modified displacement and temperature elements in Abaqus/Standard

Additional solution variables

The constant pressure hybrid element has one additional variable relating to pressure, and the linear pressure hybrid elements have four additional variables relating to pressure.

Element types Q3D10M and Q3D10MH have three additional displacement variables, one additional electric potential variable, and one additional temperature variable.

Diffusive heat transfer or mass diffusion elements

DC3D4(S)	4-node linear tetrahedron
DC3D6(S)	6-node linear triangular prism
DC3D8(S)	8-node linear brick
DC3D10(S)	10-node quadratic tetrahedron
DC3D15(S)	15-node quadratic triangular prism
DC3D20(S)	20-node quadratic brick

Active degree of freedom

11

Additional solution variables

None.

Forced convection/diffusion elements

DCC3D8(S)	8-node

DCC3D8D(S)	8-node with dispersion control

Active degree of freedom

11

Additional solution variables

None.

Coupled thermal-electrical elements

DC3D4E(S)	4-node linear tetrahedron
DC3D6E(S)	6-node linear triangular prism
DC3D8E(S)	8-node linear brick
DC3D10E(S)	10-node quadratic tetrahedron
DC3D15E(S)	15-node quadratic triangular prism
DC3D20E(S)	20-node quadratic brick

Active degrees of freedom

9, 11

Additional solution variables

None.

Pore pressure elements

C3D4P(S)	4-node linear displacement and pore pressure
C3D6P(S)	6-node linear displacement and pore pressure
C3D8P(S)	8-node trilinear displacement and pore pressure
C3D8PH(S)	8-node trilinear displacement and pore pressure, hybrid with constant pressure
C3D8RP(S)	8-node trilinear displacement and pore pressure, reduced integration
C3D8RPH(S)	8-node trilinear displacement and pore pressure, reduced integration, hybrid with constant pressure
C3D10MP(S)	10-node modified displacement and pore pressure tetrahedron, with hourglass control
C3D10MPH(S)	10-node modified displacement and pore pressure tetrahedron, with hourglass control, hybrid with linear pressure
C3D20P(S)	20-node triquadratic displacement, trilinear pore pressure
C3D20PH(S)	20-node triquadratic displacement, trilinear pore pressure, hybrid with linear pressure

C3D20RP(S)	20-node triquadratic displacement, trilinear pore pressure, reduced integration
C3D20RPH(S)	20-node triquadratic displacement, trilinear pore pressure, reduced integration, hybrid with linear pressure

Active degrees of freedom

1, 2, 3 at midside nodes for all elements except C3D10MP and C3D10MPH, which also have degree of freedom 8 active at midside nodes

1, 2, 3, 8 at corner nodes

Additional solution variables

The constant pressure hybrid elements have one additional variable relating to the effective pressure stress, and the linear pressure hybrid elements have four additional variables relating to the effective pressure stress to permit fully incompressible material modeling.

Element types C3D10MP and C3D10MPH have three additional displacement variables and one additional pore pressure variable.

Coupled temperature–pore pressure elements

C3D8PT(S)	8-node trilinear displacement, pore pressure, and temperature.
C3D8PHT(S)	8-node trilinear displacement, pore pressure, and temperature; hybrid with constant pressure
C3D8RPT(S)	8-node trilinear displacement, pore pressure, and temperature; reduced integration
C3D8RPHT(S)	8-node trilinear displacement, pore pressure, and temperature; reduced integration, hybrid with constant pressure
C3D10MPT(S)	10-node modified displacement, pore pressure, and temperature tetrahedron, with hourglass control

Active degrees of freedom

1, 2, 3, 8, 11

Additional solution variables

The constant pressure hybrid elements have one additional variable relating to the effective pressure stress to permit fully incompressible material modeling.

Element type C3D10MPT has three additional displacement variables, one additional pore pressure variable, and one additional temperature variable.

Acoustic elements

AC3D4	4-node linear tetrahedron
AC3D6	6-node linear triangular prism
AC3D8(S)	8-node linear brick

AC3D8R(E)	8-node linear brick, reduced integration with hourglass control
AC3D10(S)	10-node quadratic tetrahedron
AC3D15(S)	15-node quadratic triangular prism
AC3D20(S)	20-node quadratic brick

Active degree of freedom

8

Additional solution variables

None.

Piezoelectric elements

C3D4E(S)	4-node linear tetrahedron
C3D6E(S)	6-node linear triangular prism
C3D8E(S)	8-node linear brick
C3D10E(S)	10-node quadratic tetrahedron
C3D15E(S)	15-node quadratic triangular prism
C3D20E(S)	20-node quadratic brick
C3D20RE(S)	20-node quadratic brick, reduced integration

Active degrees of freedom

1, 2, 3, 9

Additional solution variables

None.

Electromagnetic elements

EMC3D4(S)	4-node zero-order
EMC3D8(S)	8-node zero-order

Active degree of freedom

Magnetic vector potential (for more information, see "Boundary conditions" in "Eddy current analysis," Section 6.7.5, and "Boundary conditions" in "Magnetostatic analysis," Section 6.7.6).

