3DEC™ VERSION 7.0

Distinct-Element Modeling of Jointed and Blocky Material in 3D

ABOUT *3DEC*

3DEC is numerical modeling software for advanced engineering analysis of soil, rock, blocky structures, ground water, and structural support in three dimensions. *3DEC* simulates the response of discontinuous media (such as jointed rock or masonry structures) that are subject to either static or dynamic loading.

A discontinuous medium is modeled as an assemblage of polyhedral blocks that may be rigid or made deformable through zoning. Fractures are treated as boundary conditions between blocks. Motion along discontinuities is governed by linear and nonlinear force-displacement relations for movements in both the normal and shear directions.

FEATURES

GENERAL

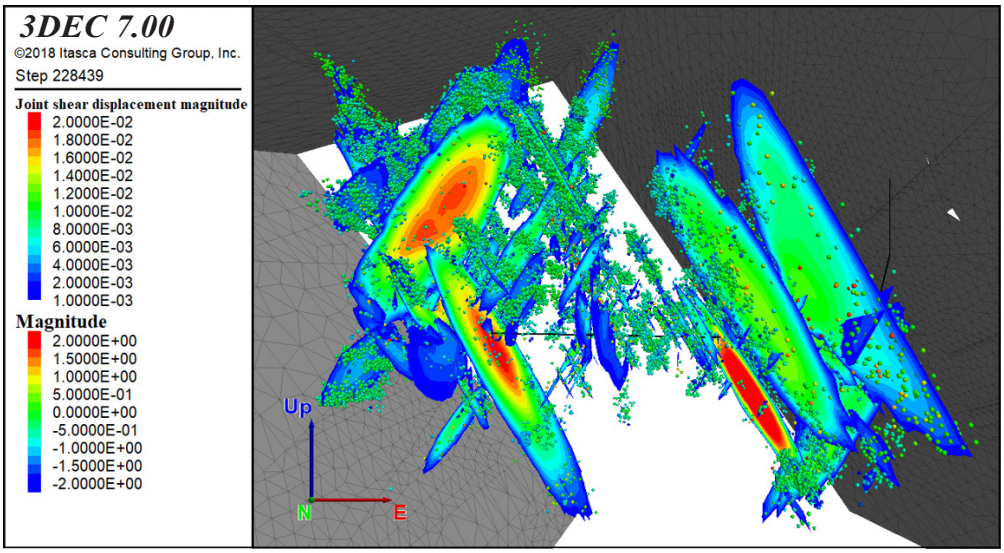
- Uses an explicit solution that provides a realistic path-dependent post-peak failure behavior in joints and zones, as well as simulation of large displacements
- Blocks may be rigid or deformable
- Joints may be assigned their own constitutive models and properties
- Joint and/or matrix fluid flow with flow between joints and matrix
- Structural elements with general coupling to blocks
- Discrete fracture network generator
- Simulate synthetic microseismicity
- *FISH*, Itasca's built-in scripting language, provides powerful user-control to parameterize, analyze, and modify nearly every aspect of the simulation
- Built-in text editor checks command syntax and allows context sensitive help
- Record model state histories
- Project management tools
- USB key, network, and web licensing

GRAPHICAL USER INTERFACE

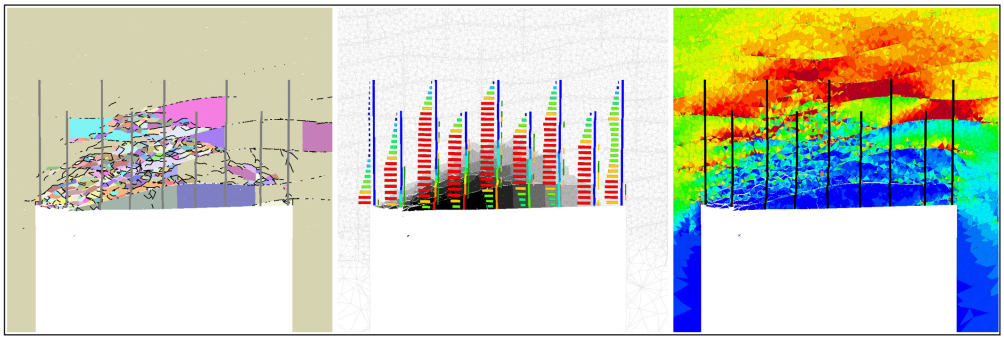
- Extensive, fast, interactive OpenGL graphics **UPDATED**
- Interactive model plot views and measurement and querying tools
- Multiple plot export formats
- Easily export tables and charts as CSV files

BOUNDARIES/CONDITIONS

- Displacement and stress boundaries
- Fractures or joints between blocks are treated as boundary conditions
- Quiet (non-reflecting) and free-field boundaries (option)



▲ *3DEC* model of the Fallon Forge geothermal site showing shear displacements along existing fractures and synthetic (predicted) microseismicity.



▲ *3DEC* model of a 5 m wide mine drift 440 m deep. The simulations predict the response of the tunnel and a particular ground support regime (#7 rebar) after a nearby stope has been excavated. The model explicitly includes persistent, undulated, sub-horizontal beds at close spacing (30 to 50 cm), with some additional crossing vertical joints present. The plots show (left) the emergent fragmentation; (center) hybrid bolt displacements (along bolts), axial forces (bars chart), and block displacements (gray scale); and (right) the maximum principle stress to be up to 90 MPa. Although 90% capacity has been consumed in one bolt and the remaining bolts have consumed up to 70% of their capacity, the model predicts that the drift will be stable.

