DIANA

SOLUTIONS FOR
YOUNG HARDENING CONCRETE

DIANA FEA
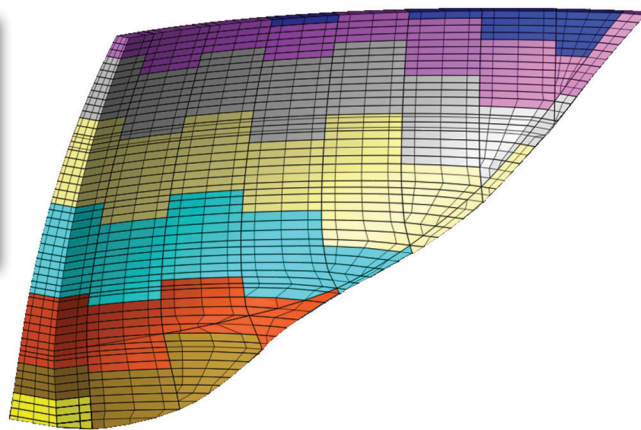
a TNO Company

Massive castings of concrete can result in premature cracking of the structure prior to its service life. This can be especially detrimental in cases, for example, of hydraulic structures. Choice of the mix, time and sequence of casting can help to reduce or preclude any cracking. In some cases, cooling techniques can also be used. Young hardening concrete behaviour is also relevant in the case of casting on a pre-existing structure, both in case of enlargement of the structure, or reparation. DIANA offers a range of young hardening concrete models and the possibility to predict cracking with linear or more detailed nonlinear analysis.

The analysis of the structure in its young age can be followed by a sequence of other analyses, which simulate different events during the life of the structure. This makes it possible to model more realistically the stress state at any time in the life of the structure, and to identify possible deficiencies during construction, which may cause damage or reduce performance of the structure.

Young Hardening Concrete Analysis

Analysis features

- Coupled thermo-stress with automatic input
- Possibility to add/remove elements or change boundary conditions during the analysis
- Calculation of the heat of hydration from:
  - Direct input of the heat production as function of the degree of reaction
  - Preprocessing from the adiabatic curve
  - User-supplied subroutine
- Heat transfer by conduction, convection and radiation
- Dependence of thermal material properties on temperature, time and degree of reaction
- Time dependence of the convective heat coefficient, to simulate presence or removal of scaffolding, and presence of wind
- Cooling pipe elements

Transient heat transfer analysis carried out during construction phases of an arch dam
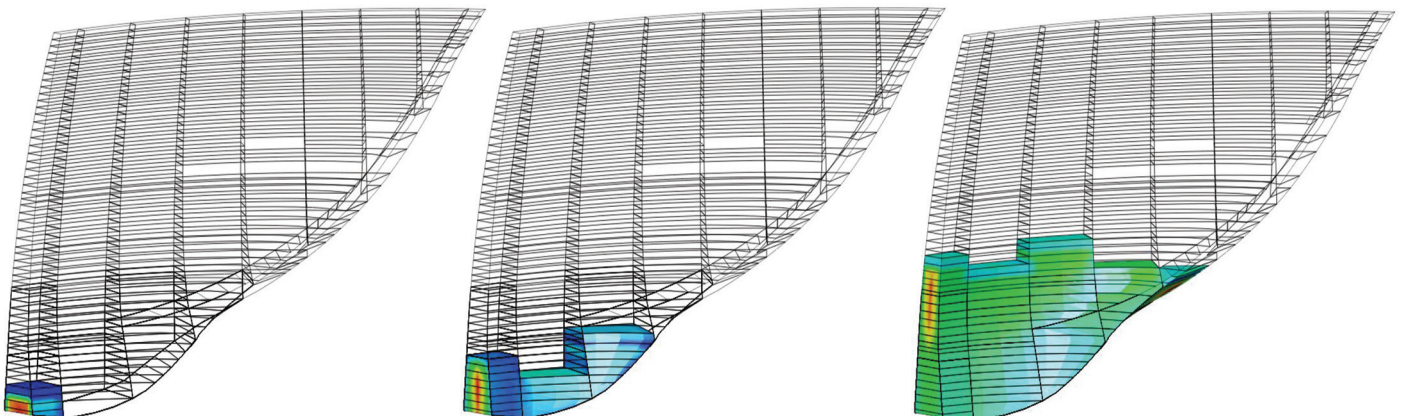
Material models

- Evolution of Young's modulus according to:
  - Reinhardt model
  - Model codes (CEB-FIP Model Code 1990 & 2010, Eurocode, ACI 209, AASHTO, NEN 6720/A4, JSCE, JCI, KCI)
  - Laboratory curves
  - User-supplied subroutine
- Visco elasticity: Double Power Law, Kelvin and Maxwell chains
- Crack prediction with the tensile strength utilisation index and degree of reaction dependent tensile strength (linear analysis)
- Crack prediction with nonlinear analysis:
  - Smeared crack models with:
    - · Maturity dependence of the tension cut-off and tension softening
    - · Maturity dependence of shear behaviour
    - · Maturity dependence of compression functions
- Discrete crack model with maturity dependence of the tension cut-off and tension softening
- Visco-elasticity with temperature dependent Young's modulus: Power law, Kelvin and Maxwell chains
- Transient creep
- User-supplied subroutines

General Product Functionality

Element types

- Truss
- Timoshenko, Bernoulli, and Mindlin beam
- Plane stress and plane strain
- Complete/general plane strain
- Axisymmetric
- Plate bending
- Flat, curved and layered shells
- Solid
- Composed (line/surface)
- Interface
- Contact
- Discrete spring/dashpot
- Base spring
- Bounding
- Point mass/damping
- Embedded reinforcements
- Flow

