Overview

The Code_Aster Professional Network aims to spread and to acknowledge the benefits of Code_Aster and Salome-Meca as open-source software. This report is the second issue, after the first one published end of June 2015. If you don’t receive this one please ask it.

New releases

- **27th July 2015** Salome-Meca 2015.2 64 bits under LGPL license with
  - SALOME 7.6.0
  - Code_Aster 12.4 stable
  - Code_Aster 11.8 old stable

- **20th August 2015** Code_Aster Open source 12.4 stable under GPL license and Code_Aster iesling 13.0. Apart from Code_Aster you will find the latest available updates:
  - astk 1.13.6 - Aster’s GUI for calculation management,
  - Eficas 2015.2 - graphical editor for command files,
  - Homard 11.2 (a mesh refining tool),
  - Med 3.0.8 library - exchange of meshes and fields with third-party codes,
  - Metis 4.0.3 [reordering tool] and Mumps 4.10.0 (linear solver),
  - Interface to MFront 2.0.2 - constitutive law generator developed by CEA and EDF

Regular and special meetings

At the beginning, the activities of the network were focused on semi-annual meetings in France. The ninth ProNet meeting was held in CLAMART (France) on November 20th, 2015.

This year, **special meetings** were arranged in various European countries:

- **LAUSANNE** in Switzerland, in **February 2015** with the help of CAE Linux, NRC Tech and EPFL and contribution of Jean-Pierre AUBRY

- **FIRENZE** in Italy, in **September 2015**, with the help of Michele BETTI - UNIVERSITA DEGLI STUDI FIRENZE

- **End of October 2015** (28th and 29th), the Code_Aster ProNet is invited to **Forum “Simulation in der Automobilindustrie”** at Knorr-Bremse Center at MÜNCHEN in Germany. This appointment was possible with the assistance of Dirk WEID (George Fischer Automotive - Switzerland).

In 2016, the tenth ProNet meeting is planned **March 18th**, after the annual meeting Code_Aster and Salomé Méca, Thursday **March 17th** at EDF LAB CLAMART.

Dedicated forum for the members

The discussions conducted in the ProNet forum are dedicated to all cooperative exchanges between members of the network, expression of needs, follow-up of developments and all feedbacks.

Contact

Jean-Raymond Lévesque – Representative of Code_Aster ProNet
contact@code-aster-pronet.org

News of members

**ITALY**

KOBE Engineering

Is a new company in progress in the field of engineering (masonry, concrete, steel, timber structures, coupled thermal-mechanical static and dynamic physics and so on)

**FRANCE**

STABILIS SAS

Create in August 2015 this company proposes :

- Development with Code_Aster structural analysis adapted to the nuclear civil engineering.
- Realization of studies in advanced simulation in civil engineering

TEACHING CORNER

MICADO Dinccs and the University Quebec Trois-Rivières signed a strategic partnership agreement. This agreement confirms the will of the two entities to work together, in particular within the framework of project Simul-SME Competence - Teaching

All teachers are welcome in Code_Aster ProNet
The meeting in LAUSANNE at EPFL (Switzerland)

During this meeting, in February 2015, Joël CUGNONI, in charge of the open source engineering platform CAE Linux, delivered an assessment of the experience feedback of this platform.

WHAT WORKS WELL

- Versatility and flexibility of Code-Aster / Salome / GMSH environment is great
- Many complex simulations are possible, many tuning options
- Very open to code coupling and file transfers, integration with external tools and custom developments in Python or Fortran
- Requires a trained user which knows what is behind (this is a + in the end)
- Diffusion of Aster through Salome-Meca is great
- Frequent updates of Code-Aster, valuable forum and feedback from Devs
- Aster is at the forefront of research in some domains but remains a generalist FEA solver with excellent Multiphysics capabilities
- Many improvement in parallel solution performance recently, becomes also more robust with contacts
- For CAE Linux: it has found a great audience, is used worldwide!

