PRONET Update - 20

QUARTERLY REPORT OF CODE aster PROFESSIONAL NETWORK

PRONET Update 1

June 2015

PRONET Update 20

January 2024

More than 200 contributions of the members

20 meetings in the world

code-aster.org

CODE aster professional network

user community of

CODE aster and salome_meca

Information content:

- Open source and ProNet
- CODE aster as a research platform
- CODE aster as an industrial platform
- CODE aster as an educational platform
- CODE aster for service providers

YouTube LinkedIn

Jean-Raymond Lévesque

Sylvie Courtier-Arnoux

Representatives of CODE aster ProNet

contact@code-aster-pronet.org

Thank you to all those who contributed to the activities of the PRONET Network and shared their experiences with CODE Aster and Salome Meca.

With regret we are ending these activities for various reasons.

Our final contribution will be the distribution of a directory of all members of the community who have agreed to have their contact details published.

Community of Users

CODE_aster development team

Electricité de France -R&D – France

Dear fellow members,

On behalf of code_aster's development team and of EDF community of users, we wish to warmly thank Jean-Raymond and Sylvie for the energetic organization of the Pronet network that they have been ensuring for the past 12 years.

The Pronet network as we have known it has irrefutably brought structure to the users community and made it grow outside its parent company, in more than 22 countries.

In this respect, this last newsletter is very special, it is the last one from the Pronet network in its current form.

The increasing use of code_aster has resulted in an increase in the amount of support requests to the development Team. Until now, these requests were handled free of charge but intermittently, by most certainly passionate developers but with limited (free) time.

The board of EDF R&D has taken the step of launching a dedicated value-creation structure to several simulation codes from EDF R&D, including code_aster. This structure will be led by Fabien Leray (fabien.leray@edf.fr). It should soon be a subsidiary of EDF.

This value-creation structure will be the entry point for the community of external users and will be responsible for editing all content (web site, newsletter) directed to you. It will also set up a commercial support and services offer.

The community of external users doesn't end now, on the contrary. We do hope that i twill keep growing under its new form.

We thank you for your membership and do hope that our relationships will continue with the same quality.

Best regards,

Bonjour,

Au nom de l'équipe de développement de code_aster et de la communauté des utilisateurs EDF de code_aster, nous souhaitons remercier Jean-Raymond et Sylvie pour l'animation dynamique du réseau Pronet qu'ils ont assurés durant 12 années.

Ce réseau a indubitablement permis de structurer et faire grandir la communauté des utilisateurs de code_aster en dehors de son entreprise mère, dans 22 pays.

Ce dernier bulletin code_aster est à ce titre très spécial, il est le dernier du réseau Pronet sous la forme que vous lui connaissez.

L'utilisation croissante de code_aster s'est traduite par une augmentation des demandes de support auprès de l'équipe de développement. Ces demandes étaient jusqu'alors traitées occasionnellement mais gracieusement, par une équipe de développeurs certainement passionnée mais au temps (libre) limité.

La direction de la R&D a pris l'initiative de monter une structure de valorisation dédiée, et qui concernera plusieurs codes de simulation d'EDF R&D, dont code_aster. Elle sera pilotée par Fabien LERAY (fabien.leray@edf.fr). Elle devrait prendre la forme d'une filiale distincte du groupe EDF.

Cette structure de valorisation sera la porte d'entrée de la communauté des utilisateurs externes à EDF, et aura donc la responsabilité de l'édition des contenus (site web, newletter) qui vous sont adressés. Elle aura également la mission de mettre en place une offre de support commerciale.

L'animation de la communauté ne s'arrête donc pas, bien au contraire. Nous espérons qu'elle pourra continuer à croître sous cette nouvelle dynamique.

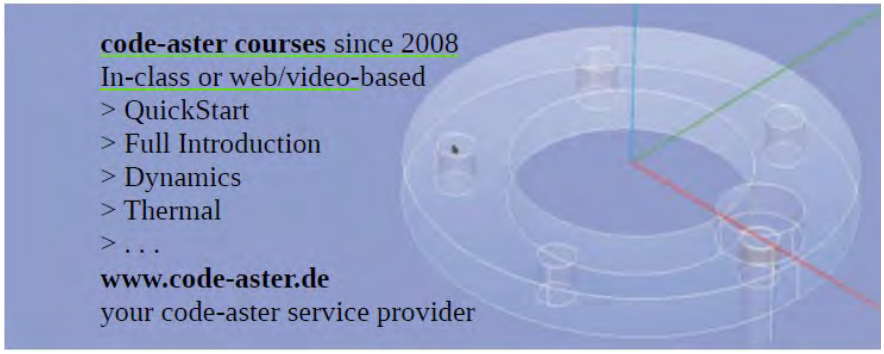
Nous vous remercions pour votre adhésion et espérons que nos relations continueront avec la même qualité d'échanges sous cette nouvelle forme.

Amicalement,

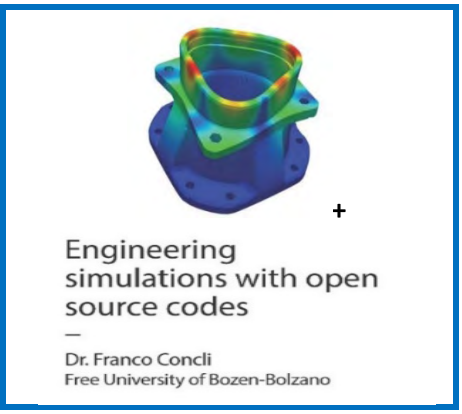
TRAINING

PHIMECA	Alter Ego	Deltacad
www.phimeca.com/Formations	www.aego.ai/training	www.code-aster-services.org

SimulEase	Fondation dell'ordine degli ingegneri della provincia di Milano	aeroengineering services in Indonesia
contact@simulease.com	info@foim.org	www.services.aeroengineering.co.id



fgcaeanalyst@gmail.com www.code-aster.de

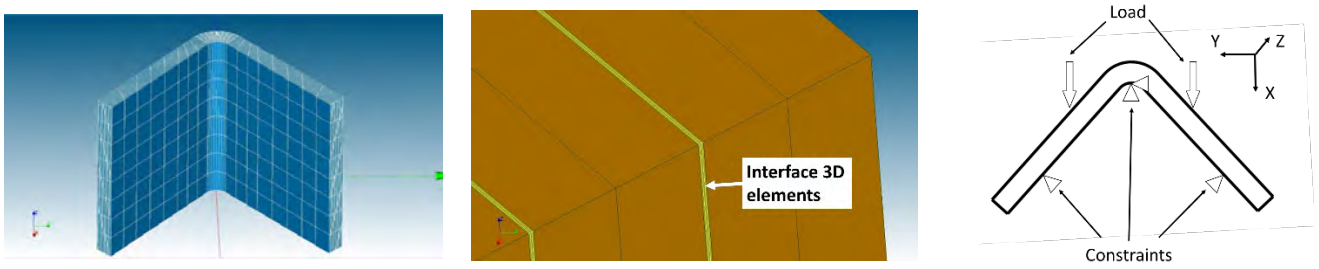


Numerical evaluation of delamination phenomena in angle beam CFRP specimen

Alessandro CASTRIOTA - Riccardo NOBILE

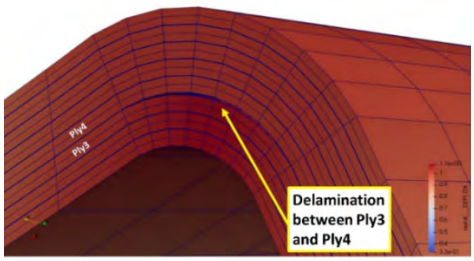
Universita de SALENTO– Italy

The most relevant failure mode of laminate composite materials is the delamination, which could determine the stiffness decay and the final failure of a structure. Since delamination is a microstructural phenomenon, but with important consequences at a structural level, the mechanical conditions that could influence this failure mode must be studied at a microscopic scale, considering the effect of the introduction of a discontinuity in a bulk material. At this purpose, **Code Aster** considers the possibility to model the evolution of discontinuities using the **X-FEM** approach and to take into account the detachment forces of the surfaces through the formulation of the **CZM** (Cohesive Zone Model). However, a limitation is represented by the impossibility to use the **X-FEM** approach for orthotropic material. To overcome this difficulty, an interesting solution is represented by the insertion of isotropic elements representing the matrix of the composite material between the orthotropic elements representing the laminae. A test case to evaluate the validity of the proposed solution was implemented considering an angle shape beam in CFRP subjected to 4-point bending. This loading condition produces a relevant out-of-plane tensile stress, which enhances the delamination phenomenon. Pre-processing was performed in **Salome Meca**; all parts of the sample were modelled as volumes. To implement the **X-FEM** approach, the surfaces that reproduce the interfaces between the volume elements were created. A numerical model with 7904 elements was obtained. Next, the **X-FEM** with **CZM** behaviour was introduced in the .comm file to simulate the delamination. The results showed how it is possible to simulate the delamination of a composite material specimen using **Code Aster**, although the code was not exclusively designed for this type of study. The tensions in two of the main directions of the plates also showed how the numerical result agrees with what is expected in experimental practice.