- Embedded pile
- Boundary surface
- Perfectly Matched Layers (PML)

Preprocessing

- CAD like geometry modelling functionality
- Parasolid built-in tools
- Import CAD/Revit file formats
- Python scripting
- Advanced selection methods
- Advanced geometry modelling
- Boolean operation for solid modelling
- Auto clash detection
- Geometry check and repair tools
- Practical mouse snapping
- Auto-, map- and protrude-mesh methods
- Hybrid mesher
- Mesh manipulation and check functionality
- Loads and boundary conditions applicable both on geometry or mesh
- Function based definition of loads and boundary conditions
- MS-Excel compatible tables

Postprocessing

- Contour and vector plots
- Iso-surface, slice, clipping and partition plot
- Diagram and vector plot
- Results extraction to MS-Excel compatible table
- Screen-shots in different picture formats
- Result animation
- Automatic report generation

Solution procedures

- Automatic solver selection
- Out-of-core direct equation solvers
- Nonlinear equation solvers
- Automatic substructuring
- Eigenvalue analysis
- Newton-Raphson, Quasi-Newton, Linear and Constant stiffness iterative procedures
- Load and displacement control incremental procedures
- Arc length control incremental procedure
- Adaptive load and time increments (auto load step option)
- Automatic incremental loading
- Direct, iterative and eigen solvers with Parallel processing
- Updated and total Lagrange geometrical nonlinear formulation
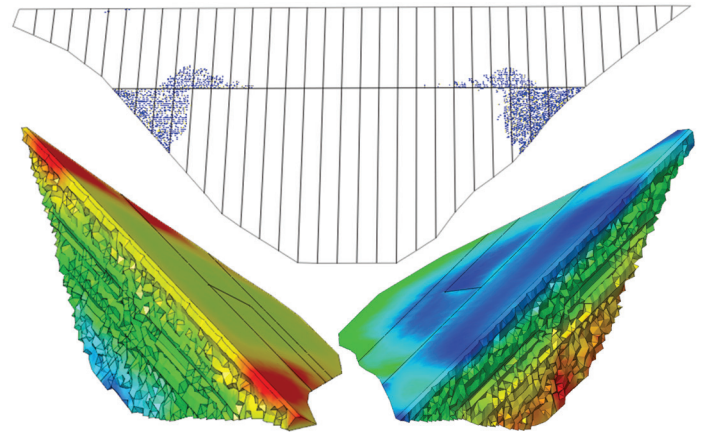
Principle and Von Mises stress analysis & crack analysis carried out during constructions phases of a concrete face dam

Services

Support & training

Successful finite element modelling requires sound understanding of the background theory with good engineering judgment. We at DIANA FEA BV together with our partners are dedicated to provide the highest level of service for DIANA:

- Personalised hotline and Email support by highly qualified staff
- Customised training solutions
- Regular training courses
- Extensive technical and theoretical manuals
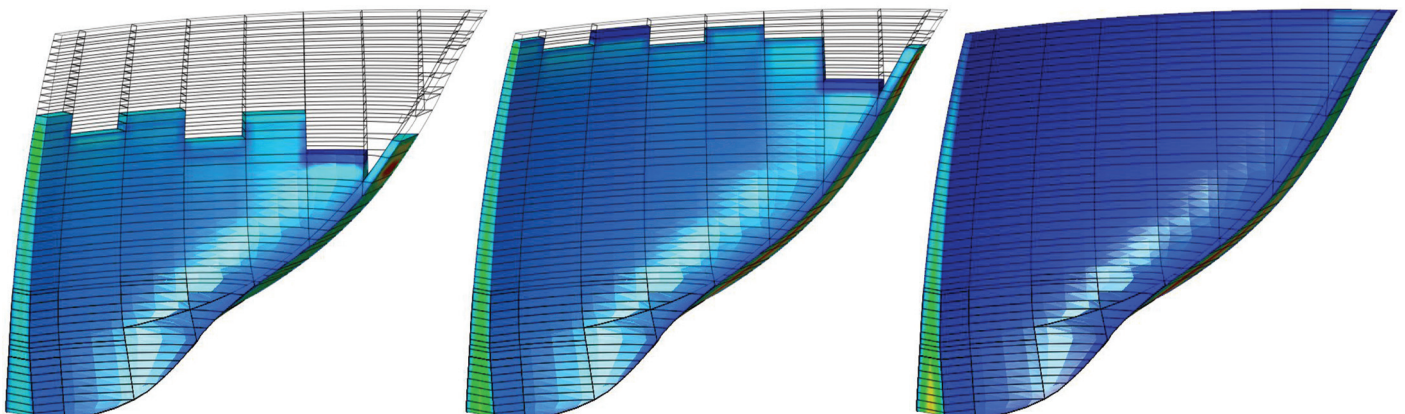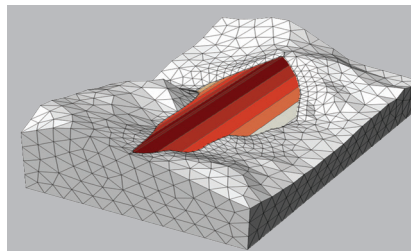- Online training sessions

Analysis consultancy

DIANA FEA BV offers to carry out analysis consultancy projects on behalf of their clients which includes the analysis with DIANA and the interpretation of results

Software services

DIANA FEA BV Consultants and software development team can provide customised solutions for your engineering problems:

- Specialised software with dedicated GUI
- New modelling capabilities development and implementation
- Integration with customer software

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