PragTic – status quo

Jan Papuga, November 8, 2013

Fatigue analysis enabled on

- Finite element models
    - nodes (averaged)
    - nodes of elements
    - element centroids
- Isolated points (points in the space with link to material properties)

Import of FEA-models

- ANSYS – a macro built in ANSYS APDL to prepare *.pti file, which is read to PragTic
- ABAQUS – a macro built in Python to prepare *.pti file, which is read to PragTic
- NASTRAN - *.nas/*.dat files for geometry, *.pch file for results
- a universal importer
    - specialized function able to import any ASCII output from FEA (geometry, results)
    - learning procedure quickens any next import
    - used also for reading e.g. load histories, sets,…

Export to FEA (PragTic doesn't dispose of its own graphical post-processor)

- ANSYS – a text file with an APDL macro allowing to read the data back to ANSYS
- ABAQUS – a macro built in Python to prepare *.pto file exported from PragTic
- FEMAP – neutral file

Own database

- Data are imported to own database, they are not only linked and reimported every time the saved task is opened again

Interface

- main menu
- database tree structure
- command line (parts of the preparation can be already now done from command line or batch file -> next version will include Python as the macro-language)
- view/edit forms for viewing or input of parts of the analysis
    - quick copy to clipboard and e.g. to Excel

Work with FEA models

- Filtering the data (by geometric attributes, links to parameters, local loads)
- Generating new coordinate systems, transformation of geometry, results to them
- Static analysis (a prepared feature enabling to evaluate the stress combinations from various result files by static criteria)

Setup of loading

- multi-channel loading allowed (up to 64 concurrent channels)
- loads defined by:
    - arithmetic formula
    - load history record
    - load spectrum (covers also rain-flow matrix)
    - result file concerning local load history for every geometric item (node, element)
    - sequence of result files
- i.e. it allows superposition of load channels but also running transient analysis

Methods available for fatigue analyses

- uniaxial strain-based
  - SWT
  - Morrow
  - Landgraf
  - Feltner
  - Morrow energetic
  - Bergmann
  - Erdogan
- multiaxial strain-based
  - Socie, Fatemi-Socie, multiaxial SWT
  - Brown & Wang, potential of modification to maximum damage criterion, modification by Kim, Park and Lee
  - Brown & Wang acc. to their paper in 1996 on decomposing multiaxial load histories
  - Findley acc. to Socie
- stress-based methods for estimating the fatigue index (ratio of the actual stress to fatigue strength)
  - NASALIFE methods
    - Manson-McKnight, also with modification
    - Sines-Ohgi
    - etc.
  - Dang Van
  - Fogue
  - Carpinteri & Spagnoli
  - Susmel
  - Goncalves
  - Ninic
  - Robert
  - Findley
  - Sines
  - Kakuno-Kawada
  - Crossland
  - McDiarmid
  - Liu-Mahadevan
  - Papadopoulos
  - Papadopoulos critical plane version
  - Liu-Zenner
  - Papuga PCr
  - Papuga PIr
  - QCP
- stress-based methods for deriving the lifetime
  - LESA (currently only uniaxial solution) – based on Femfat and FKM recommendation

Setup of calculation method

- an extensive list of variables of setups
- default variables of setups for every method
- automated check of material parameters necessary for run of the analyses

Setup of analysis

- mixing the load regimes to be analyzed for which computational methods on which geometric entities – multiple analyses can be run in one moment
- setup can be saved and reread

Computational process

- Rain-flow analysis, also clones for multiaxial load histories
- minimum circumscribed circle method implemented for deriving shear stress/strain amplitude on evaluated planes (iterative process, an enhanced solution recently bought to speed-up the process)
- Neuber, Glinka methods for conversion of elastic stresses/strains to elastic-plastic ones
- critical plane criteria, integral criteria
- stress gradient effect

Tools

- rain-flow of the input signal, showing rain-flow matrix
- analysis of the minimum circumscribed circle around specified points
- watching local load histories projected to specific directions, variables…
- analysis of result files – von Mises, Tresca, principal stresses, principal directions – filtering the data based on those values
- S-N curve parameter derivation from input data

Next version:

- new interface based on web browser
- avoids use of commercial programming tools in order to allow sharing parts of the code
- client <–> server architecture
    - allows to prepare task from distant computer (e.g. smartphone) and run it on the server
    - mini-server can be installed also locally
    - more PragTic analyses can be run simultaneously
- Python as internal programming language allowing to run complete solution from a batch
- import of material data from dedicated website databases (www.fadoff.eu)

Next next version:

- paralelization
- thermo-mechanical fatigue
- a clone of PragTic dedicated for a computation based on FKM-Richtlinie
- coupling with crack-growth module

Some current disadvantages:

- no graphic post-processor (without it, weld module cannot be expected)
- work with shell structures not sufficiently checked
- stress gradient effect allowed only for LESA
- surface treatment effects allowed only for LESA
- more impact should be dedicated to quicken the analyses

Most substantial advantage:

- As the only fatigue solver, PragTic will provide an extensive database of benchmark computations, so that the user could test it and understand, what is the predictive capability of used methods