Additional solution variables

None.

Nodal coordinates required

X, *Y*, *Z*

Element property definition

Input File Usage: *SOLID SECTION

Abaqus/CAE Usage: Property module: **Create Section**: select **Solid** as the section **Category** and **Homogeneous** or **Electromagnetic, Solid** as the section **Type**

Element-based loading

Distributed loads

Distributed loads are available for all elements with displacement degrees of freedom. They are specified as described in "Distributed loads," Section 33.4.3.

Load ID (*DLOAD): BX

Abaqus/CAE Load/Interaction: **Body force**

Units: FL^{-3}

Description: Body force in global *X*-direction.

Load ID (*DLOAD): BY

Abaqus/CAE Load/Interaction: **Body force**

Units: FL^{-3}

Description: Body force in global *Y*-direction.

Load ID (*DLOAD): BZ

Abaqus/CAE Load/Interaction: **Body force**

Units: FL^{-3}

Description: Body force in global *Z*-direction.

Load ID (*DLOAD): BXNU

Abaqus/CAE Load/Interaction: **Body force**

Units: FL^{-3}

Description: Nonuniform body force in global *X*-direction with magnitude supplied via user subroutine `DLOAD` in Abaqus/Standard and `VDLOAD` in Abaqus/Explicit.

Load ID (*DLOAD): BYNU

Abaqus/CAE Load/Interaction: **Body force**

Units: FL^{-3}

Description: Nonuniform body force in global *Y*-direction with magnitude supplied via user subroutine DLOAD in Abaqus/Standard and VDLOAD in Abaqus/Explicit.

Load ID (*DLOAD): BZNU

Abaqus/CAE Load/Interaction: **Body force**

Units: FL^{-3}

Description: Nonuniform body force in global *Z*-direction with magnitude supplied via user subroutine DLOAD in Abaqus/Standard and VDLOAD in Abaqus/Explicit.

Load ID (*DLOAD): CENT(S)

Abaqus/CAE Load/Interaction: Not supported

Units: $FL^{-4}(ML^{-3}T^{-2})$

Description: Centrifugal load (magnitude is input as $\rho\omega^2$, where ρ is the mass density per unit volume, ω is the angular velocity). Not available for pore pressure elements.

Load ID (*DLOAD): CENTRIF(S)

Abaqus/CAE Load/Interaction: **Rotational body force**

Units: T^{-2}

Description: Centrifugal load (magnitude is input as ω^2, where ω is the angular velocity).

Load ID (*DLOAD): CORIO(S)

Abaqus/CAE Load/Interaction: **Coriolis force**

Units: $FL^{-4}T\ (ML^{-3}T^{-1})$

Description: Coriolis force (magnitude is input as $\rho\omega$, where ρ is the mass density per unit volume, ω is the angular velocity). Not available for pore pressure elements.

Load ID (*DLOAD): GRAV

Abaqus/CAE Load/Interaction: **Gravity**

Units: LT^{-2}

Description: Gravity loading in a specified direction (magnitude is input as acceleration).

Load ID (*DLOAD): HP*n*(S)

Abaqus/CAE Load/Interaction: Not supported

Units: FL^{-2}

Description: Hydrostatic pressure on face *n*, linear in global *Z*.

Load ID (*DLOAD): P*n*

Abaqus/CAE Load/Interaction: **Pressure**

Units: FL^{-2}

Description: Pressure on face *n*.

Load ID (*DLOAD): P*n*NU

Abaqus/CAE Load/Interaction: Not supported

Units: FL^{-2}

Description: Nonuniform pressure on face *n* with magnitude supplied via user subroutine DLOAD in Abaqus/Standard and VDLOAD in Abaqus/Explicit.

Load ID (*DLOAD): ROTA(S)

Abaqus/CAE Load/Interaction: **Rotational body force**

Units: T^{-2}

Description: Rotary acceleration load (magnitude is input as α, where α is the rotary acceleration).

Load ID (*DLOAD): ROTDYNF(S)

Abaqus/CAE Load/Interaction: Not supported

Units: T^{-1}

Description: Rotordynamic load (magnitude is input as ω, where ω is the angular velocity).

Load ID (*DLOAD): SBF$^{(E)}$

Abaqus/CAE Load/Interaction: Not supported

Units: $FL^{-5}T^{2}$

Description: Stagnation body force in global *X*-, *Y*-, and *Z*-directions.

Load ID (*DLOAD): SP*n*$^{(E)}$

Abaqus/CAE Load/Interaction: Not supported

Units: $FL^{-4}T^{2}$

Description: Stagnation pressure on face *n*.

Load ID (*DLOAD): TRSHR*n*

Abaqus/CAE Load/Interaction: **Surface traction**

Units: FL^{-2}

Description: Shear traction on face *n*.

Load ID (*DLOAD): TRSHR*n*NU$^{(S)}$

Abaqus/CAE Load/Interaction: Not supported

Units: FL^{-2}

Description: Nonuniform shear traction on face *n* with magnitude and direction supplied via user subroutine UTRACLOAD.