WHAT COULD BE IMPROVED

- English doc is hard to read… start an open human « translation project »?
- More methodological docs & intermediate level tutorials to ease learning
- Salome Wizards could be expanded to help the transition between beginner and expert levels
- Small community, needs more interactions to keep it alive
- Default settings in non-linear solution and automatic time stepping could be improved for better performance. Trying to replicate (and set as default) Abaqus time stepping / convergence analysis would be highly beneficial.
- Display performance issues in Salome Mesh & Visu but improved recently
- Some inconsistencies in post-processing, issues with Von Mises in tetrahedra, slow post-processing (CALC_CHAMP) compared to solver...
- Deploying Linux in companies remains an issue, even with Virtual Machines
- More synergies between actors should be found to mutualize development / training and support
- For CAE Linux: should migrate to an open development model

TO FOLLOW

Starting from an example provided by Dirk WEID (Georg Fischer Automotive) and a first student’s work, Joël CUGNONI realized an extensive benchmark on the performances in nonlinear analysis of the parallel versions of Abaqus and Code_Aster.

Future work & needs (Research at EPFL – LMAF ) proposed by Joël CUGNONI

- Develop an open source homogenization platform
- Develop an open source platform for biomedical engineering (bone modelling)
- Further development of Composite modeling tools
Collaboration between members - Projects

Project PIA PAMSIM - (France)

The project PAMSIM (Massive parallelism in Digital simulation for Mechanics) is financed by the French program "Investments with A future" (Development of the Digital economy). Project PAMSIM lies within the scope as of research efforts to develop a version massively parallel of Code_Aster, to fill the delay of the implicit digital simulation in structural analysis, by comparison with other fields of physics like the fluid mechanics.

That corresponds to the needs for simulations multi-scales and multi-physics, the treatment of uncertainties, ...

This need is confronted with the challenges of research as for the modularity and the interfacing of tools paralleled within the platforms of industrial calculation and in heterogeneous architectures of computers.

Coordinated by EDF R & D, project PAMSIM gathers a multi-field community of researchers and engineers of the stage of Co-design (architecture, algorithms) to the means of industrial deployment of the finished product (API, platform of calculation).

Collaborations between members - PHD THESIS

An accurate Local Average Contact (LAC) method for nonmatching meshes in 2D and 3D

In his PhD thesis, defended last September, Guillaume DROUET extend the mortar finite element method to handle the unilateral contact model between two deformable bodies. The corresponding variational inequality is approximated using finite elements with meshes which do not fit on the contact zone.

The mortar technique allows to match (independent) discretization within each solid and to express in a satisfying way the contact conditions. Then, he realize a numerical analysis of the algorithm and, using a bootstrapping argument, and give an upper bound of the convergence rate similar to that already obtained for compatible grids.

He confirm his capacity to numerically manage the unilateral contact with incompatible grids in an optimal way following the example of the classical methods “mortar”, while remaining easily implement in an industrial computer code as Code_Aster.

It is thus shown, that the method passes the patch test of Taylor. Finally, we show his contribution in term of robustness and on the level of the quality of contact pressures on study of an industrial type.
Collaborations between members - PHD THESIS

Homogenized nonlinear stress resultant constitutive model for cracked reinforced concrete panels


The objective is to model the nonlinear behavior and the cyclic response of structures of big size subjected to seismic solicitations using finite elements of plates, modelling at the same time the concrete and the reinforced bars with a cost of limited computer time.

This law takes into account 4 sources different from nonlinearities of the behavior (or dissipative phenomena): loss of stiffness of the concrete (or damage), appearance and development of cracking in the concrete, relative slip between the steel bars and the concrete with stresses of adherence to the interface, and plasticization of the steel bars.

The theoretical formulation of the law of behavior was carried out by an analytical homogenization of the problem on a reinforced concrete membrane with only one network of cracks, was followed of an extension to the case of a second network of cracks and, finally, a generalization of the model obtained in the case of a plate also subjected to efforts out of plane.

The results are confronted with experiments and other modelling approaches.

Optimization of inspections plan for structures submitted to stochastic degradation processes. Application on Reinforced Concrete Structures

The defense of the PhD thesis, prepared by Rodrigue DECATOIRE prepared under the supervision of Pr. F. SCHŒFS (Univ. Nantes), Dr. S. M. ELACHACHI (Univ. Bordeaux) and Dr. T. YALAMAS (Phimeca) is planned the 15th December 2015.

