

## Innovations and modifications of version 10

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### Summary:

The object of this document is to give a comprehensive view of the modifications of syntax and new opportunities of the orders of *Code\_Aster* intervened during the development of version 10, i.e. since version 9.4.10.

For more precise details, one will consult the documentation of the orders and the file `histor` corresponding under-version (e.g.: [10.1.7], section *Support/Histor* site [www.code-aster.org](http://www.code-aster.org)).

## 1 Breaking process

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### 1.1 XFEM

Formulations:

- Contact rubbing in small/great slips
- Without contact
- Axisymetry
- Great rotations

Features:

- Multi-cracking
- Junctions
- Boundary conditions on nodes XFEM
- Pressure imposed on border XFEM

Tally of use:

- Non-linear behaviors
- Thermomechanical

Propagation of crack:

Possibility of multiple cracks like in 3D: `PROPA_FISS`

Postprocessings: principle of Iso-functionality between FEM and XFEM

Standard postprocessings EF:

- Probability of rupture per cleavage: `POST_BORDET`
- Extension to the free grid: `POST_K1_K2_K3`
- Improvement of the performances of `POST_RCCM`

Postprocessings exploiting framework XFEM:

- Plane and not-plane cracks `POST_K1_K2_K3`
- Extension to the non-linear one `CALC_G`

### 1.2 Cohesive models

Features:

- Starting and propagation of crack
- Tiredness
- Rubbing contact
- Hydro-mechanical coupling

Scopes of application:

- Statics and dynamics
- Linear and non-linear
- Brittle and ductile fracture

Family of modelings:

- Joined elements
- Elements with discontinuity
- Elements of interface

## 2 Linear and non-linear dynamics

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## 2.1 Dialogue calculation-tests

Exploitation of experimental measurements:

- Interactive graphic functionality
- Identification of efforts, structural modification,...: new operator `CALC_ESSAI`

Retiming in dynamics:

- Retiming on the basis of clean mode
- Genetic algorithm `MACR_RECAL`

## 2.2 Couplings

Implicit-explicit:

- Explicit implicit non-linear dynamics: `MACR_BASCULE_SCHEMA`
- Single setting in data Code\_Aster-Europlexus: `CALC_EUROPLEXUS`

Ground-structure

- Extension to non-linear structure: `CALC_MISS`
- Answer to a variable seismic movement in space: `DYNA_ISS_VARI`

## 2.3 Modal analysis

Revolving machines:

- Modal calculation of lines of trees
- Gyroscopic effect for all the types of beams
- Diagram Campbell

Fissured structures:

- Extension to XFEM
- Calculation of  $G$  modal by `K_G_MODAL`

## 2.4 Ergonomics

Modal analysis:

- Simulation supplements in an order: `CALC_MODAL`

dynamic Under-structuring:

- Production of macronutrients `CREA_ELEM_SSD, ASSE_ELEM_SSD`

Interaction ground-structure:

- Preprocessings, calculation and postprocessing `CALC_MISS`

Behavior:

- Determination of the parameters materials homogenized `GLRC_DM` by the order `DEFI_GLRC`

Restitution of the results in physical coordinates:

- Clarification of the features
- Bursting of the order `REST_BASE_PHYS` in three orders : `REST_GENE_PHYS, REST_SOUS_STRUC, REST_COND_TRAN`

## 3 Thermo-hydro-mécanique

### 3.1 Formulations:

Modelings HH and HH2:

- Pure hydraulics, without thermics, mechanics
- HH: 2 phases, 1 component by phase
- HH2: 2 phases, 2 components per phase

Diphasic flows in porous environment

- SUSHI (Design Using Stabilization and Hybrid Interfaces), formulation in finished volumes

Flows in a crack/propagation under fluid pressure

- Joint with hydro-mechanical coupling
- Selective integration \* \_JHMS

Regularization adapted to the porous environments

- Modeling with gradient of voluminal deformation to avoid the problems of localization

Model of damage dedicated to heterogeneous materials

- Random distribution of microphone-defects (Weibull) D\_PLAN\_GRAD\_SIGM + ENDO\_HETEROGENE
- Fracturing of the rocks due to the gas injection

## 3.2 Laws of behavior

Mechanics

- Cyclic law of Hujeux: Law multi-mechanisms for sands and clays, earth embankments
- Lois de Laigle and Kleine, of viscous Drücker-Prager: viscoplastic laws for the rocks (in particular mudstones); rocks of the sites of storage

Hydraulics

- Law of Mualem-Van Genuchten: hydrodynamic law of the unsaturated grounds. Taking into account of disappearance/appearance of phases. Rocks of the sites of storage

## 4 Digital methods

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### 4.1 Non-linear methods

Method of Newton

- Pas de adaptive times, vent-driven DEFI\_LIST\_INST
- Mixed linear research: extension to mechanics, thermics, THM

Alternative to Newton: IMPLEX

- Robust for the lenitive problems: approached solutions, dependence with the step of time
- Support the automatic management of the step of time

Great deformations [Miehe *et al.* ]

- Isotropic and kinematic work hardening, anisotropy
- Any law written in HP
- Symmetrical matrix, quadratic convergence GDEF\_LOG

Mixed formulation  $u - p$

- Treatment of the incompressibility
- Linear and quadratic elements \* \_INCO\_UP

### 4.2 Contact

New operator dedicated to the contact DEFI\_CONTACT

- Setting in data common to all the methods
- Better legibility
- Important profits in performances

New methodological documentation to help the user:

- Note of use of the U2.04.04 contact

## 5 Architecture, ergonomics, performances

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### 5.1 Ergonomics

Easy programming of the laws of behavior:

- Pas de knowledge of data-processing architecture necessary: 1 file to be created, 2 files to be modified
- See the document [D5.04.01] "To introduce a new law of behavior"
- Exhaustive description via catalogues of laws of behavior

External programming of laws of behavior per interfacing UMAT

- Format of definition of law of behavior user of Abaqus
- Facility of compilation grace with or T it `as_run`
- Small/great deformations

Simplification of the names of the fields

- From 3 items, one passes to 2: `SIEF_ELNO_ELGA` becomes `SIEF_ELNO`
- Translator available

### 5.2 Performances

More effective and measurable management of the memory by posting of consumption

Generalization of parallel calculation

- To change a keyword (`SOLVEUR`) + to specify the number of processors
- Distribution of elementary calculations
- Parallel resolution linear systems
- Iso-functionality with the sequential one