Load ID (*DLOAD): TRVEC*n*

Abaqus/CAE Load/Interaction: **Surface traction**

Units: FL^{-2}

Description: General traction on face *n*.

Load ID (*DLOAD): TRVEC*n*NU$^{(S)}$

Abaqus/CAE Load/Interaction: Not supported

Units: FL^{-2}

Description: Nonuniform general traction on face *n* with magnitude and direction supplied via user subroutine UTRACLOAD.

Load ID (*DLOAD): VBF$^{(E)}$

Abaqus/CAE Load/Interaction: Not supported

Units: $FL^{-4}T$

Description: Viscous body force in global *X*-, *Y*-, and *Z*-directions.

Load ID (*DLOAD): VP*n*$^{(E)}$

Abaqus/CAE Load/Interaction: Not supported

Units: $FL^{-3}T$

Description: Viscous pressure on face *n*, applying a pressure proportional to the velocity normal to the face and opposing the motion.

Foundations

Foundations are available for Abaqus/Standard elements with displacement degrees of freedom. They are specified as described in "Element foundations," Section 2.2.2.

Load ID (*FOUNDATION): F*n*$^{(S)}$

Abaqus/CAE Load/Interaction: **Elastic foundation**

Units: FL^{-3}

Description: Elastic foundation on face *n*.

Distributed heat fluxes

Distributed heat fluxes are available for all elements with temperature degrees of freedom. They are specified as described in "Thermal loads," Section 33.4.4.

Load ID (*DFLUX): BF

Abaqus/CAE Load/Interaction: **Body heat flux**

Units: $JL^{-3}T^{-1}$

Description: Heat body flux per unit volume.

Load ID (*DFLUX): BFNU$^{(S)}$

Abaqus/CAE Load/Interaction: **Body heat flux**

Units: $JL^{-3}T^{-1}$

Description: Nonuniform heat body flux per unit volume with magnitude supplied via user subroutine DFLUX.

Load ID (*DFLUX): S*n*

Abaqus/CAE Load/Interaction: **Surface heat flux**

Units: $JL^{-2}T^{-1}$

Description: Heat surface flux per unit area into face *n*.

Load ID (*DFLUX): S*n*NU$^{(S)}$

Abaqus/CAE Load/Interaction: Not supported

Units: $JL^{-2}T^{-1}$

Description: Nonuniform heat surface flux per unit area into face *n* with magnitude supplied via user subroutine DFLUX.

Film conditions

Film conditions are available for all elements with temperature degrees of freedom. They are specified as described in "Thermal loads," Section 33.4.4.

Load ID (*FILM): F*n*

Abaqus/CAE Load/Interaction: **Surface film condition**

Units: $JL^{-2}T^{-1}\theta^{-1}$

Description: Film coefficient and sink temperature (units of θ) provided on face *n*.

Load ID (*FILM): F*n*NU$^{(S)}$

Abaqus/CAE Load/Interaction: Not supported

Units: $JL^{-2}T^{-1}\theta^{-1}$

Description: Nonuniform film coefficient and sink temperature (units of θ) provided on face *n* with magnitude supplied via user subroutine FILM.

Radiation types

Radiation conditions are available for all elements with temperature degrees of freedom. They are specified as described in "Thermal loads," Section 33.4.4.

Load ID (*RADIATE): R*n*

Abaqus/CAE Load/Interaction: **Surface radiation**

Units: Dimensionless

Description: Emissivity and sink temperature (units of θ) provided on face *n*.

Distributed flows

Distributed flows are available for all elements with pore pressure degrees of freedom. They are specified as described in "Pore fluid flow," Section 33.4.7.

Load ID (*FLOW): Q*n*$^{(S)}$

Abaqus/CAE Load/Interaction: Not supported

Units: $F^{-1}L^{3}T^{-1}$

Description: Seepage coefficient and reference sink pore pressure (units of FL^{-2}) provided on face *n*.

Load ID (*FLOW): Q*n*D$^{(S)}$

Abaqus/CAE Load/Interaction: Not supported

Units: $F^{-1}L^{3}T^{-1}$

Description: Drainage-only seepage coefficient provided on face *n*.

Load ID (*FLOW): Q*n*NU$^{(S)}$

Abaqus/CAE Load/Interaction: Not supported

Units: $F^{-1}L^{3}T^{-1}$

Description: Nonuniform seepage coefficient and reference sink pore pressure (units of FL^{-2}) provided on face *n* with magnitude supplied via user subroutine `FLOW`.

Load ID (*DFLOW): S*n*$^{(S)}$

Abaqus/CAE Load/Interaction: **Surface pore fluid**

Units: LT^{-1}

Description: Prescribed pore fluid effective velocity (outward from the face) on face *n*.

Load ID (*DFLOW): S*n*NU$^{(S)}$

Abaqus/CAE Load/Interaction: Not supported

Units: LT^{-1}

Description: Nonuniform prescribed pore fluid effective velocity (outward from the face) on face *n* with magnitude supplied via user subroutine `DFLOW`.

Distributed impedances

Distributed impedances are available for all elements with acoustic pressure degrees of freedom. They are specified as described in "Acoustic and shock loads," Section 33.4.6.