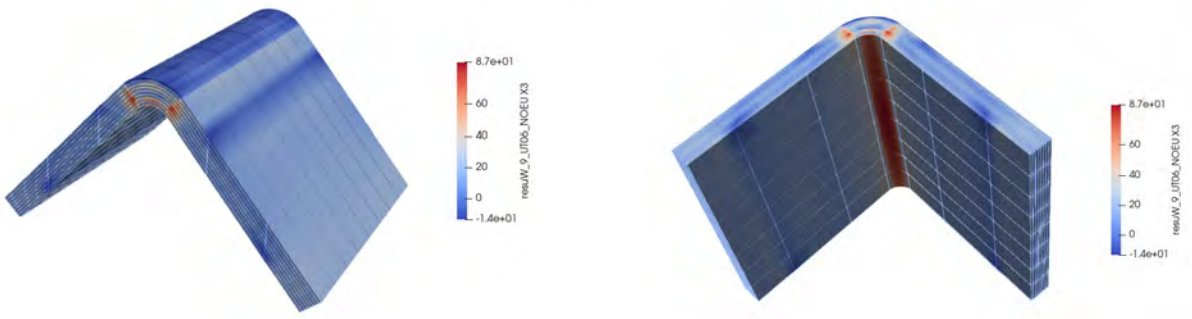


(a) (b) (c)

Fig. 1. (a) Mesh of the numerical model; (b) interface between plies; Constraints and load of the numerical model



(a)



(b) (c)

Fig. 2. (a) Delamination between Ply3 and Ply 4; (b) top view and (c) bottom view of stresses along the local Z direction after delamination

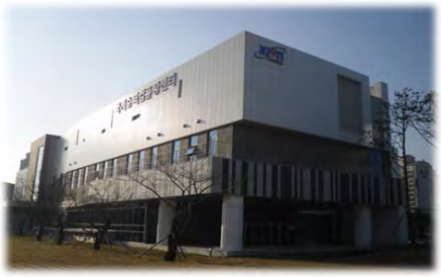
South Korea Code_Aster & Salome-Meca training course opened

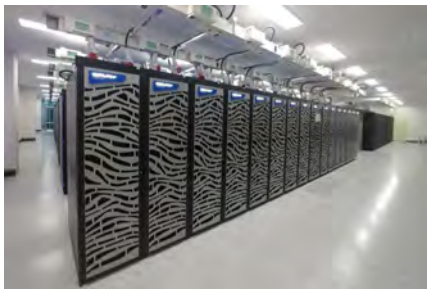
Tae Ho YOON

KISTI (Korea Institute of Science and Technology Information– Korea

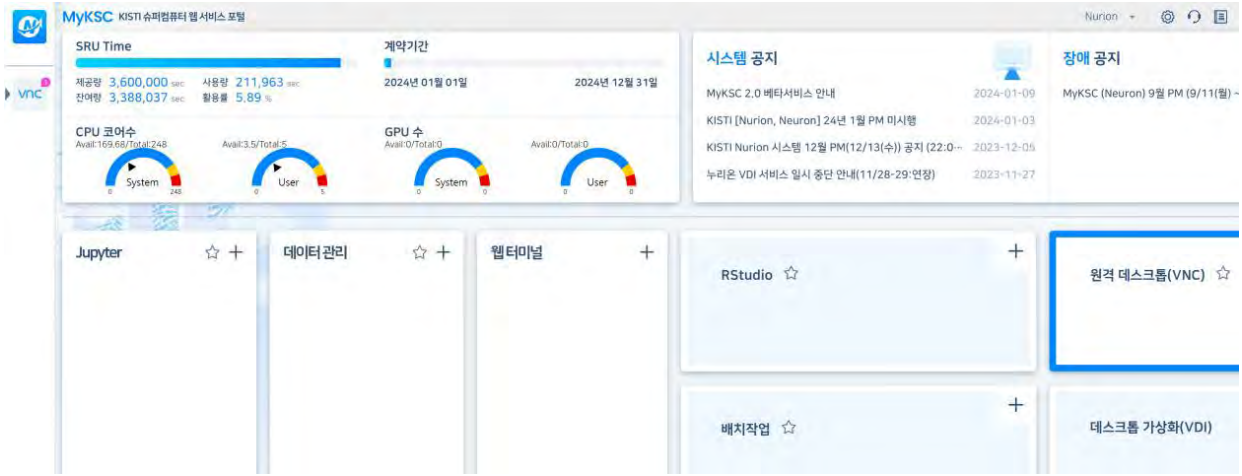
KISTI (Korea Institute of Science and Technology Information, https://www.kisti.re.kr/eng/), a leading research institute in science and technology information, leads open science based on science and technology infrastructure, and leads digital-based R&D innovation and new growth engines with world-class supercomputing and data analysis technology.

KISTI is the first Korean institution to provide Code_Aster & Salome-Meca as a supercomputing application service and free training course. Code_Aster & Salome-Meca are also installed on KISTI's national supercomputer and the myKSC web service portal(https://my.ksc.re.kr/). KISTI National Supercomuting Center is expected to play an important role in revitalizing the community of many researchers from domestic industry, academia, and research institutes using Code_Aster & Salome-Meca.

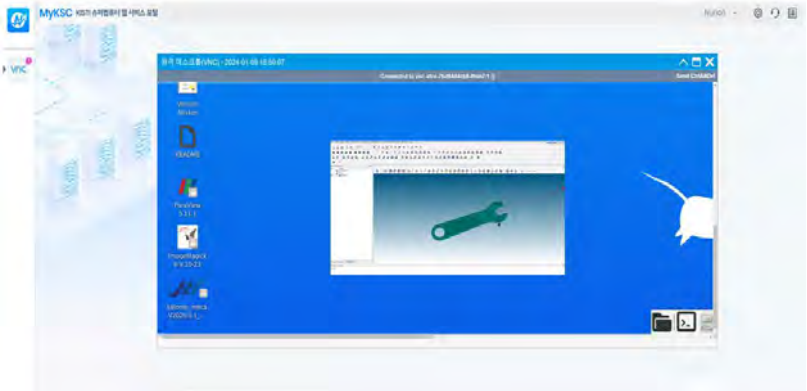




< National Supercomputing Center & National Supercomputer Unit 5 'Nurion'>



< myKSC KSTI Supercomputer Web Service Portal > https://my.ksc.re.kr>



<Salome-Meca VNC service of myKSC>

Contact:Tae Ho Yoon(+82-42-869-0736, thyoon@kisti.re.kr)
Address: 245 Daehak-ro, Yuseong-gu, Daejeon, 34141, Korea

