3DEC Version 4.1

***3DEC* (*3-Dimensional Distinct Element Code*) is the three-dimensional extension of Itasca's two-dimensional code *UDEC*. It is specifically designed for the simulation of rock media containing multiple, intersecting joint structures and subjected either to quasi-static or to dynamic loading.**

***3DEC* 4.1** includes a version (in addition to the 32-bit version) that **is operable on a 64-bit processor computer** that allows the creation of unlimited model size. The **new *3DEC* interface** features faster, **OpenGL**-based model rendering for rapid rotation and translation of model views. In addition, the interface includes **a built-in data file editor** with syntax highlighting and one-click execution, easier access to tools for plotting, interactive tools for view manipulation and range definition, complete menu-driven access to all *3DEC* file handling operations, and new attributes for **plot items including transparency**. The user can now **import 3D surfaces from DXF files** and use them as a pattern to construct a *3DEC* model.
The new **Nodal Mixed Discretization (NMD) technique** provides more accurate solutions for plasticity analyses with models composed of linear tetrahedral zones, overcoming the over-stiff behaviour observed during plastic flow with this type of zone.
User-defined joint constitutive models can be created and compiled as dll. **Revisions to the FISH language** include a **new debugging capability**, the ability to **pass arguments to FISH functions**, the ability to create local variables in a function, and the ability to dynamically create and destroy FISH arrays. In addition, user-defined FISH intrinsics can be created as C++ dlls.
A **new logic** has been added which simplifies the task of defining locations for **structural element liners**. The new command **SOLVE fos** allows to determine the factor of safety of a slope against general failure or collapse.
The user can also **control damping parameters** used for the interactions between blocks. In addition to the standard per-machine license, the **new network key facility** allows a single hardware key to be installed on a central (server) computer for a network. *3DEC* is run from any computer on the network — depending on the number of licenses available from the key. Network keys require a special licensing arrangement and installation.
Finally, a **new compiled HTML help** has been included in *3DEC* 4.1

APPLICATIONS IN THE FOLLOWING FIELDS

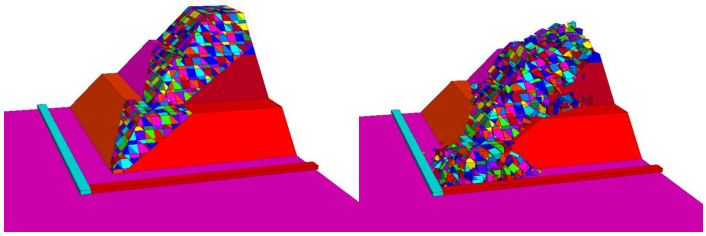
- **Stability analysis of slopes, retaining walls, or open pits;**
- **Study of fractured media or masonry structures subjected to monotonous or cyclic loading;**
- **Stability analysis of dams in jointed rock foundations under hydraulic and/or dynamic conditions;**
- **Thermo-hydro-mechanical studies of fractured media dedicated to host nuclear waste.**

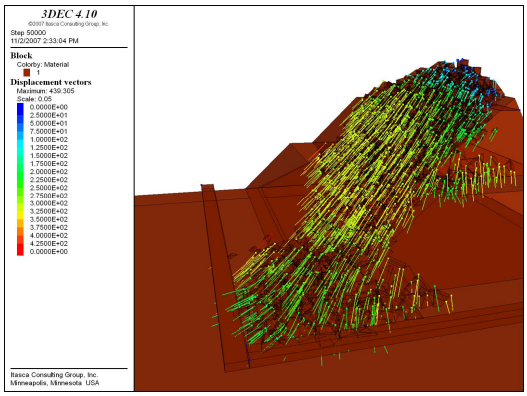
3DEC GENERAL FEATURES

MODEL GENERATION

The **discontinuous medium** is treated as an assembly of **discrete rigid or deformable polyhedra**. *3DEC* allows multiple contact modes between blocks. The relative motion along discontinuities in both the normal and the shear directions is governed by linear and non-linear force-displacement relations. Deformable blocks contain elements whose behaviour is controlled by stress/strain laws.