Load ID (*IMPEDANCE): I*n*

Abaqus/CAE Load/Interaction: Not supported

Units: None

Description: Name of the impedance property that defines the impedance on face *n*.

Electric fluxes

Electric fluxes are available for piezoelectric elements. They are specified as described in "Piezoelectric analysis," Section 6.7.2.

Load ID (*DECHARGE): EBF$^{(S)}$

Abaqus/CAE Load/Interaction: Body charge

Units: CL^{-3}

Description: Body flux per unit volume.

Load ID (*DECHARGE): ES*n*$^{(S)}$

Abaqus/CAE Load/Interaction: Surface charge

Units: CL^{-2}

Description: Prescribed surface charge on face *n*.

Distributed electric current densities

Distributed electric current densities are available for coupled thermal-electrical, coupled thermal-electrical-structural elements, and electromagnetic elements. They are specified as described in "Coupled thermal-electrical analysis," Section 6.7.3; "Fully coupled thermal-electrical-structural analysis," Section 6.7.4; and "Eddy current analysis," Section 6.7.5.

Load ID (*DECURRENT): CBF$^{(S)}$

Abaqus/CAE Load/Interaction: Body current

Units: $CL^{-3}T^{-1}$

Description: Volumetric current source density.

Load ID (*DECURRENT): CS*n*$^{(S)}$

Abaqus/CAE Load/Interaction: Surface current

Units: $CL^{-2}T^{-1}$

Description: Current density on face *n*.

Load ID (*DECURRENT): CJ$^{(S)}$

Abaqus/CAE Load/Interaction: Body current density

Units: $CL^{-2}T^{-1}$

Description: Volume current density vector in an eddy current analysis.

Distributed concentration fluxes

Distributed concentration fluxes are available for mass diffusion elements. They are specified as described in "Mass diffusion analysis," Section 6.9.1.

Load ID (*DFLUX): BF$^{(S)}$

Abaqus/CAE Load/Interaction: **Body concentration flux**

Units: PT^{-1}

Description: Concentration body flux per unit volume.

Load ID (*DFLUX): BFNU$^{(S)}$

Abaqus/CAE Load/Interaction: **Body concentration flux**

Units: PT^{-1}

Description: Nonuniform concentration body flux per unit volume with magnitude supplied via user subroutine DFLUX.

Load ID (*DFLUX): S*n*$^{(S)}$

Abaqus/CAE Load/Interaction: **Surface concentration flux**

Units: PLT^{-1}

Description: Concentration surface flux per unit area into face *n*.

Load ID (*DFLUX): S*n*NU$^{(S)}$

Abaqus/CAE Load/Interaction: **Surface concentration flux**

Units: PLT^{-1}

Description: Nonuniform concentration surface flux per unit area into face *n* with magnitude supplied via user subroutine DFLUX.

Surface-based loading

Distributed loads

Surface-based distributed loads are available for all elements with displacement degrees of freedom. They are specified as described in "Distributed loads," Section 33.4.3.

Load ID (*DSLOAD): HP[(S)]

Abaqus/CAE Load/Interaction: **Pressure**

Units: FL^{-2}

Description: Hydrostatic pressure on the element surface, linear in global *Z*.

Load ID (*DSLOAD): P

Abaqus/CAE Load/Interaction: **Pressure**

Units: FL^{-2}

Description: Pressure on the element surface.

Load ID (*DSLOAD): PNU

Abaqus/CAE Load/Interaction: **Pressure**

Units: FL^{-2}

Description: Nonuniform pressure on the element surface with magnitude supplied via user subroutine `DLOAD` in Abaqus/Standard and `VDLOAD` in Abaqus/Explicit.

Load ID (*DSLOAD): SP[(E)]

Abaqus/CAE Load/Interaction: **Pressure**

Units: $FL^{-4}T^2$

Description: Stagnation pressure on the element surface.

Load ID (*DSLOAD): TRSHR

Abaqus/CAE Load/Interaction: **Surface traction**

Units: FL^{-2}

Description: Shear traction on the element surface.

Load ID (*DSLOAD): TRSHRNU[(S)]

Abaqus/CAE Load/Interaction: Surface traction

Units: FL^{-2}

Description: Nonuniform shear traction on the element surface with magnitude and direction supplied via user subroutine UTRACLOAD.

Load ID (*DSLOAD): TRVEC

Abaqus/CAE Load/Interaction: Surface traction

Units: FL^{-2}

Description: General traction on the element surface.

Load ID (*DSLOAD): TRVECNU$^{(S)}$

Abaqus/CAE Load/Interaction: Surface traction

Units: FL^{-2}

Description: Nonuniform general traction on the element surface with magnitude and direction supplied via user subroutine UTRACLOAD.

Load ID (*DSLOAD): VP$^{(E)}$

Abaqus/CAE Load/Interaction: Pressure

Units: $FL^{-3}T$

Description: Viscous pressure applied on the element surface. The viscous pressure is proportional to the velocity normal to the element face and opposing the motion.

Distributed heat fluxes

Surface-based heat fluxes are available for all elements with temperature degrees of freedom. They are specified as described in "Thermal loads," Section 33.4.4.