Code_Aster training

Ing. Gomez Lucio

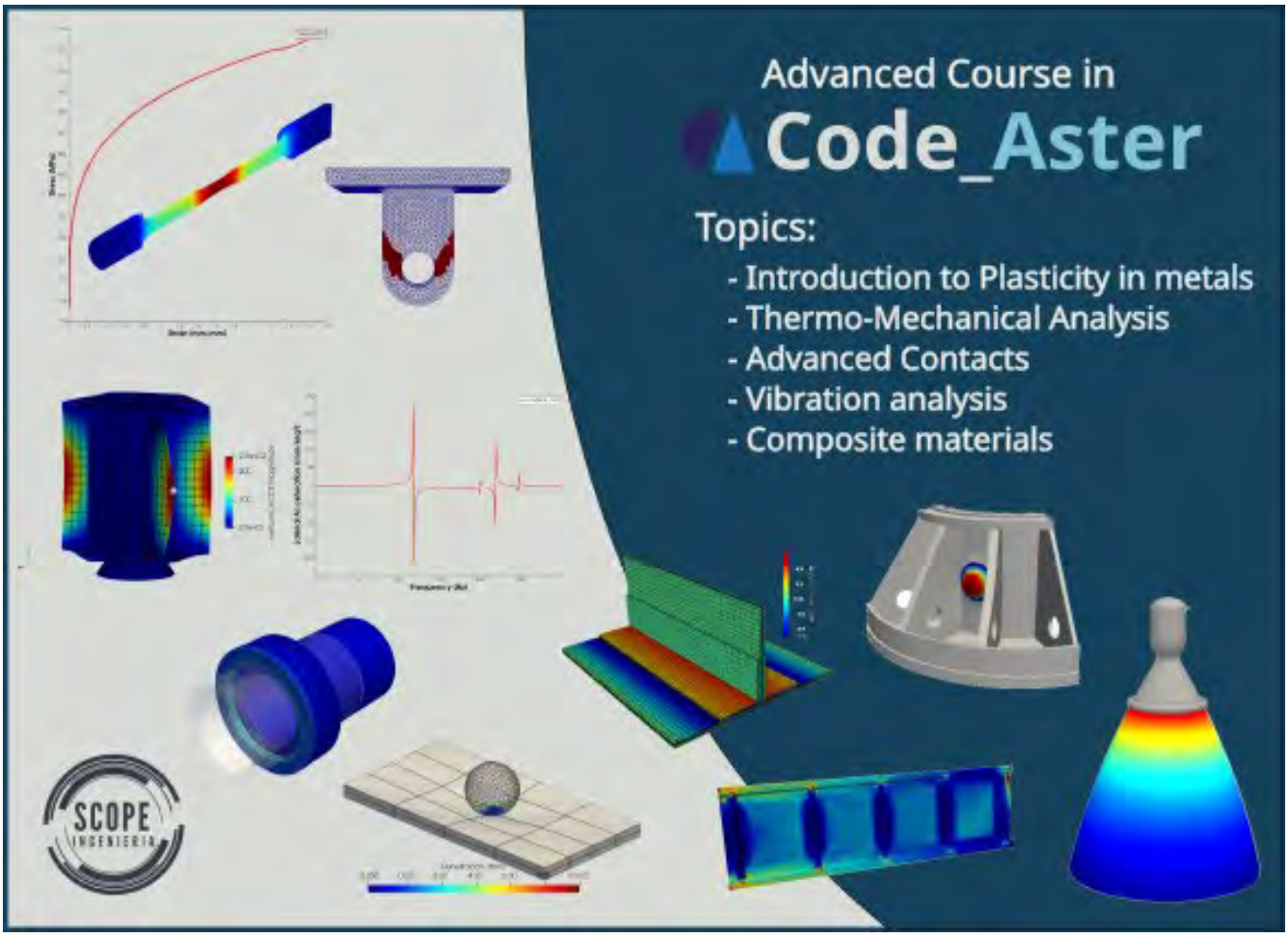
SCOPE Ingenieria – Argentina

As new this year, we were able to carry out 2 training sessions on Introduction to Code_Aster, where in total we had more than 30 students.

Additionally, for the first time in November/December we taught an advanced course in the use of Salome_Meca/Code_Aster with topics such as

- plasticity in metals,
- nonlinear contacts,
- transient thermal and thermo-mechanical analysis,
- harmonic analysis
- Shock Response Spectrum (SRS)
- composite materials

where 15 professionals from Spain, Mexico, Chile and Argentina participated.



Code_Aster at Framatome

Benoit SERRE

Framatome – Centre de calcul Bourgogne – France

Creation in 2021 of the Bourgogne calculation center and the mechanical center of excellence with the objective of:

- •Evaluation of the code_aster as an alternative to the codes usually used
- •Use of the code_aster in the studies of diversification (except nuclear) but also on the nuclear scope
- •Pooling of tools within the various Framatome entities

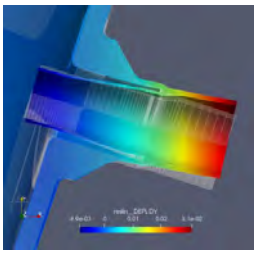
INDUSTRIALIZATION ACTIONS

- Use of code_aster in the Framatome IS:
  - ➢ Retained solution: use of code_aster and Salomé-méca on remote server for the operations of pre and postprocessing and calculations
- Business evaluation of the functionalities of code_aster and Salomé-méca:
  - ➢ Scopes targeted: tooling studies, component justification, line justification
  - ➢ Static and thermomechanical mechanical calculations
  - ➢ Vibratory and dynamic calculations evaluated in a 2nd time
- Definition of development actions in order to complete the functionalities of code_aster and Salomé-méca
- User training:
  - ➢ •Realization of internal training via the Center Calculs Bourgogne training center.

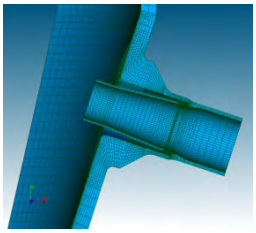
ASTER CODE ASSESSMENT – Feeding Water Tubing

♣Key points of the study:

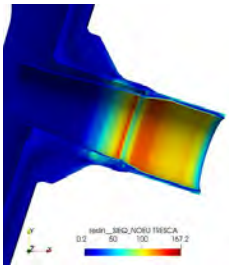
- Creation of geometry and mesh
  - ➢ -Complete tools (Shaper+ Geometry+ Mesh) but long process
- Mechanical calculations (pressure, bottom effect, torsors)
  - -Application of mechanical torsor not suitable for half model
- Thermomechanical calculations (transient)
  - Automatic adaptation of the time step is not always available
- Elastoplastic behavior
- Phenomenon of gradual heating
  - ➢ Switch from graphic mode to text mode + python
- Creation of cutting sections and extraction of results in a given format (readable by ALLIANCE)
  - Possibility to extract total or linearized constraints on sections, but not suitable for industrial use



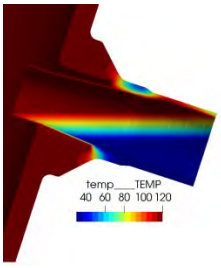
Application torsor



Mesh



Thermomechanical stresses



Gradual heating

CONCLUSION

- Year 2021 and 2022:
  - ➢ Years dedicated to the evaluation of code_asteret to the construction of a calculation chain between code_asteret the internal tools of Framatome
- Year 2023 – on the way to code_aster:: Implementation of a very important training of employees
- And more

Use of Code_aster in the Civil Engineering Department of Orano Projets

Sara QORADI – Civil Structural Engineer – David LOHIER – Mechanical Expert

OranoProjets – France

OranoProjets is specialized in nuclear fuel cycle engineering and project management. Its services range from support engineering for operators to comprehensive EPCM (Engineering, Procurement, Construction, Management) responsibilities

Civil Structural Engineering department :

- Evaluation of existing structures according to new regulation
- Design of new structures
- Revamping
- Detailed design validation

- Reinforced concrete buildings, steel frames and geotechnical constructions (underground structures, retaining walls, etc.)
- Linear and Nonlinear analysis (Material and/or geometric)
- Seismic calculations: Modal response spectrum analysis, time history analysis, floor response spectra calculation
- Structural dynamics (explicit and implicit FEM) : Drop load, Blast loading, Impact load, etc.

Code Aster in Orano Projets

7 engineers were trained to use the software and an Installation phase (on a linux Cluster for a **Testing phase** :

- Code_Aster test cases
- Tests on simple models
- Reinforced concrete calculation and post-processing
- Python routines to optimize data setting for models

What next ?

- Comparing testing results with other Software results(on existing building models)
- Nonlinear dynamic analysis tests
- Calculations on large building models
- Post-processing developments
- Use of MISS3D for ground-structure interaction

Projet MECANUM@

David LOHIER- Mechanical expert

OranoProjets – France

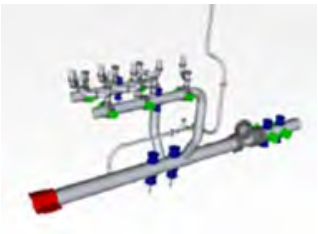
MECANUM@ - GOAL: D**evelop software about piping calculations adapted for nuclear industry and gain sovereignty and efficiency for coming big national programs: EDF – CEA – Framatome – Orano – NAVAL Group**

6 domains of R&D :

1 - acquisition of relyable digital datas of existing installations (3D scan, AI, oldscan ID recognition)
2 - improve material data by intensive tests
3 – develop a piping calculations software more efficient than Pipestress, using **Code ASTER** as solver
4 - fast dynamics piping simulations (high energy pipes)
5 - advance seismic analysis for piping
6 - advance fatigue & fracture analysis

Orano's scope :

- Implement Piping codes verification (EN 13480, RCCM, CODETI)
- Develop a metalanguage in order to describe a model with an editor
- Develop a tool conversion between CAD format and Piping Master, and vice versa
- Develop a tool to generate automatically piping calculations report
- Export piping efforts for supports calculations



CODE_ASTER : a R&D collaboration tool between EDF and NAVAL GROUP

Cédric LEBLOND - Astrid FILIOT & Mickaël ABBAS

NAVAL Group – EDF R&D – France

A FRAMEWORK AGREEMENT BETWEEN NAVAL GROUP AND EDF

- **15 to 20 active working groups**
- **GT 23 « Reduced Order Model in vibro acoustics», with objectives :**
  - **Improve the functionalities in vibro acoustics in code_aster**
  - **Continue the integration of model reduction techniques in code_aster**
  - **Mutualize development costs via EDF / Naval Group partnership**
  - **Make "out of reach calculations" accessible (parametric, stochastic, sensitivity, etc.)**
  - **Apply these approaches to concrete problems (shock, earthquake, thruster, wind turbine, etc.)**