This event is coupled with a workshop on Probabilistic approaches for maintenance optimization of civil engineering structures with the participation of

- Pr. J. SORENSEN (Aalborg University) – Reliability and operation & maintenance for offshore wind turbines
- Pr. A. O’CONNOR (Trinity College Dublin) – Risk Assessment of Infrastructure Networks in Response to Extreme Weather Events
- Pr. A. CHÂTEAUNEUF (UBP Clermont-Ferrand) – Reliability Based Life Cycle Cost Optimization of Infrastructures
- Pr. F. DUPRAT (INSA Toulouse) – EVADEOS Project outlines and results from the project

This module is still at the mock-up (or model) stage. More functionalities will be progressively implement, such as the capability of taking into account more uncertainties or complex buildings systems. Furthermore, the results will be post-processed through PARAVIS.

DEVELOPMENT FOR SALOME MECA

The objectives are double:

- Develop a new module in Salome-Meca that computes fragility curves for a building submitted to seismic loadings,
- Give the tools to build a specific module in Salome-Meca,
- Evaluate the difficulties.

This work was done in an internship frame. In Fragility module, 6 steps are needed for a seismic study:

- Build and mesh the building model
- Define material properties
- Define geometrical characteristics
- Define modal analysis
- Specify accelerograms generation
- Give the working directory

The module is still at the mock-up (or model) stage. More functionalities will be progressively implement, such as the capability of taking into account more uncertainties or complex buildings systems. Furthermore, the results will be post-processed through PARAVIS.
Contributions to the development by the Community

**Dynamic analysis of structures with viscoelastic materials having frequency dependent properties**

*Presented by Nicolas MERLETTE at ProNet Meeting 20th November 2015*

In practice, dynamic behaviour of Visco Elastic Materials (VEM) varies with environmental factors as humidity, pressure, temperature and frequency. This leads to a complex representation of Young’s modulus $E'(\omega,T)$ and Loss factor $\eta(\omega,T)$.

Experiments in tension compression (or in shear) gives tabulated values of these quantities.

The computing methodology leads to use the complex stiffness matrix for each frequency step and determined frequency dependent modes.

The way how these modes can be used to improve the modal projection method is described in the Reference document R5.05.10

The approach to frequency dependent modes has been implemented in Code_Aster, by Tangent’delta, via a macro command, namely DYNA_VISCO, now available in stable version 12.4.

This script uses standard commands existing in Code_Aster for the conventional modal method. Python codes have been added for the new developments:

- definition of a frequency dependent behaviour,
- computation of frequency dependent modes by the iterative algorithm,
- frequency response computation with realization of the stiffness matrix at each frequency step.

**Application to a booster-like stage demonstrate the frequency dependent behaviour**

**MFront: simple, efficient and portable implementations of mechanical behaviours**

*Presented by Thomas HELFER at NAFEMS Simulation of Materials Seminar 19th November 2015*

Nuclear fuel elements simulations require a rigorous material knowledge management strategy.

Developed since 2009 in the context of the PLEIADES project, co-developed by CEA and EDF, MFront is a code generator which aims at [1]:

- Simplifying the implementation of mechanical behaviours,
- Providing efficient implementations,
- Sharing the implementations between various FEM or FTT solvers through interfaces (currently Code_Aster, Cast3M, Zebulon, Abaqus, AMITEX_FFT ...).

MFront can handle small and finite strain behaviors, cohesive zone models. Support for non-local behaviours is planned.

Since 2014, MFront is open-source, co-developed with the Code_Aster team, and distributed with the Code_Aster package. The community of users is steadily growing. More information are provided on the web site [2].


Seismic assessment of masonry constructions requires, regardless of the employed typology of analysis (nonlinear static or time-history analysis) the proper definition of the nonlinear behaviour of masonry. Code_Aster has a wide library of material nonlinear behaviour laws, including the continuum damage model of Mazars.

This model, originally proposed for the analysis of the concrete, requires, for its definition a reduced number of parameters with clear physical meaning that makes it particularly interesting (such parameters can be, in fact, easily derived from compressive and tensile tests).

To analyse the seismic behaviour of a masonry building, preliminary sensitivity analyses on the Mazars's parameter have been performed. In particular results of available diagonal compression tests carried out on masonry wallets have been considered. Fig. 1 reports the collapse damage map obtained assuming three different values of the constant $\beta$ (whose determination would requires a shear test).

The identified material parameters have been employed to characterize the masonry nonlinear behaviour, and a FE model of the whole building has been built with the platform Salomé-Méca (Fig. 2). The building investigated, in particular, is one of the two masonry prototypes built at the CNR-ENEA research centre of Casaccia (Roma, Italy) tested through an extensive experimental investigation on shaking table.