Load ID (*DSFLUX): S

Abaqus/CAE Load/Interaction: Surface heat flux

Units: $JL^{-2}T^{-1}$

Description: Heat surface flux per unit area into the element surface.

Load ID (*DSFLUX): SNU(S)

Abaqus/CAE Load/Interaction: **Surface heat flux**

Units: $JL^{-2}T^{-1}$

Description: Nonuniform heat surface flux per unit area into the element surface with magnitude supplied via user subroutine DFLUX.

Film conditions

Surface-based film conditions are available for all elements with temperature degrees of freedom. They are specified as described in “Thermal loads,” Section 33.4.4.

Load ID (*SFILM): F

Abaqus/CAE Load/Interaction: **Surface film condition**

Units: $JL^{-2}T^{-1}\theta^{-1}$

Description: Film coefficient and sink temperature (units of θ) provided on the element surface.

Load ID (*SFILM): FNU(S)

Abaqus/CAE Load/Interaction: **Surface film condition**

Units: $JL^{-2}T^{-1}\theta^{-1}$

Description: Nonuniform film coefficient and sink temperature (units of θ) provided on the element surface with magnitude supplied via user subroutine FILM.

Radiation types

Surface-based radiation conditions are available for all elements with temperature degrees of freedom. They are specified as described in “Thermal loads,” Section 33.4.4.

Load ID (*SRADIATE): R

Abaqus/CAE Load/Interaction: **Surface radiation**

Units: Dimensionless

Description: Emissivity and sink temperature (units of θ) provided on the element surface.

Distributed flows

Surface-based flows are available for all elements with pore pressure degrees of freedom. They are specified as described in "Pore fluid flow," Section 33.4.7.

Load ID (*SFLOW): $Q^{(S)}$

Abaqus/CAE Load/Interaction: Not supported

Units: $F^{-1}L^{3}T^{-1}$

Description: Seepage coefficient and reference sink pore pressure (units of FL^{-2}) provided on the element surface.

Load ID (*SFLOW): $QD^{(S)}$

Abaqus/CAE Load/Interaction: Not supported

Units: $F^{-1}L^{3}T^{-1}$

Description: Drainage-only seepage coefficient provided on the element surface.

Load ID (*SFLOW): $QNU^{(S)}$

Abaqus/CAE Load/Interaction: Not supported

Units: $F^{-1}L^{3}T^{-1}$

Description: Nonuniform seepage coefficient and reference sink pore pressure (units of FL^{-2}) provided on the element surface with magnitude supplied via user subroutine `FLOW`.

Load ID (*DSFLOW): $S^{(S)}$

Abaqus/CAE Load/Interaction: **Surface pore fluid**

Units: LT^{-1}

Description: Prescribed pore fluid effective velocity outward from the element surface.

Load ID (*DSFLOW): $SNU^{(S)}$

Abaqus/CAE Load/Interaction: **Surface pore fluid**

Units: LT^{-1}

Description: Nonuniform prescribed pore fluid effective velocity outward from the element surface with magnitude supplied via user subroutine `DFLOW`.

Distributed impedances

Surface-based impedances are available for all elements with acoustic pressure degrees of freedom. They are specified as described in “Acoustic and shock loads,” Section 33.4.6.

Incident wave loading

Surface-based incident wave loads are available for all elements with displacement degrees of freedom or acoustic pressure degrees of freedom. They are specified as described in “Acoustic and shock loads,” Section 33.4.6. If the incident wave field includes a reflection off a plane outside the boundaries of the mesh, this effect can be included.

Electric fluxes

Surface-based electric fluxes are available for piezoelectric elements. They are specified as described in “Piezoelectric analysis,” Section 6.7.2.

Load ID (*DSECHARGE): $ES^{(S)}$

Abaqus/CAE Load/Interaction: Surface charge

Units: CL^{-2}

Description: Prescribed surface charge on the element surface.

Distributed electric current densities

Surface-based electric current densities are available for coupled thermal-electrical, coupled thermal-electrical-structural, and electromagnetic elements. They are specified as described in “Coupled thermal-electrical analysis,” Section 6.7.3, “Fully coupled thermal-electrical-structural analysis,” Section 6.7.4, and “Eddy current analysis,” Section 6.7.5.

Load ID (*DSECURRENT): $CS^{(S)}$

Abaqus/CAE Load/Interaction: Surface current

Units: $CL^{-2}T^{-1}$

Description: Current density on the element surface.

Load ID (*DSECURRENT): $CK^{(S)}$

Abaqus/CAE Load/Interaction: Surface current density

Units: $CL^{-1}T^{-1}$

Description: Surface current density vector in an eddy current analysis.

Element output

For most elements output is in global directions unless a local coordinate system is assigned to the element through the section definition ("Orientations," Section 2.2.5) in which case output is in the local coordinate system (which rotates with the motion in large-displacement analysis). See "State storage," Section 1.5.4 of the Abaqus Theory Manual, for details.