GT23 merged with GT28 (Simulation platform)

EXAMPLES OF COMMON RESULTS

- **PhD thesis of L. KHOUN**

Transient ROM stability theorem
Implementation of new vibro-acoustic formulations in code_aster
Implementation of reduction algorithms in code_aster for parametric problems
Consideration of geometry variability

Industrial applications for EDF

- **Evaluation of the coupled fluid-structure eigenmodes of the main primary circuit (CPP) for EPR reactor**
- **Evaluation of the transient earthquake response of a dam using an implicit approach for the application of the Sommerfeld condition**

- **PhD thesis of Q. RAKOTOMALALA**

Objective: tool for the design of damped composite structures (propeller application for Naval Group and wind turbine for EDF)

Theoretical work to separate two main phenomena :

- **Steady propulsive**
- **Vibroacoustic phenomenon :**

Proposal of a hyper-viscoelastic constitutive law based on compressible Mooney-Rivlin law

OPENING TO OTHER APPLICATIONS

- **Numerical simulation for diffusion welding – Compression under high temperature**

Constitutive law validation with multi-plate compression tests
Simulation of mechanical compression test under high temperature

Evaluation of the stress distribution in multi-grooved plate structure
Local mechanical simulation

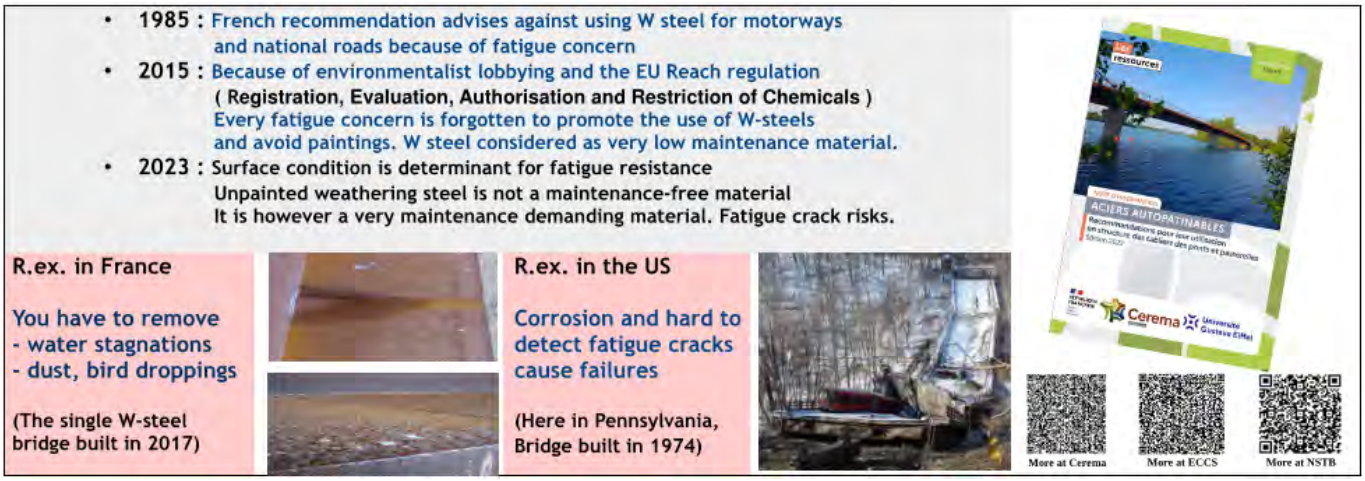
- **Real-time structural health monitoring**

Assessment method for fatigue regarding existing motorway bridges made of weathering steel.

Jacques BERTHELLEMY – Directeur Technique

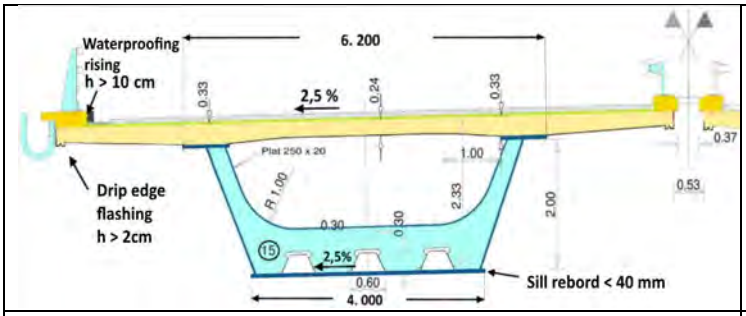
CEREMA – France

The experimental study by Professor Kunz that I used was commissioned by the Czech Electricity Company in the 2000s.who wanted to evaluate the aging of weathering steel used in power line support pylons.
And it is the best study in the world that can be found on the subject.

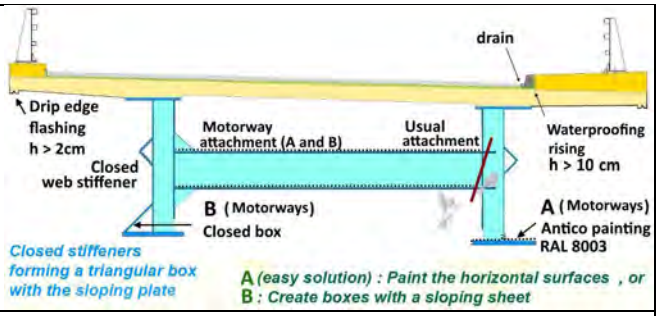


Complements to these general recommendations:

1 - Design of motorway bridges with W-Steels



Box girder bridges have a key advantage for motorway W-steel bridges

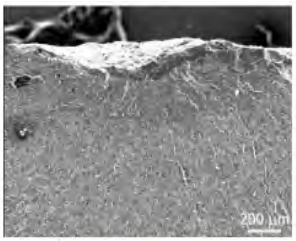


Options to reach the same level as with a box girder using double I-girder made of W-steel

2 – Application of Clause 7.1(5) of the 2011 French National Annex to EC3 1-9 (or the future Eurocode 3 Part 1-9 of 2026) Using the L. KUNZ results in reference in the 2023 information note to evaluate the modified stresses

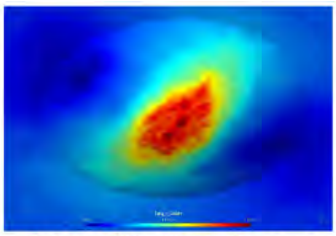
Fatigue test specimen used by Kunz et all

Specimens were exposed for more than 20 years in central Bohemia in a rural countryside



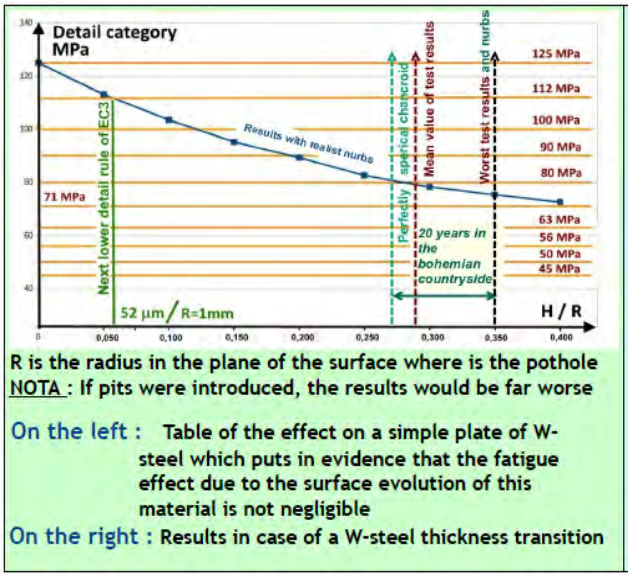
Example of 2 mm diameter 200 µm deep pothole observed at the surface of W steel

SCF in the center about 1,50



Recalculation of Kunz's results : agreement
Two parameters Radius R (pothole)= 1 mm
Deep H (pothole) varying

