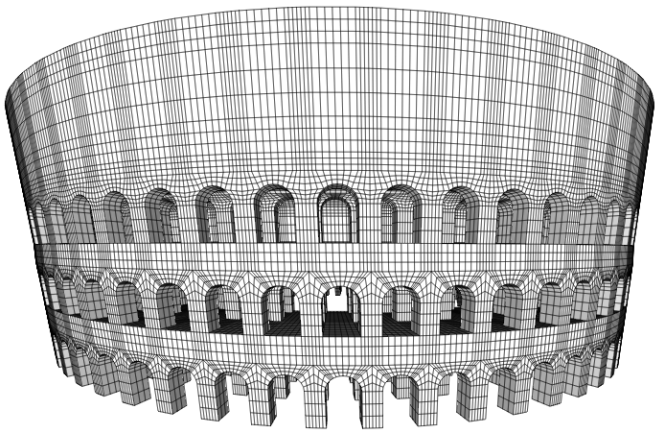
DIANA

SOLUTIONS FOR MASONRY & HISTORICAL STRUCTURES



DIANA FEA
a TNO Company

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SOLUTIONS FOR MASONRY & HISTORICAL STRUCTURES

Historical structures are a human inheritance that represent the recorded history of a country which translates to a source of income, from tourism, for its economy. The importance of ensuring the structural safety of these entities while preserving their artistic value is paramount.

The analysis of historical structures is more complex than that of more modern constructions. There is uncertainty surrounding the materials from which they are built, on the construction sequence, and on the events that have occurred during the lifetime of the structure. Any required strengthening, restoration or any other intervention should be not visible to the visitors' eyes.

In short, the analyses of historical structures require different and more sophisticated tools than is the case for new structures. Historical structures are often masonry and DIANA is a unique program that allows the possibility of analysing masonry structures in detail or as a whole, under standard or extreme loading such as earthquakes.

Meso-level Modelling

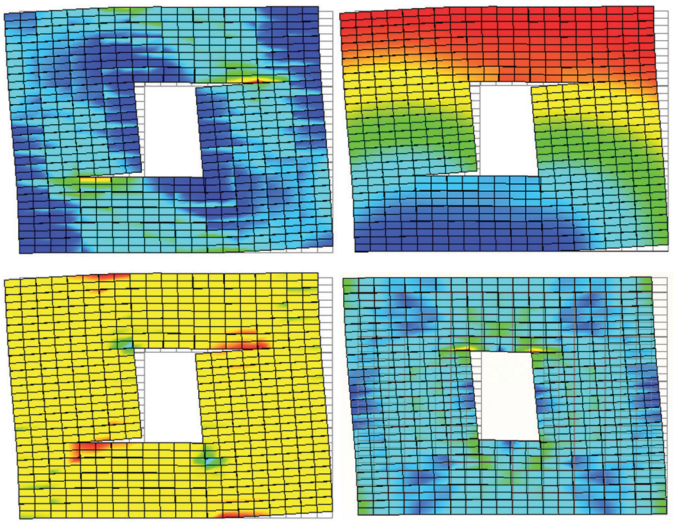
At the meso-level, bricks are modelled with continuum elements and joints with interface elements

Joints

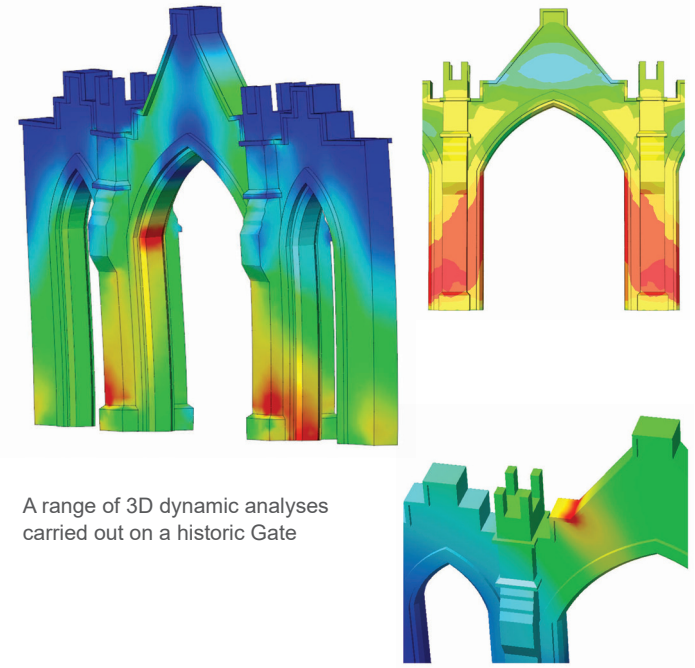
- Discrete crack model with or without crack dilatancy
- Coulomb friction model
- Combined cracking-shearing-crushing model
- User-supplied subroutines