Stress, strain, and other tensor components

Stress and other tensors (including strain tensors) are available for elements with displacement degrees of freedom. All tensors have the same components. For example, the stress components are as follows:

S11	XX, direct stress.
S22	YY, direct stress.
S33	ZZ, direct stress.
S12	XY, shear stress.
S13	XZ, shear stress.
S23	YZ, shear stress.

Note: the order shown above is not the same as that used in user subroutine VUMAT.

Heat flux components

Available for elements with temperature degrees of freedom.

HFL1	Heat flux in the *X*-direction.
HFL2	Heat flux in the *Y*-direction.
HFL3	Heat flux in the *Z*-direction.

Pore fluid velocity components

Available for elements with pore pressure degrees of freedom.

FLVEL1	Pore fluid effective velocity in the *X*-direction.
FLVEL2	Pore fluid effective velocity in the *Y*-direction.
FLVEL3	Pore fluid effective velocity in the *Z*-direction.

Mass concentration flux components

Available for elements with normalized concentration degrees of freedom.

MFL1	Concentration flux in the *X*-direction.
MFL2	Concentration flux in the *Y*-direction.
MFL3	Concentration flux in the *Z*-direction.

Electrical potential gradient

Available for elements with electrical potential degrees of freedom.

EPG1	Electrical potential gradient in the *X*-direction.

EPG2	Electrical potential gradient in the *Y*-direction.
EPG3	Electrical potential gradient in the *Z*-direction.

Electrical flux components

Available for piezoelectric elements.

EFLX1	Electrical flux in the *X*-direction.
EFLX2	Electrical flux in the *Y*-direction.
EFLX3	Electrical flux in the *Z*-direction.

Electrical current density components

Available for coupled thermal-electrical and coupled thermal-electrical-structural elements.

ECD1	Electrical current density in the *X*-direction.
ECD2	Electrical current density in the *Y*-direction.
ECD3	Electrical current density in the *Z*-direction.

Electrical field components

Available for electromagnetic elements in an eddy current analysis.

EME1	Electric field in the *X*-direction.
EME2	Electric field in the *Y*-direction.
EME3	Electric field in the *Z*-direction.

Magnetic flux density components

Available for electromagnetic elements.

EMB1	Magnetic flux density in the *X*-direction.
EMB2	Magnetic flux density in the *Y*-direction.
EMB3	Magnetic flux density in the *Z*-direction.

Magnetic field components

Available for electromagnetic elements.

EMH1	Magnetic field in the *X*-direction.
EMH2	Magnetic field in the *Y*-direction.
EMH3	Magnetic field in the *Z*-direction.

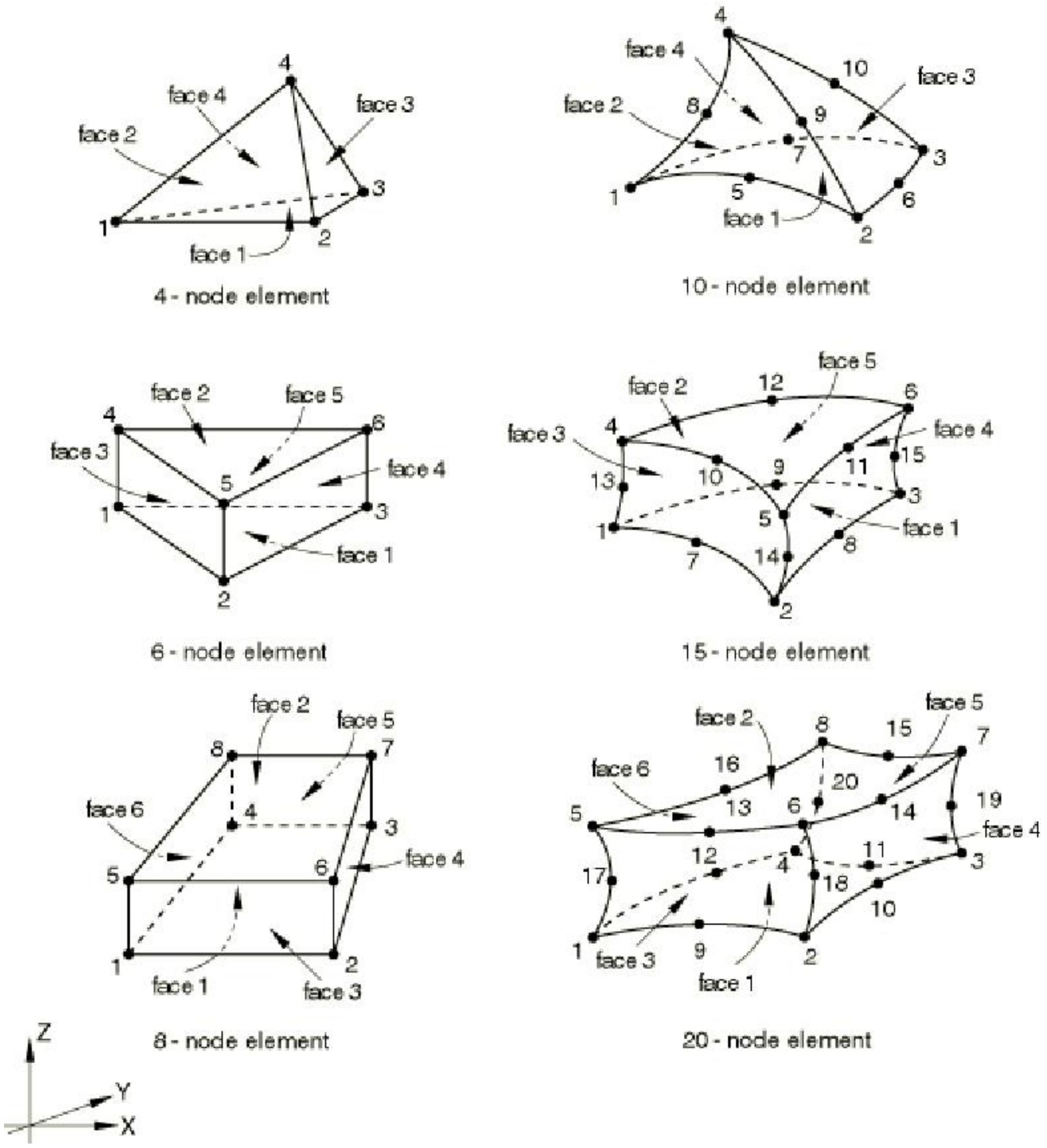
Electrical current density components in an eddy current analysis