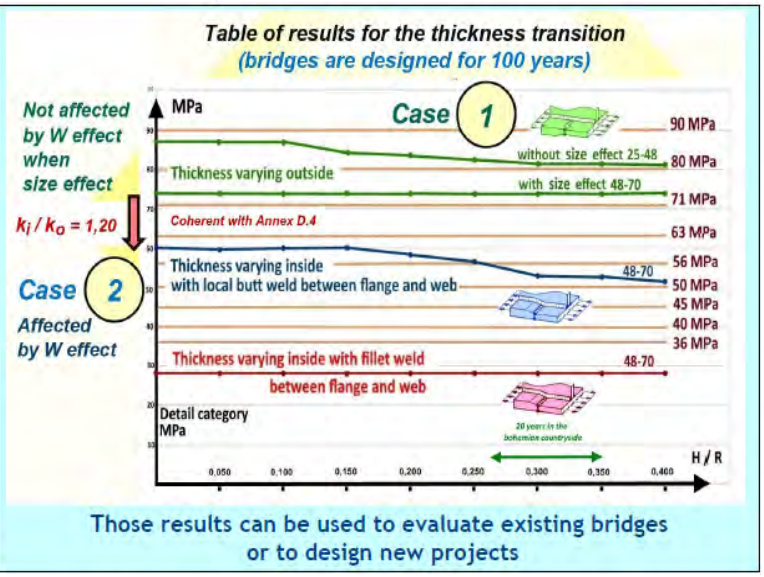
The effective notch stress method is used to modelize the potholes for Code_Aster studie



R is the radius in the plane of the surface where is the pothole
NOTA : If pits were introduced, the results would be far worse

On the left : Table of the effect on a simple plate of W-steel which puts in evidence that the fatigue effect due to the surface evolution of this material is not negligible

On the right : Results in case of a W-steel thickness transition



Those results can be used to evaluate existing bridges or to design new projects

Documentatiion Code_aster / Salome_meca published in Italian

Francesco GRISPO and alii

Code_Aster in Italia – Italy

CODE_ASTER ITALIA

La community italiana di Code_Aster e del CAE Opensource

Documentazione

To date, the **Code_Aster** documentation is present only in French and English.

Wanting to expand the use of this software, in **Code_Aster Italia** we are trying to translate all the documents present on the official site and subjected to the GNU license from French into Italian.

The translation will be divided into 3 steps:

1) Translation of all documents automatically using google translate documents. (GT)
2) Manual translation of documents with major inconsistencies. (GTR)
3) Review of the documents that will be reported. (R.XX)

Each document will be accompanied by an indication indicating the revision status it is in.

In the studio, on the other hand, you will find simplified handouts that will guide you on setting up the analyses, explaining the various processes in a simplified way.

It will take a long time to complete each section, but it will certainly make a significant contribution to the growth of the Italian community.

By the way, if you want to contribute, write to us at **fgcaeanalyst@gmail.com**

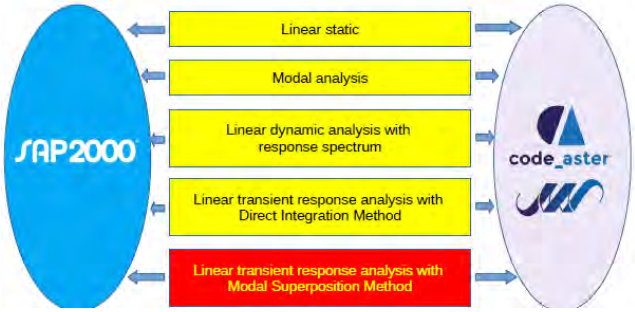
Linear transient analysis for the seismic vulnerability assessment of a building

Andrea Lucio MARROCCHELLA

Universita DEGLI STUDI FIRENZE – (DICEA) – Italy

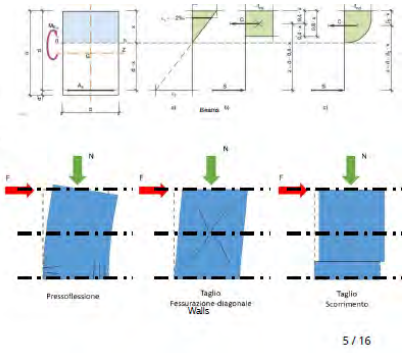
Introduction to the case study

Benchmark

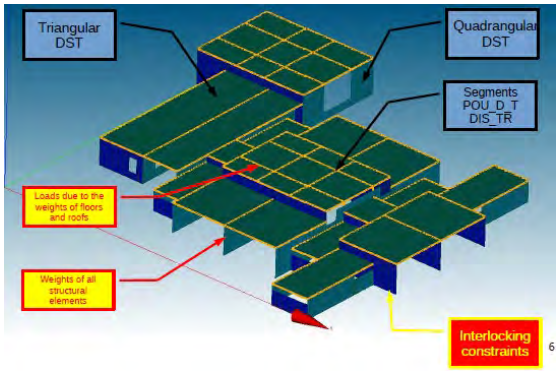


Analysis' goals

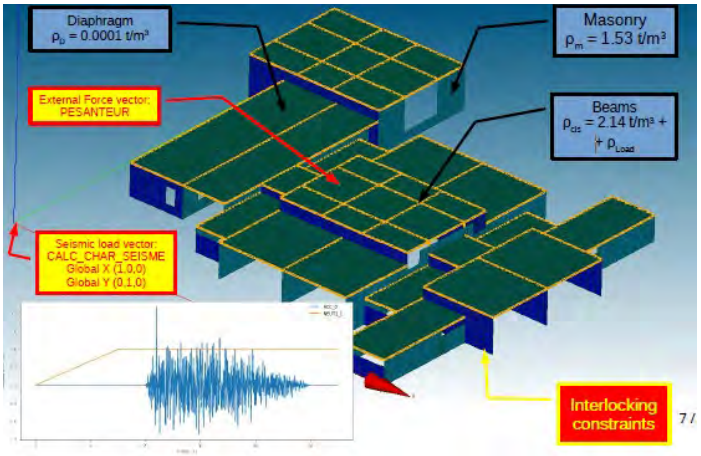
- Test the method
- Limit State checks: find extreme values for {DX,DY,DZ} and {N,M,T} that must be < R_i
- In beams (EFGE_ELNO or SIPO_ELNO)
- In walls resulting forces at the base, middle, top



Mesh and model description



Dynamic analysis parameters



Modal Base defined by DEFI_BASE_MODALE

Structure's mode shapes with CALC_MODES

NUME_ ORDRE	FREQ	TOT_MASS_ EFFE_UN_DX	TOT_MASS_ EFFE_UN_DY	TOT_MASS_ EFFE_UN_DZ
94	6.131 Hz 38.098 Hz	88.77%	88.79%	58.54%

+ Static Modes with MODE_STATIQUE

Projection of mass, and stiffness matrix and loads vectors in this base by PROJ_BASE macro-command

Computation of motion equation with DYNA_VIBRA(
TYPE_CALCUL='TRAN',
BASE_CALCUL='GENE',
SCHEMA_TEMPS=_F(
SCHEMA='NEWMARK'),
....)

Starting time	0.0 s
Time when unit ramp is 1	15.0 s
Start time for oscillations	20.0 s
End time	60.0 s
Intergration step	0.001 s
Solution archiving step	Every 0.05 s
Damping	0.05

8 /

Conclusions

- Through this analysis method it is possible to determine the displacements and extreme stresses of any building under static and dynamic loads.
- Useful to carry out the structural checks required by law and estimate the seismic vulnerability.
- It is also a method to deal with masonry structures.

Selection of Appropriate Method of Excavation for Sustainable Slope along Highways in the Northeastern Himalayas

Pramod KHOIROM, Former Graduate student - – Sukumar BAISHYA-, Professor

NERIST – Department of Civil Engineering – India

Need of sustainable highway infrastructure development in the fragile Himalayan soil needs consideration of effects of excavation and the method of excavation on the stability of excavated slopes, thereby identification of appropriate method of excavation for increased stability of excavated slopes. Study was conducted in the Department of Civil Engineering, North Easter Regional Institute of Science and Technology, Arunachal Pradesh, India, (https://www.nerist.ac.in) to fulfil these objectives. **Code-aster/Salome-Meca** is used to simulate the excavation process of slopes, considering different commonly applied methods of excavation and then evaluating the factor of safety (FOS) of the excavated slopes using the well-known Strength Reduction Method. Some of the salient findings of the study are illustrated below. This also demonstrates successful utilisation of Code-Aster/Salome-Meca in geotechnical engineering simulation.

Fig 1 shows the distribution of horizontal displacement within the slope for 12 m excavation at the toe of the slope, using three different methods of excavation, viz. (a) oblique excavation parallel to slope, (b) oblique excavation parallel to with Benching and (c) excavation with vertical cutting at the toe. Equal volume of soil is excavated In all these methods for meaningful comparison. Vertical toe cutting is identified as the most unsafe method with localised displacement at the toe of the slope.