Bricks

- Elastic or nonlinear material models



Discrete masonry modelling



A range of 3D dynamic analyses carried out on a historic Gate

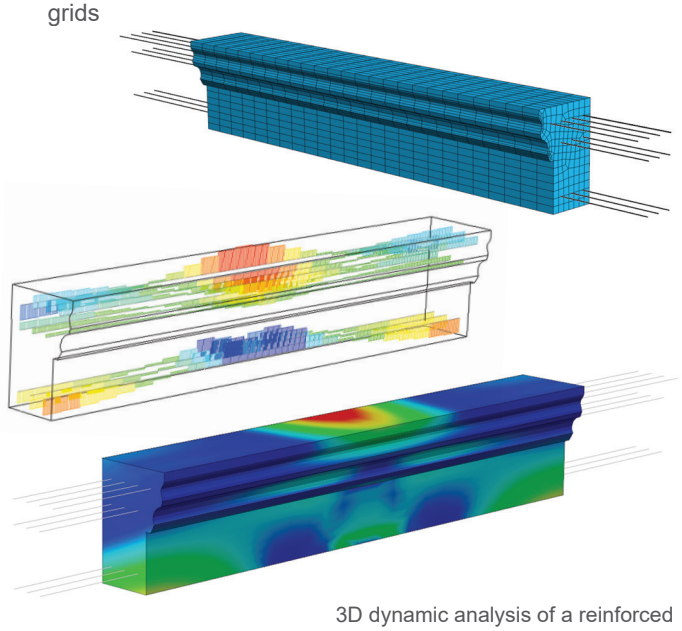
Macro-level Modelling

At macro-level masonry is modelled with continuum elements

- Anisotropic Rankine-Hill plasticity model for 2D/3D models with optional crack rate dependency
- Multi-directional fixed crack models in combination with creep and shrinkage
- Total-strain crack models
- Engineering masonry model

Reinforcement Modelling

- Explicit bars or grids with bond-slip interfaces
- Bonded or unbonded attributes for embedded bars and grids



3D dynamic analysis of a reinforced lintel showing stress and strain

General Product Functionality

Element types

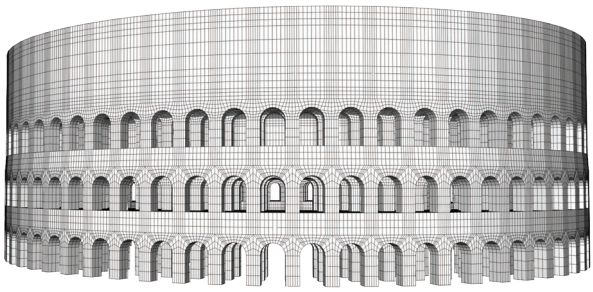
- Truss
- Timoshenko, Bernoulli, and Mindlin beam
- Plane stress and plane strain
- Complete/general plane strain
- Axisymmetric
- Plate bending
- Flat, curved and layered shells
- Solid
- Composed (line/surface)
- Interface
- Contact
- Discrete spring/dashpot
- Base spring
- Bounding
- Point mass/damping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

Services

Support & training

Successful finite element modelling requires a sound understanding of the background theory with good engineering judgement. 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

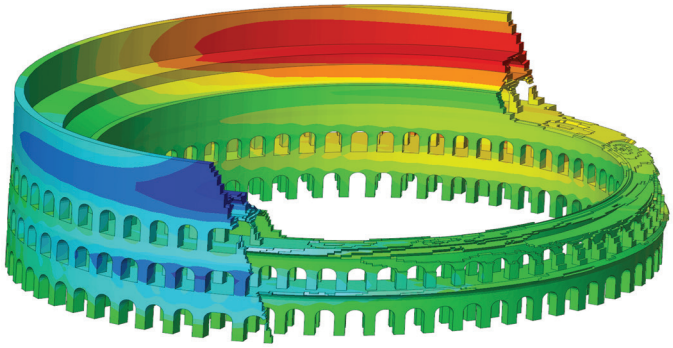
Analysis consultancy

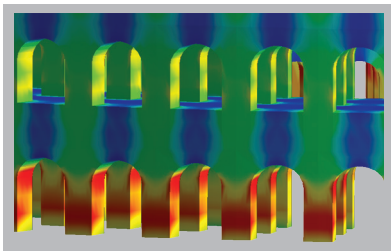
DIANA FEA BV carries out analysis consultancy projects on behalf of their clients which includes analysis with DIANA and the interpretation of results

Software services

The DIANA FEA BV software development team and consultants 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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