Available for electromagnetic elements in an eddy current analysis.

EMCD1	Electrical current density in the *X*-direction.
EMCD2	Electrical current density in the *Y*-direction.
EMCD3	Electrical current density in the *Z*-direction.

Node ordering and face numbering on elements

All elements except variable node elements



Tetrahedral element faces

Face 1 1 – 2 – 3 face
Face 2 1 – 4 – 2 face
Face 3 2 – 4 – 3 face
Face 4 3 – 4 – 1 face

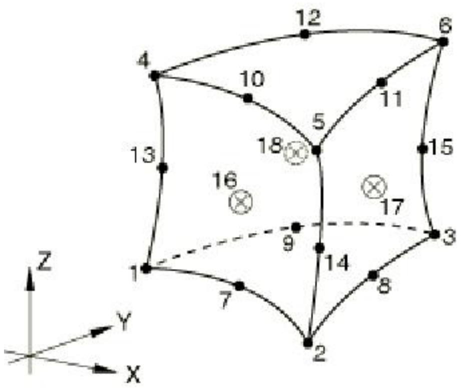
Wedge (triangular prism) element faces

Face 1 1 – 2 – 3 face
Face 2 4 – 6 – 5 face
Face 3 1 – 4 – 5 – 2 face
Face 4 2 – 5 – 6 – 3 face
Face 5 3 – 6 – 4 – 1 face

Hexahedron (brick) element faces

Face 1	1 – 2 – 3 – 4 face
Face 2	5 – 8 – 7 – 6 face
Face 3	1 – 5 – 6 – 2 face
Face 4	2 – 6 – 7 – 3 face
Face 5	3 – 7 – 8 – 4 face
Face 6	4 – 8 – 5 – 1 face

Variable node elements

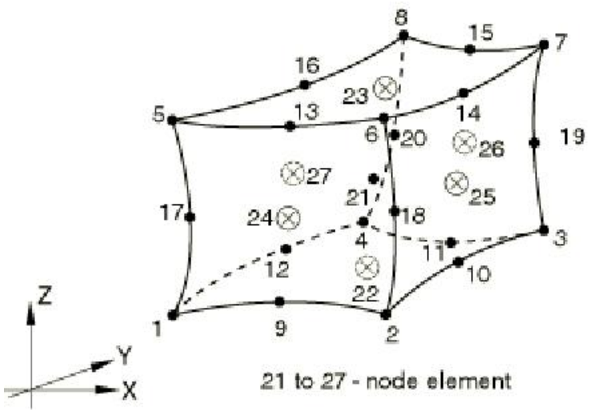


15 to 18 - node element

⊗ 16–18 are midface nodes on the three rectangular faces (see below for faces 1 to 5). These ⊗ nodes can be omitted from an element by entering a zero or blank in the corresponding position when giving the nodes on the element. Only nodes 16–18 can be omitted.

Face location of nodes 16 to 18

Face node number	Corner nodes on face
16	1 – 4 – 5 – 2
17	2 – 5 – 6 – 3
18	3 – 6 – 4 – 1



21 to 27 - node element

Node 21 is located at the centroid of the element.