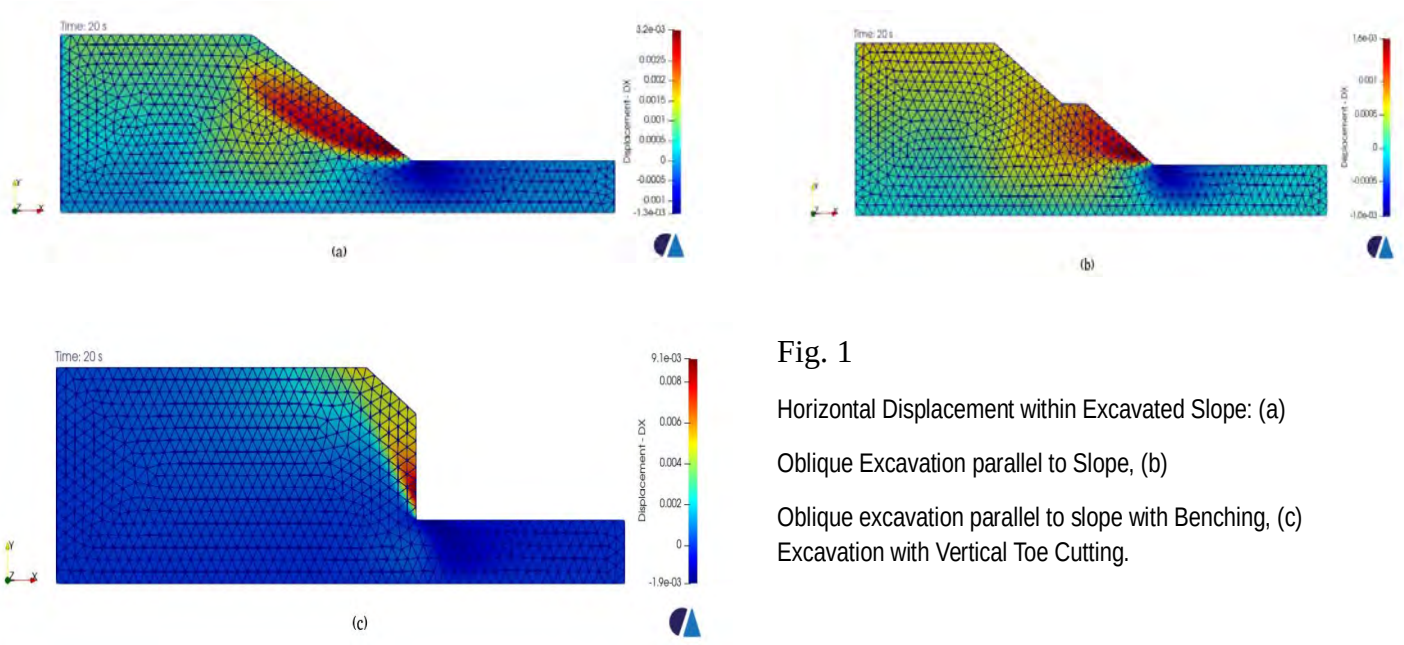
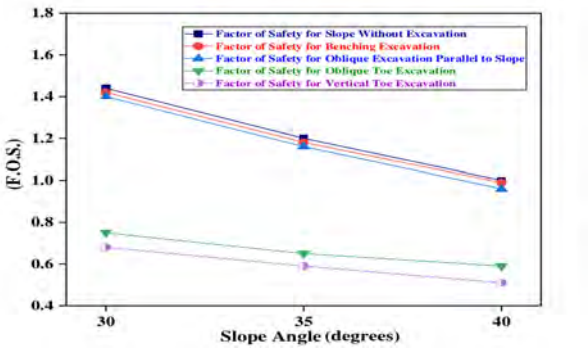


Fig. 1

Horizontal Displacement within Excavated Slope: (a) Oblique Excavation parallel to Slope, (b) Oblique excavation parallel to slope with Benching, (c) Excavation with Vertical Toe Cutting.

Fig. 2 shows the variation of FOS while adopting different methods of excavation. It is concluded that oblique excavation with benching is the best and vertical toe cutting is the worst method of slope excavation for all the slope angles considered.



LNTSOLD – Usage of Code Aster

Rodrigo M. FARIAS

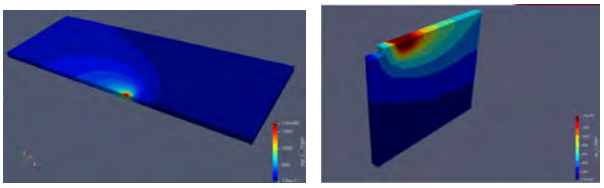
LNTSOLD -Federal University of Rio de Janeiro– Brazil

LNTSold – Main Work subjects

- **Welding of steels (C-Mn, low-alloy, 9%Ni, stainless) and non-ferrous alloys (Ni, Al, Ti, Zr, etc.)**
- **Special welding processes - PAW**
- **Influence of the welding parameters on welded joints properties**
- **Welded joint microstructure characterization**
- **Material computational modeling applied to welding and WAAM problems**
- **Welding overlay (cladding)**
- **Wire arc additive manufacturing (WAAM)**
- **3D Printed parts (low-alloy steel, duplex stainless steel, 625 nickel alloy, and 718 nickel alloy)**

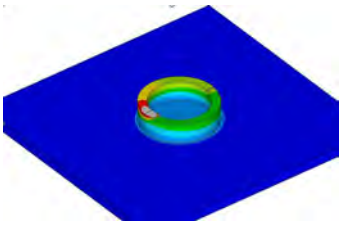
Previous Work

- **Adaptation of ANSYS® models to CA (3D)**
- **Welding (transient heat transfer, properties as f(T))**
- **AM (transient heat transfer, properties as f(T))**



Next Steps Usage of Code Aster

- **Add to Salome's interface "boxes" for inputs of the current models.**
- **Small scholarship granted for a grad student.**
- **Improve post-processing capabilities.**
- **Better understanding of metallurgical models**
- **Test thermo-mechanical capabilities**



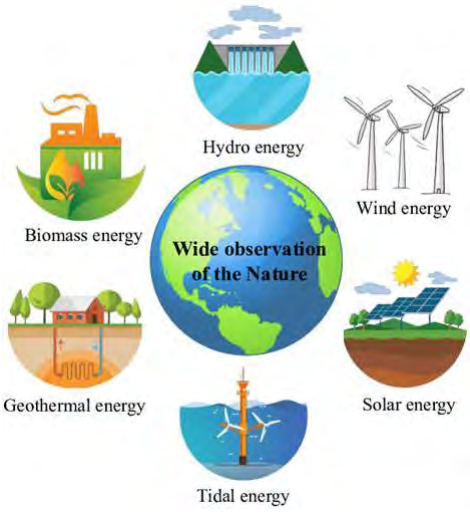
LNTSold – Challenges and Next Goals

Internal goals

- **Penetration in the renewable energy market**
- **Multi-materials printing**
- **Closed-loop control (monitoring and discontinuities detection)**
- **Raw material (wire, substrate, and shielding gas) analysis related to control and quality assurance**
- **Post-processing (when needed)**

Technology challenges

- **Standardization: much has been done, but still more coming soon**
- **Dissemination in the Brazilian market**



Development of a Web Based Tool for the Calculation of Rotatory Kilns

Johannes ACKVA - Thomas STUTZ - Jordie BIEMOLD

Ingenieurburo fur Mechanik – Germany
TomTom-Tools GmbH – Switzerland

Fig. 1: Rotatory kiln (indicated yellow deection line)

For the cement production rather large and heavy rotary kilns are employed (Fig. 1). Static analyses are conducted to foresee and to reduce fatigue cracks due to high stresses in the kiln shell and in the supports (rings and rollers).

TomTom-Tools GmbH, a swiss company providing measurement tools for the cement industry, is developping with Ingenieurburo fur Mechanik, a provider of Code-Aster services a web based calculation tool. This tool will be easily operable and will allow to easily try out several inputs, for example geometry and load parameters.

The input mask for the kiln's geometry is shown in Fig 2. The red cifers indicate:

1. clicking on a part symbol (cone, tire, (cylindrical) shell) and providing the respective dimensions (radius, thickness, length etc) the kiln model is started to be created or extended by that part
2. the kiln model as defined so far (not in scale): here 3 cylindrical shells and 2 tires with rollers
3. diagram showing along the kiln's length Wall Thickness, (inner) Diameter and support Misalignment
4. steps 2-4 (mask not shown) are to setup material and load parameters, to do the analysis, to postprocess.