3DEC contains a statistically-based **Joint-Set Generator** that allows to rapidly create joints on the basis of orientation, length and spacing date … The command "tunnel" is used to automatically create ideal forms.





Collapse of a rock mass and propagation of the blocks till the retaining structure

Visualization of displacement vectors ↑

← *Visualization of rock blocks (initial state on the left hand side and final state on the right hand side)*

CONSTITUTIVE MODELS

Several block and joint material built-in constitutive models are provided in *3DEC*.

For blocks :

- Elastic models
  - Null (excavated material
  - Isotropic
  - Anisotropic
- Elasto-plastic models
  - Mohr-Coulomb
  - Strain hardening/softening
  - Drucker-Prager (*option*)
  - Double yield (*option*)
  - Ubiquitous-joint (*option*)
- Modified Cam-clay (*option*)
- Thermal models (*option*)
- Creep models (*option*)
  - Classical viscoelastic
  - Power law
  - WIPP, modified WIPP
  - Burger
  - Crushed salt

For joints :

- Coulomb slip
- Continuously yielding

Possibility to **develop one's own constitutive model** in C++ **(*available as an option)*. This model can be used in most of the Itasca codes. Moreover, the user can access** constitutive models developed by other users, via our web site http://www.itasca-udm.com/.

STRUCTURAL ELEMENTS

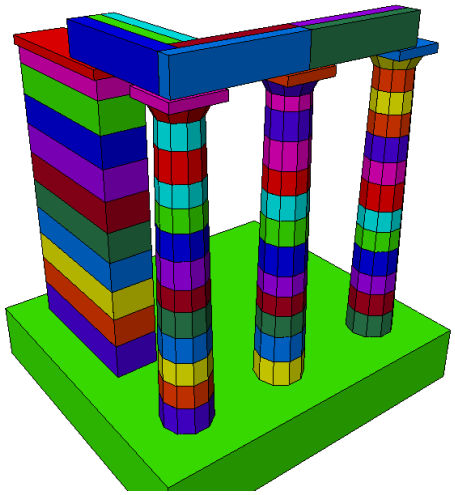
- **Reinforcement support (local and global),** cable elements that cannot sustain a bending moment (nails, rock bolts, cable bolts and tiebacks - pre-tensioned or not).
- **Beam Elements,** that allow the simulation of spaced support such as steel collars.
- **Surface support: structural liners,** which are placed on the interior of an excavation (tunnel lining);

INITIAL CONDITIONS

Certain gridpoint and zone variables can be initialized: stress state, pore pressures, saturation, velocity, temperature, mechanical pressure …

BOUNDARY CONDITIONS

Certain gridpoint and zone variables can be fixed: stress state, pore pressures, saturation, velocity, temperature, mechanical pressure, absorbing boundaries …



Cross section of the Parthenon model that was analyzed against dynamic loading.

LOADING

- **Mechanical**: simulation of an excavation, a stress field, a surface load …
- **Hydraulic**: modeling of fluid-flow through fractured media, possibly coupled to mechanical and thermal processes.
- **Thermal** (option): simulation of transient heat conduction in materials and the development of thermally-induced displacements and stresses. The thermal analysis may be coupled to the mechanical and the fluid calculations.
- **Creep** (option): modeling of visco-plastic behaviour of certain materials.
- **Dynamic** (option): simulation of an earthquake or an explosion

FISH MACRO-LANGUAGE

All ITASCA codes possess the built-in programming language *FISH* that allows users to customize their analyses to suit their needs. Loading patterns, servo-control of test conditions and block generation sequences may be defined using *FISH*

INTERNATIONAL RECOGNITION

ITASCA Consultants, an expert in numerical modelling, offers a new vision of numerical solutions thanks to its know-how and its software solutions. At the crossroads of consulting and Research & Development, Itasca Consultants provides computer modelling solutions for both the public sector and consulting firms.

ASSISTANCE

Installation and general codes operations are provided for free by phone, fax or email. Web site support (**www.hcitasca.com)** includes free codes updates and a « Frequently Asked Questions » (FAQ) page.

Training courses, general or tailored to users' needs, are regularly organized by ITASCA. Do not hesitate to contact us.

As provider of consulting services, ITASCA provides tailored help to solve technical problems and write specific procedures.

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