MODEL CONSTRUCTION

- Automatic mesh generation in fully deformable blocks UPDATED
- Build models directly from closed geometry surfaces (e.g. DXF): NEW
  - fill volume with tetrahedral blocks or
  - merge blocks to form zones within single closed surfaces
- Cut blocks with DXF geometry NEW
- Create blocks from VRML files
- Built-in voronoi block generator NEW
- New *grid* file format for importing and exporting blocks and zones UPDATED
- Convert tetrahedral blocks into zones during import. Blocks with the same group name can be merged together to form multiple zones within a single block. 2-3x faster than joining. NEW
- Automatic tunnel region generator
- Beam, cable, and pile geometry can be imported from CAD data NEW
- Define groups using visual and property-based ranges UPDATED
- Built-in tools to statistically generate discrete fracture networks
- Import 3DEC *grids* created by the *Griddle* plug-in in Rhinoceros 3D CAD

CONSTITUTIVE MODELS

- Standard block material models:
  - Elastic
  - Anisotropic
  - Mohr-Coulomb
  - Hoek-Brown
  - Modified Hoek-Brown
  - Ubiquitous joints
  - Bilinear plasticity
  - Strain-softening
  - Visco-plastic creep
  - Visco-elastic creep
- Standard joint models:
  - Elastic
  - Mohr-Coulomb
  - Continuously yielding
  - Softening healing Mohr-Coulomb NEW
  - Bilinear Mohr-Coulomb NEW
  - Creep NEW
- User-defined models (option)

SOLUTIONS / SEQUENCING

- Continuous or sequenced solutions
- Bonded block modeling (BBM) to simulate intact rock fragmentation
- Automatic time-step calculation
- Automatic factor of safety (**FOS**) calculation based on the Shear Strength Reduction method for:
  - Mohr-Coulomb
  - Hoek-Brown
  - Ubiquitous joint
- Nodal mixed discretization for even more accurate plastic solutions
- Effective stress (pore-pressure)
- Mechanical models can be coupled with both fluid-flow and thermal (option) models

FLUID FLOW

- Fluid flow through fractures and matrix (blocks between fractures)
- Fracture fluid pressure and matrix fluid pressures are also coupled
- Mechanical-fluid coupling
- Simulate the transport and mechanical effects of proppant fluid-filled joints

STRUCTURAL ELEMENTS

- Structural liners included* NEW
- Elastic finite element blocks (20 or 28-noded hexahedra) included* NEW
- Hybrid bolts add dowel segments to cable bolts to resist shearing and opening across joints NEW
- Powerful plotting and querying tools
- Cables are compatible for dynamic (option) simulations
- More structural elements (beams, piles, shells, and geogrids) NEW

COMMANDS AND SCRIPTING

- Updated commands that are intuitive, easy to learn, and easy to apply NEW
- Automatic conversion tool to translate *3DEC* 5.2 data files to the updated *3DEC* 7.0 syntax NEW
- Powerful, built-in text editor UPDATED
- A record of all events modifying the model (commands, *FISH*, mouse) for undo and repeatable functionality NEW
- Inline *FISH* (within a command)
- *FISH* management control set displays the current values of *FISH* variables and functions, even during cycling NEW
- The *foreach* object construct greatly simplifies *3DEC* FISH NEW
- More variable types: Map, Matrix, Boolean, Symmetric Tensor, and Structures NEW
- Multi-threaded *FISH* for much faster iterative calculations NEW
- Fully integrated Python scripting NEW

HELP

- Documentation is now in HTML format NEW
- Access Help at the command prompt or within a data file [F1] NEW
- Access Keyword Help [? + Enter] at the command prompt to list the possible commands/keywords given the preceding command input
- Access Inline Help [Ctrl + Spacebar] to auto-complete commands NEW

OTHER NEW FEATURES

- Seismic wizard to pre-process ground waves for dynamic (option) analysis
- Groups and extra variables for all objects, including structural elements and flow planes
- Save files can be automatically (optionally) compressed
- Save files will be compatible with future *3DEC* versions

OPTIONS

DYNAMIC

- Permits three-dimensional, fully dynamic simulation of wave propagation for the analysis of earthquakes, blasts, impulse loading, rock bursts, and particle flow
- May be coupled to structural elements
- Dynamic boundaries include non-reflecting (quiet) and free-field

USER-DEFINED C++ MODELS (UDM)

- Permits users to create their own *3DEC* constitutive model written in C++ for zones and joints

Exchange of user-defined *3DEC* models for can be found at:

www.itascacg.com/udms

THERMAL

- Simulation of transient heat conduction in materials
- Development of thermally induced displacements and stresses
- Couple to mechanical and fluid models

TRY THE DEMO

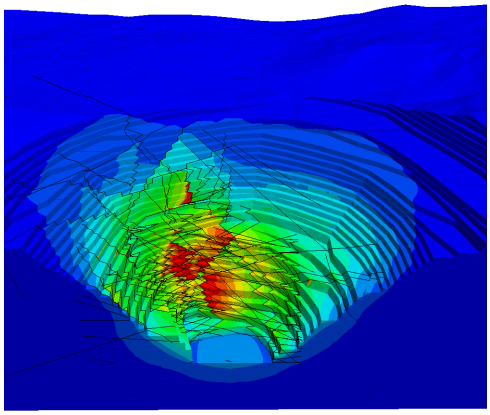
Itasca is pleased to offer free demo versions of all software for download. There is no restriction to the length of time you can use the demos, but some model size restrictions apply.

www.itascacg.com/demos

SALES

Itasca sales offices and agents vary geographically. To locate or contact the agent for your region, visit:

www.itascacg.com/sales



▲ *3DEC* model of an open pit mine with many large-scale faults. Plot contours indicate total displacement.

*This was previously an option at additional cost.