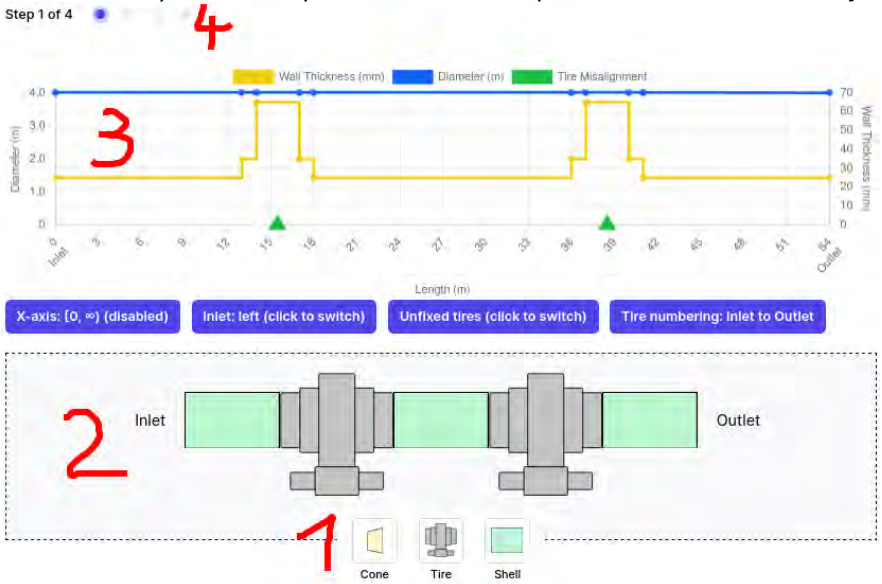


Fig. 2: Input mask for geometry of the kiln

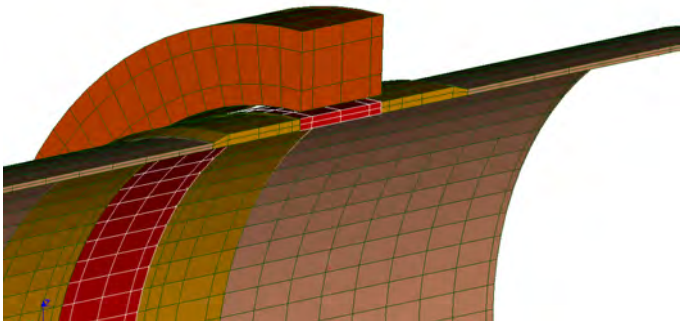


Fig. 3 shows the mesh, for better insight only one half. The mesh is automatically generated by a gmsh script according to the user's geometrical input parameters.

Fig. 3: Mesh, Kiln and Tire parts

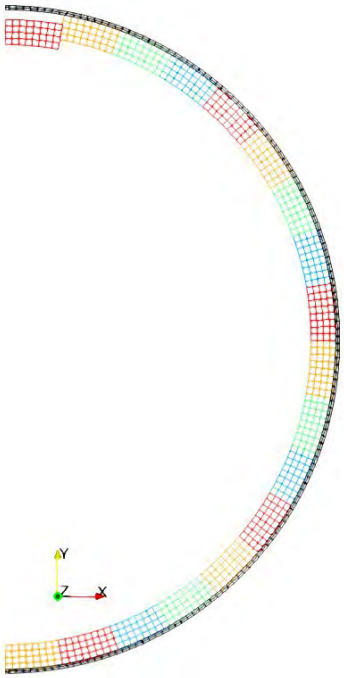


Fig. 4 shows a (half) plane model including the kiln shell and the vault of 36 (half: 18) refractory stones. It is also automatically generated and calculated with contact between all stones and the kiln shell in order to establish the surface loads acting on the kiln's inner surface due to the weigth of the vault.

Fig. 4: Displacements of the refractory stones under gravity load in a plane model of kiln and vault

. The following Figures shows a small selection of available results:

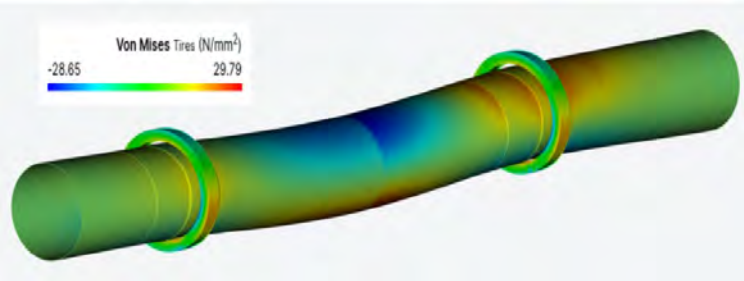


Fig. 5: Van Mises Stress

Support Loads

Pier	Vertical Load (Z)	Lateral Load (Y)
CntForc_4 (unknown section)	-3895 kN	0 kN
CntForc_12 (unknown section)	-3727 kN	1 kN

Fig. 6: Contact forces between kiln and tires

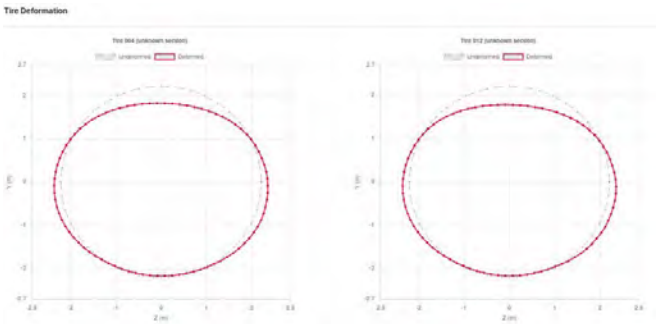


Fig. 7: Deformation of Kiln shell in correspondence to the tires

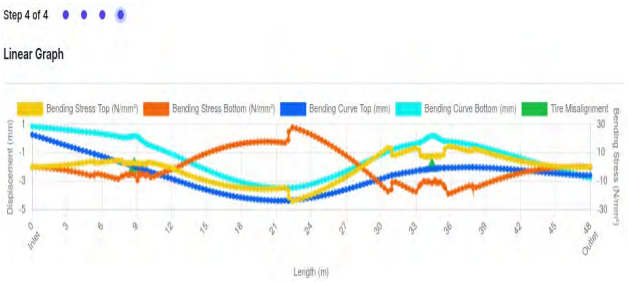


Fig. 8: Results along top- and bottom-line of the kiln

Collaboration between SimScale and Aether Engineering : Bolt preload

Guillermo BARRAZA - Lorenzo RIPARBELLI

SimScale - Aether Engineering – Germany - Italy

Bring simulation into your early stage design:

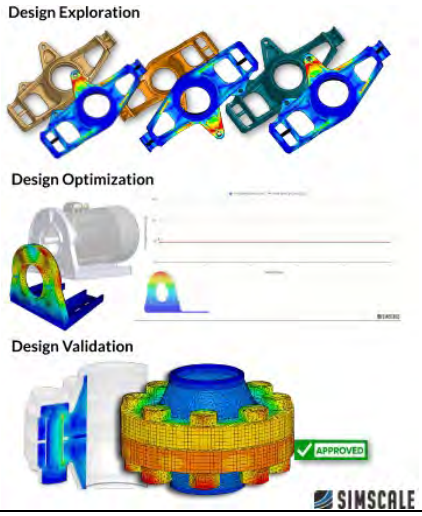
Crucial design insights before prototyping

- Disqualify poor concepts upfront and focus on high potential ideas
- Speed up design cycles

Low cost design space exploration

- Increase innovation
- Reduce costs and time wastage associated with prototyping

Replication of physical testing to gain detailed understanding of structural risk and allow for focused mitigation



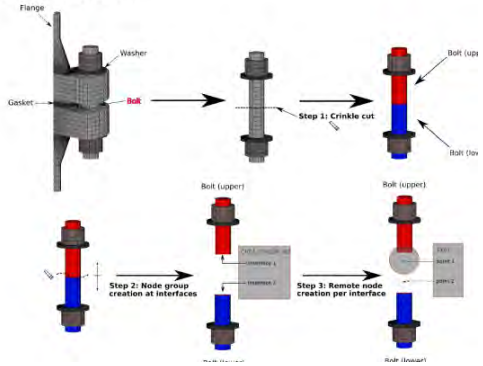
Bolt preload modelling

- Bolts are present in the majority of assembled structures and can have various orientations
- Preload occurs before any solicitation of an assembly and determines its initial state, thus, stress distribution in the bolts and the surrounding areas is of high importance
- Provide a straightforward way to apply a preload in 3D-modelled bolts, without geometry simplification
- Need of an automated solution to model bolt preloads in an easy manner, avoiding a cumbersome and repetitive procedure.

