


LowLevelFEM – API logical structure (draft, function-level)

 Working document. This is NOT documentation, but a planning map for later API restructuring.

Core

Fundamental data structures and concepts.

Problem and materials

- Problem
- Material
- material
- elastic_constants
- elasticSupport
- elasticSupportMatrix
- printElasticConstantsTable

Fields

- ScalarField
- VectorField
- TensorField
- scalarField
- vectorField
- tensorField
- field
- mergeFields
- projectScalarField
- fieldError
- loadField
- saveField
- isNodal

- isElementwise
- isSaved

Mesh and geometry

- Geometry
- CoordinateSystem
- generateMesh
- rotateNodes
- projectTo2D
- expandTo3D
- getDimForPhysicalName
- getTagForPhysicalName

Mapping and integration

- nodesToElements
- elementsToNodes
- integrate
- normalVector
- normalVector1D
- tangentVector

Preprocessing

Preparation of FEM problems.

Boundary conditions

- BoundaryCondition
- BoundaryConditionFields
- displacementConstraint
- temperatureConstraint
- pressureConstraint
- elasticSupport
- applyBoundaryConditions

- applyBoundaryConditions!
- applyElasticSupport!
- suppressDeformationAtBoundaries
- suppressDeformationAtBoundaries!

Initial conditions

- initialDisplacement
- initialDisplacement!
- initialVelocity
- initialVelocity!
- initialTemperature
- initialTemperature!

Loads and sources

- loadVector
- loadVectorOld
- loadVectorNew
- nonFollowerLoadVector
- equivalentNodalForce
- thermalLoadVector
- thermalLoadVectorAXI
- thermalLoadVectorSolid
- heatSource
- heatSourceVector
- heatFlux
- heatFluxVector
- heatConvection
- heatConvectionVector

Operators

Weak-form building blocks, physics-independent.

Scalar field operators (Poisson / Laplace)

- poissonMatrix
- poissonMatrixVector
- poissonMatrixSymGradF
- stiffnessMatrixPoissonAllInOne
- traceLaplaceMatrix
- tensorLaplaceMatrix
- reactionMatrix
- sourceVector
- solveField

Vector field operators

- gradMatrix
- gradDivMatrix
- gradDivMatrixF
- curlCurlMatrix
- symmetricGradientMatrix
- tensorDivDivMatrix
- beltramiMichellMatrix

Advection and flow-related operators

- advectionMatrix
- navierStokesAdvectionMatrix

Mass and auxiliary operators

- massMatrix
- mapScalarField
- unitTensor
- estimateLengthOfIJV

Mechanics

Linear mechanics

Small-deformation solid mechanics.

Stiffness and mass

- stiffnessMatrix
- stiffnessMatrixSolid
- stiffnessMatrixSolidParallel
- stiffnessMatrixSolidParallelNew
- stiffnessMatrixAXI
- stiffnessMatrixTruss
- massMatrixSolid
- massMatrixSolidParallel
- massMatrixTruss
- dampingMatrix

Constitutive relations

- constitutive_matrix
- constitutive_matrix_stress

Solvers

- solveDisplacement
- solveStress
- solveStressSlow
- solveStrain
- solveStrainNew
- solveAxialForce

Eigenvalue and stability

- solveEigenModes
- solveModalAnalysis
- solveBuckling
- solveBucklingModes
- largestEigenValue
- smallestEigenValue
- largestPeriodTime

- `smallestPeriodTime`
-

Nonlinear mechanics

Large deformation and energy-based formulations.

Kinematics

- `deformationGradient`
- `nodePositionVector`
- `grad`
- `grad_xy`
- `div`
- `curl`
- `rot`

Internal forces and stresses

- `internalForceVector`
- `internalForceTL`
- `stress_from_energy`
- `IIPiolaKirchhoff`

Tangent operators

- `materialTangentMatrix`
- `tangentMatrixConstitutive`
- `tangentMatrixInitialStress`
- `geometricTangentMatrix`
- `tangent_from_energy`
- `externalTangentFollower`
- `externalTangentFollowerTL`

Solvers and postprocessing

- `solveDeformation`
 - `showDeformationResults`
-

Structural dynamics

Mechanical systems with inertia.

- massMatrix
 - dynamicResidual
 - dynamicTangent
 - HHT
 - CDM
 - initialStressMatrix
-

Heat transfer

Steady-state heat conduction

- heatConductionMatrix
- heatCondMatrixSolid
- heatCondMatrixAXI
- heatFluxVector
- solveHeatFlux

Transient heat conduction

- heatCapacityMatrix
 - latentHeatMatrix
 - solveTemperature
 - q_free
 - q_theta
 - FDM
-

Postprocessing

Evaluation and visualization of results.

Field visualization

- showScalarResults
- showStressResults
- showStrainResults
- showHeatFluxResults
- showModalResults
- showBucklingResults
- showElementResults
- showOnSurface
- plotOnPath
- probe

Resultants and derived values

- resultant
- resultant2
- flowRate
- fieldsToVolume

Utilities

Internal helpers, debugging, and infrastructure.

- debugMatrix
- debugVector
- checkConsistency
- make_workspace
- make_ws
- make_ws_axi
- inv2x2_fast
- inv3x3
- inv3x3_fast
- openPreProcessor
- openPostProcessor
- showGapThickness