The pushover analyses has been performed considering two time invariant load distributions for the lateral forces, namely: i) a distribution along the height proportional to the masses (uniform distribution, U) and ii) a distribution along the height proportional to the masses times the heights (triangular distribution, T). Distributions U and T were applied separately in +X, –X, +Y and –Y directions, so 8 nonlinear static analyses were performed. Fig. 3 reports the damage maps obtained in two of these cases.

The FE model is able to predict, with respect to the damage experienced by the prototype during the shaking tests, the damaged areas and the incipient collapse mechanism.
Applications submitted by members

On the design of clock components

November 20th 2015

Fabiano COLPO – R&D ROLEX – GENEVA - Switzerland

Fabiano COLPO presents a large variety of examples from material properties identification to optimisation of behaviour of clock components:
Community Code_Aster aims the safeguard of the historical heritage
In Spain

Cracking process of an oval dome in the cathedral of TORTOSA
Assessment of the collapse mechanism
July 2012
J. Lluis i GINOVART, A. COSTA, G. FORTUNY, P. SOLA-MORALES, J.M. TOLDRA - Universitat ROVIRA I VIRGILI. REUS (Spain)

In April of 2011, one of the masonry domes of the cathedral of TORTOSA enclosure (Tarragona), built at late XVIII century, suddenly broke. The paper presents the evolution of the rupture and its causes, analyzing the cracking process initiated with the runout of the lantern.
It is analyzed the equilibrium conditions starting from the initial constructive assessment in order to know the behavior of the dome and its bearing capacity. There are used complementary traditional graphical methods and tridimensional models by finite elements (FEM) by means of the free software Salome-Meca 6.3.
Through the interpretation of the results, the assessment concludes that the dome by itself can hold the weight of the lantern. Thus, the cracking of one of the roof beams causes the bending of the lantern, and therefore the formation of collapse joints from the asymmetrical distribution of loads.

FEM assessments on roofing constructive solutions applied to a twelfth century Romanesque church at Vall d’Aran (Spain)

WIT Press 2015
A. COSTA, G. FORTUNY, J. FABREGAT, A. ROYO
Universitat ROVIRA I VIRGILI. REUS (Spain)

The Church of Santa Eulària d’Unha is with a basilica plan floor, very common in the area, with large deformations of the masonry structure. The use of advanced techniques of indirect measurement has enabled a mapping with unprecedented detail.
The exhaustive analysis of the registered deformations has allowed the identification of an inclination of up to 4.6% in the perimeter walls. The location of the loads of the roof over the masonry structure has a major influence on its stability, and restoration works often imply the intervention on this element. The paper presents a comparison between different solutions.
The survey enables building a model 3D of the deformed shape with mesh and calculation by Salome Meca.
Community **Code_Aster** aims the safeguard of the historical heritage

**In Italy**
September 19th, 2015 (WEEF Conference)

The Palace of **PIANCASTAGNAIO** (South Tuscany, Italy) is a masonry building with a rectangular plane section (Fig. 1) The discretization of the geometry into finite elements was carried out by adopting the algorithm *netgen* with one-dimensional input and generating a tetrahedral mesh reasonably uniform and regular.

To reproduce the masonry non-linear behaviour the continuum damage model of Mazars was adopted. In its local version, preliminary parametric tests were carried out to verify the dependence of the solution from the discretization leading to stable results.

The results allowed to identify that the damage in the palace was due to a local failure of the ground under the middle part of the eastern façade of the palace.

The Michelangelo’s **David** was unveiled on 1504 and it remained in front of the main entrance of Florence town hall until 1873. Since 1872 a growing concern arouses about the David deterioration and stability due to a series of visible cracks. The statue is an interesting case study due to the Michelangelo’s conception: the David stands with one leg holding its full weight (the right) and the other leg (the left) forward. The statue is hence characterized by a significant eccentricity between the center of mass and the center of the supporting base.

The stress concentration on the legs is visible where the Von Mises stresses obtained with a static linear analysis. The Code_Aster numerical model has been also employed to evaluate the dynamic behavior of the statue.
65 members in 13 countries

Industrial and research organizations, services providers and teachers are welcome at