

## ATENA 2026 – Technical Specifications

January 2026

### MATERIAL MODELS

- 3D fracture-plastic concrete model based on Menetrey-Willam law: smeared cracks, fracture-energy based softening, Compression Field Theory, aggregate interlock in shear, non-associated plasticity, unloading direction, user defined functions, variable parameters, fiber-reinforced concrete FRC, UHPFRC, SHCC, ECC
- 2D SBETA concrete model, also for high strength and SFRC: smeared cracks, crack-band, fracture-energy-based softening, Kupfer's compressive failure, variable shear retention, strength reduction of cracked concrete.
- Reinforcement bi-linear and multi-linear. Reinforcement with bond. Cyclic reinforcement (Menegotto-Pinto / Bauschinger effect) and bond.
- Von Mises plasticity for metals.
- Drucker-Prager plasticity with associated / non-associated flow rule for rock and soil.
- Bazant M4/M7 microplane concrete.
- Interface with Mohr-Coulomb material law.
- Isotropic elastic.
- Non-linear springs.
- Temperature dependent material properties (Fire loading).
- Creep and shrinkage (Bazant B3, Eurocode, ACI).
- Heat and moisture transport, hydration heat model CERHYD.
- Fatigue of concrete in tension.
- User-defined material model (user-compiled DLL in C/C++ or FORTRAN).
- Durability modeling: chlorides, carbonation, reinforcement corrosion, ASR.
- Time dependent material properties and element activation for 3D printing simulation.

### LOADING

- Load cases: body forces, loading forces, supports, prescribed deformations, temperature, shrinkage, prestressing.
- Load steps: combination of load cases, solution methods.
- Arbitrary load history in steps, non-proportional, cyclic, dynamic.
- Construction process.

### FINITE ELEMENTS

- 2D isoparametric elements, quadrilateral, triangular, axisymmetrical elements.
- 3D solid elements: tetrahedron, brick, wedge; low- and high-order. Shells (layered) and beams (fiber).
- 1D fiber beam elements and 2D layered shell/plate elements.
- Truss elements for reinforcement, external cable elements.
- Spring supports – point, line, surface.
- Interface elements, 2D and 3D.

### SOLUTION METHODS

- Direct band (skyline), PARDISO and sparse iterative equation system solvers; eigenvalues.
- Newton-Raphson, modified Newton-Raphson, arc-length; line-search.
- Tangential and elastic stiffness predictors.
- Newmark and Hughes Alpha for dynamics.
- 32 bit and 64 bit solution core.

### GRAPHICAL USER ENVIRONMENT

- 2D GUE. Graphical user environment: pre-processing (geometrical modeling, reinforcement (bars, smeared), automatic meshing, material properties, loading and supports, solution methods, monitoring), solution (non-linear FE solution, graphical monitoring, restart), post-processing (iso-lines, iso-areas, rendering, vectors, tensors, cracks, response diagrams, cuts/sections, internal forces (M, N, T), user-defined numerical output).
- 3D GUE. Graphical user environment: pre-processing (geometrical modeling, reinforcement (bars, smeared), copy and move, automatic meshing, material properties, loading and supports, solution methods, monitoring), solution (direct or sparse iterative, graphical monitoring, restart), post-processing (iso-lines, iso-areas, rendering, vectors, tensors, cracks, response diagrams, cuts/sections, user-defined numerical output).
- ATENA Studio. Graphical user interface for ATENA Science for solution and post-processing of 2D and 3D models.
- GiD interface (GiD - general FE pre- and post-processor from CIMNE, Spain) with interface to ATENA.

### SYSTEM REQUIREMENTS

**Minimum:** PC with MS Windows 11, 4 GB RAM memory and 500 GB HDD, graphics card with OpenGL 1.1 and 1024x768 resolution. GiD 9 or later (for ATENA Sci/Full).

**Recommended:** PC with MS Windows 11, 32 GB RAM memory, 4 TB hard disk, discrete graphics card with resolution of 1920x1080 and OpenGL 1.4 with 3D hw-acceleration, designed for CAD (e.g., nVidia FX, ATI FireGL/FirePro). GiD 64bit 17 or later (for ATENA Sci/Full).