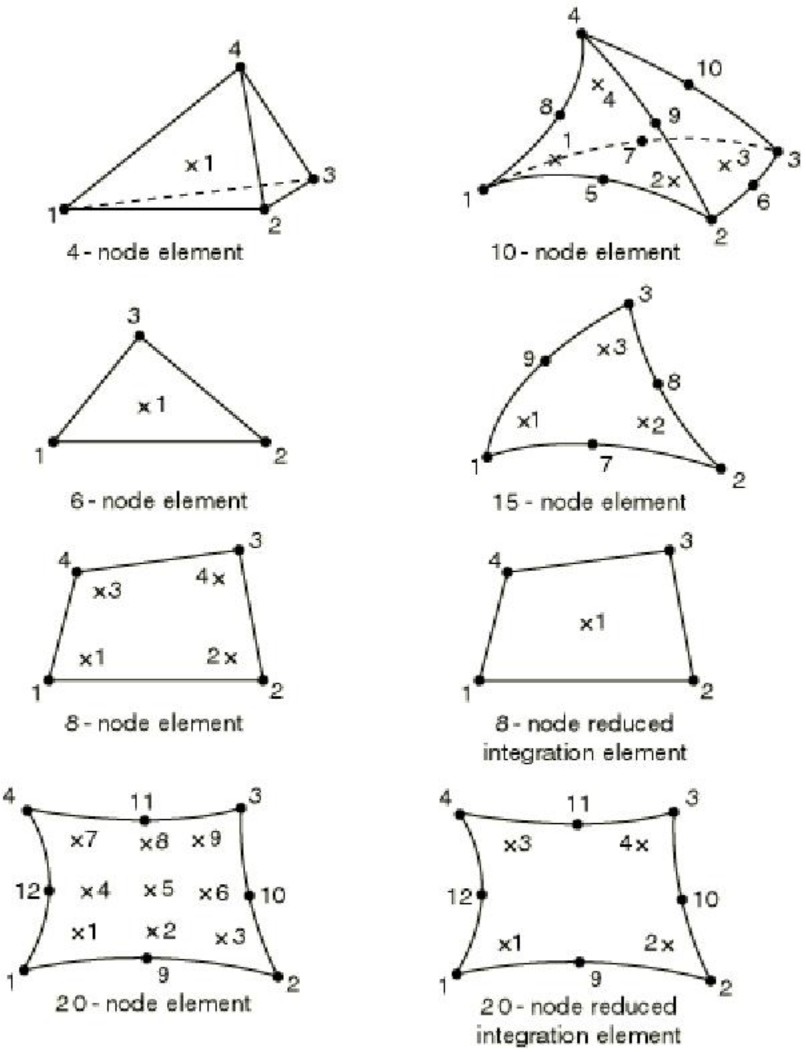
⊗ (nodes 22–27) are midface nodes on the six faces (see below for faces 1 to 6). These ⊗ nodes can be deleted from an element by entering a zero or blank in the corresponding position when giving the nodes on the element. Only nodes 22–27 can be omitted.

Face location of nodes 22 to 27

Face node number	Corner nodes on face
22	1 – 2 – 3 – 4
23	5 – 8 – 7 – 6
24	1 – 5 – 6 – 2
25	2 – 6 – 7 – 3
26	3 – 7 – 8 – 4
27	4 – 8 – 5 – 1

Numbering of integration points for output

All elements except variable node elements



This shows the scheme in the layer closest to the 1–2–3 and 1–2–3–4 faces. The integration points in the second and third layers are numbered consecutively. Multiple layers are used for composite solid elements.

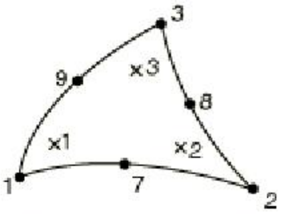
For heat transfer applications a different integration scheme is used for tetrahedral and wedge elements, as described in "Triangular, tetrahedral, and wedge elements," Section 3.2.6 of the Abaqus Theory Manual.

For linear triangular prisms in Abaqus/Explicit reduced integration is used; therefore, a C3D6 element and a C3D6T element have only one integration point.

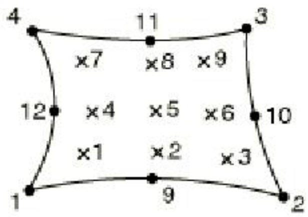
For the general-purpose C3D10I 10-node tetrahedra in Abaqus/Standard improved stress visualization is obtained through an 11-point integration rule, consisting of 10 integration points at the elements' nodes and one integration point at their centroid.

For acoustic tetrahedra and wedges in Abaqus/Standard full integration is used; therefore, an AC3D4 element has 4 integration points, an AC3D6 element has 6 integration points, an AC3D10 element has 10 integration points, and an AC3D15 element has 18 integration points.

Variable node elements

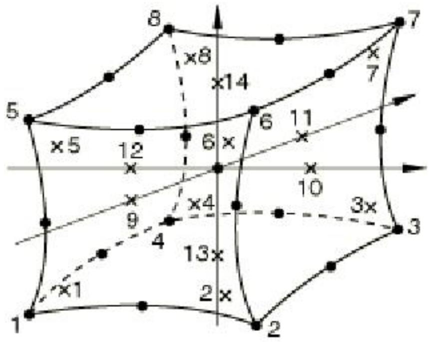


15 to 18 - node element



21 to 27 - node element

This shows the scheme in the layer closest to the 1–2–3 and 1–2–3–4 faces. The integration points in the second and third layers are numbered consecutively. Multiple layers are used for composite solid elements. The face nodes do not appear.



21 to 27 - node reduced integration element

Node 21 is located at the centroid of the element.