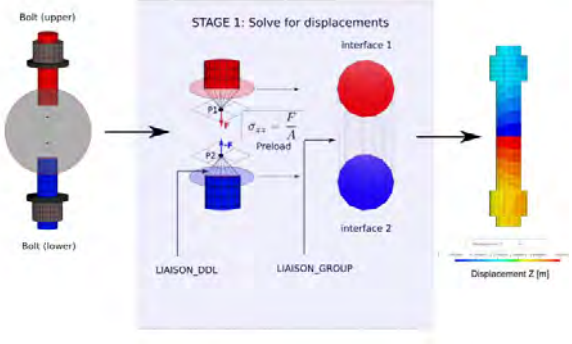
Solutions tested

- Validation results
- Different applications
- Benefits and limitations

Mesh preparation



Modelling



Collaborative and iterative approach to the joint development

- Thermal preload
- Pre-strain (PRE_EPSI)
- Simplified linear relations (LIAISON_DDL)

Linear relations proved the most promising.

- Additional iterations on the coupling which finally reduced artificial stress concentrations

Efficiently coupling Code_Aster with other codes: the preCICE open-source library

D. COLOMBO, J.M.GRATIEN, S.DE CHAISEMARTIN, B.VIALAY, A.PASTEAU

IFP Energies Nouvelles – France - ANDRA – France

Introduction

Code coupling is an effective solution to make multi-physics simulations when efficient single-physics specialized codes exist. The most straightforward way to couple codes is a centralized model where a coupling supervisor drives codes execution and files on disk are used to exchange data between the codes. In spite of its simplicity, this model has several drawbacks especially when dealing with HPC simulations. In particular, data transfer between two HPC codes is non trivial because the meshes used by the codes are non-coincident and each code uses a different number of CPUs and, consequently, a different number of domain partitions. Parallel projection algorithms must be therefore implemented in the coupling supervisor to successfully transfer data between the codes. Data transfer performance could heavily impact the overall performance of the coupled code for big models. The use of a coupling library constitutes an effective alternative to in-house centralized supervisors permitting to focus the developments on the physics of the coupling instead of focusing on data transfer problems and to create a simple and performant coupled code.

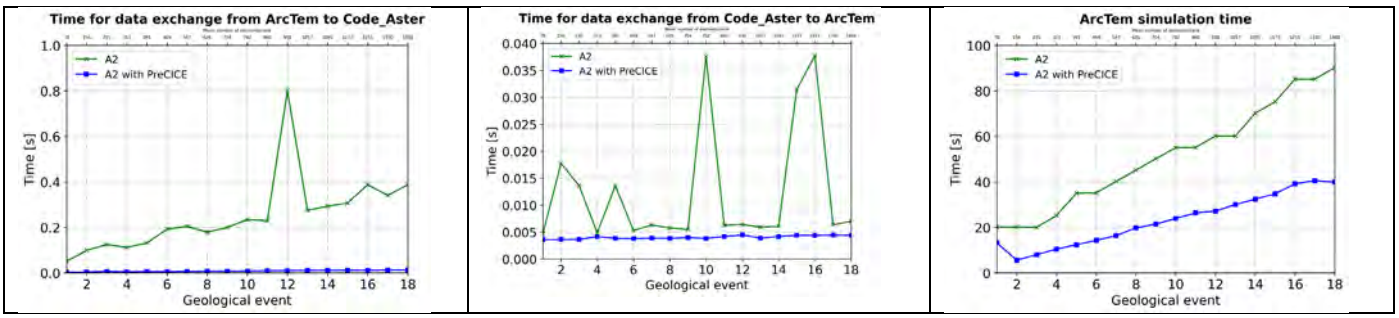
Coupling Code_Aster with the preCICE open-source coupling library

PreCICE (http://precice.org) is an open-source coupling library for partitioned multi-physics simulations. It makes easy to build decentralized parallel coupled codes. The library is included in each participant code by means of one of the high level API offered by the library (C++, C, Python, Fortran, Matlab). Data exchange between the codes, including projections and interpolation on non-matching meshes and non-matching domain partitions, is managed by the library in parallel (MPI) and in a transparent way. No data is exchanged by files on disk. Coupling workflow is automatically managed by the library.

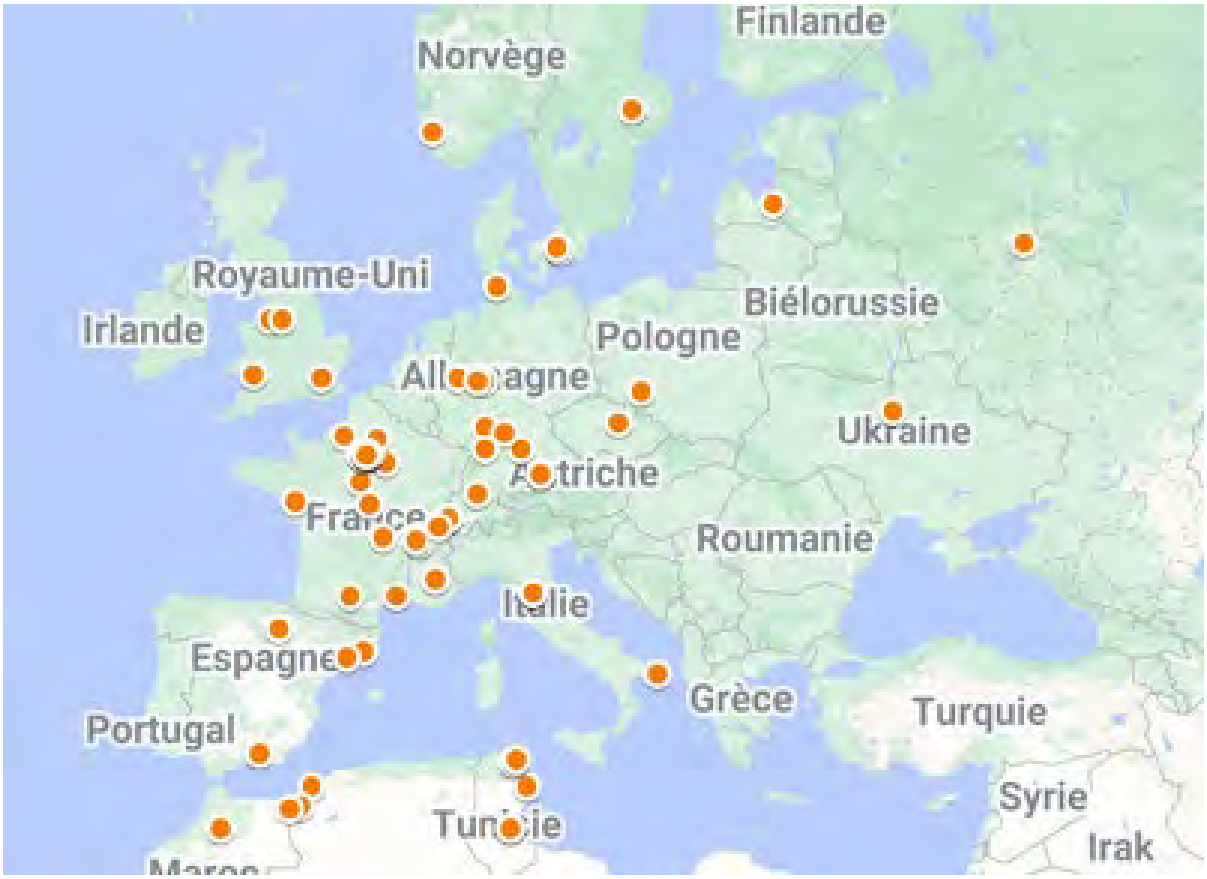
The creation of the coupled code is therefore enormously simplified by the use of this library. We have tested the preCICE library by rewriting an IFPEN coupled prototype code (A2) used to simulate the hydromechanical evolution of sedimentary basins from their formation up to the present day.

These simulations provide the evolution of stress/strain field, pore pressure, rock porosity and permeability distributions in the basin through geological eras. Code_Aster is used for the mechanical part of the coupling and ArcTem, a basin simulator code developed by IFPEN, is used for the fluid flow simulation. The original centralized coupling supervisor has been rewritten in order to use preCICE capabilities. PreCICE library has been included in Code_Aster by means of the library python bindings. The library C++ API has been used for the inclusion in ArcTem. The performance of the coupled prototype using preCICE has been compared to the performance of the original code using the centralized supervisor with file data exchange.

The comparison has been carried out on a small basin model (102.000 elements, 18 geological events, 72 CPUs) [1]. The results are shown in the following figures for **one simulation step at each geological event**. Even if the CPU time differences are not big due to the small size of the model used for the performance test, the results clearly show that the use of the preCICE library mitigates the impact of mesh size (proportional to the geological event number) on data exchange and ArcTem CPU time.



[1] Berthelon J., Bruch A., Colombo D., Frey J., Traby R., Bouziat A., Cacas-Stentz M.C., Cornu T., *Impact of tectonic shortening on fluid overpressure in petroleum system modelling: insights from the Neuquén basin, Argentina*, Marine and Petroleum Geology, 127 (2021), 104933. doi: 10.1016/j.marpetgeo.2021.104933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