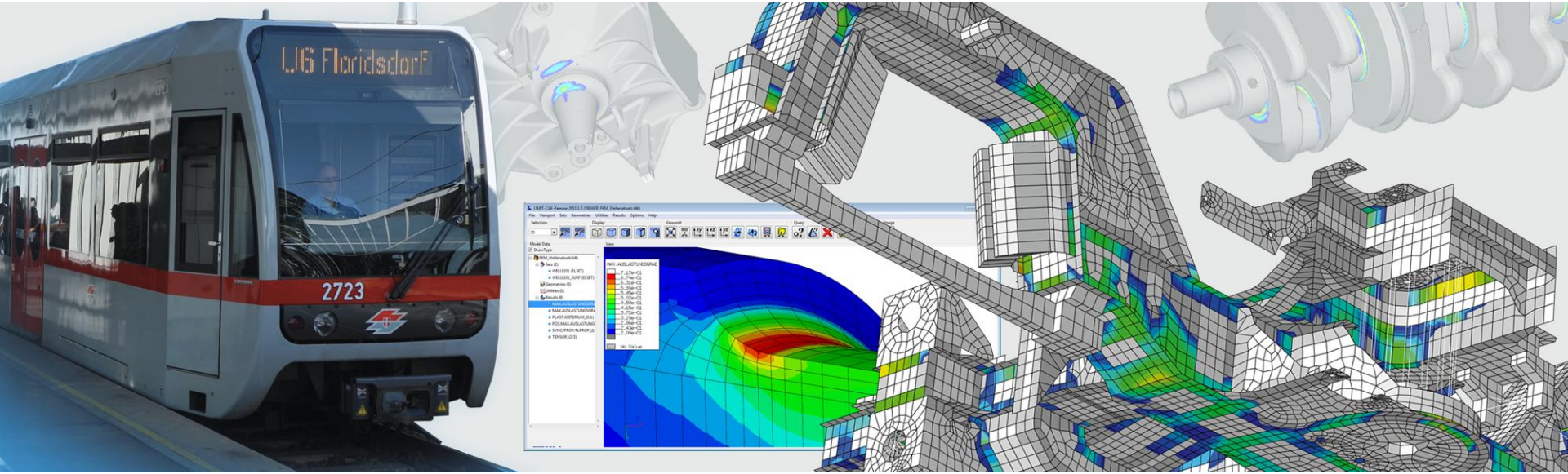
LIMIT
stress evaluation

Documentation



LIMIT: Important Features with FKM 6th Edition

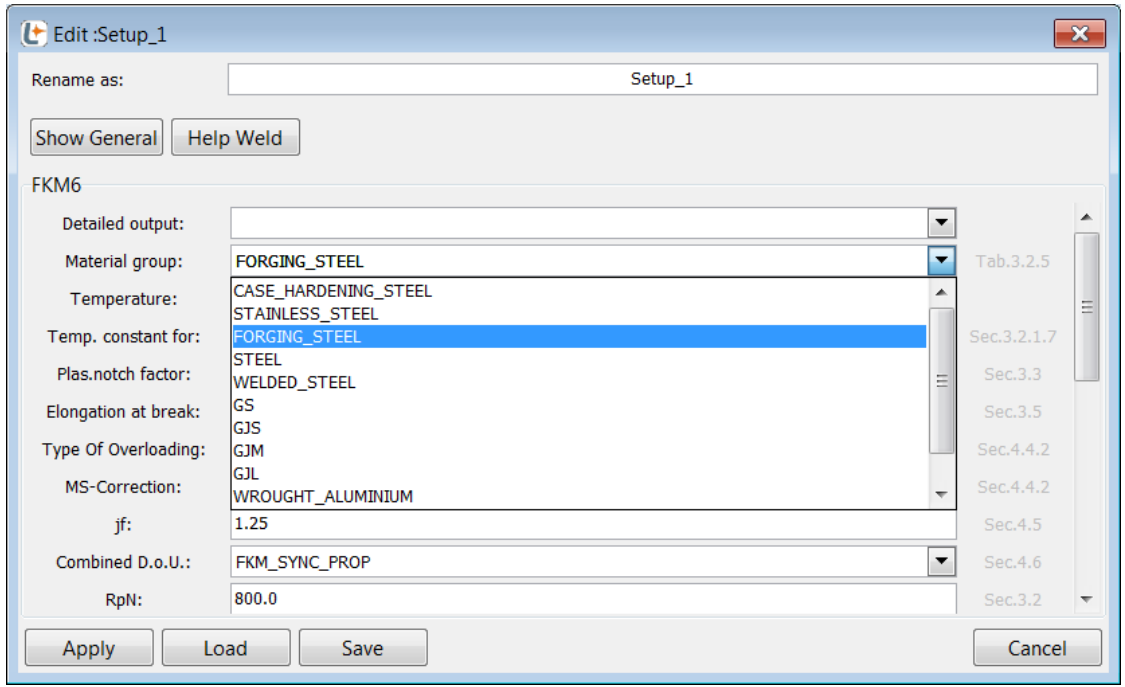
Version LIMIT2014

Overview

- Base material assessment using local stresses
- Assessment of welded structures using local stresses
- Assessment of welded structures using nominal or structural hot spot stresses
- Combined degree of utilization
- Synchronous/proportional loads
- Non-proportional loads

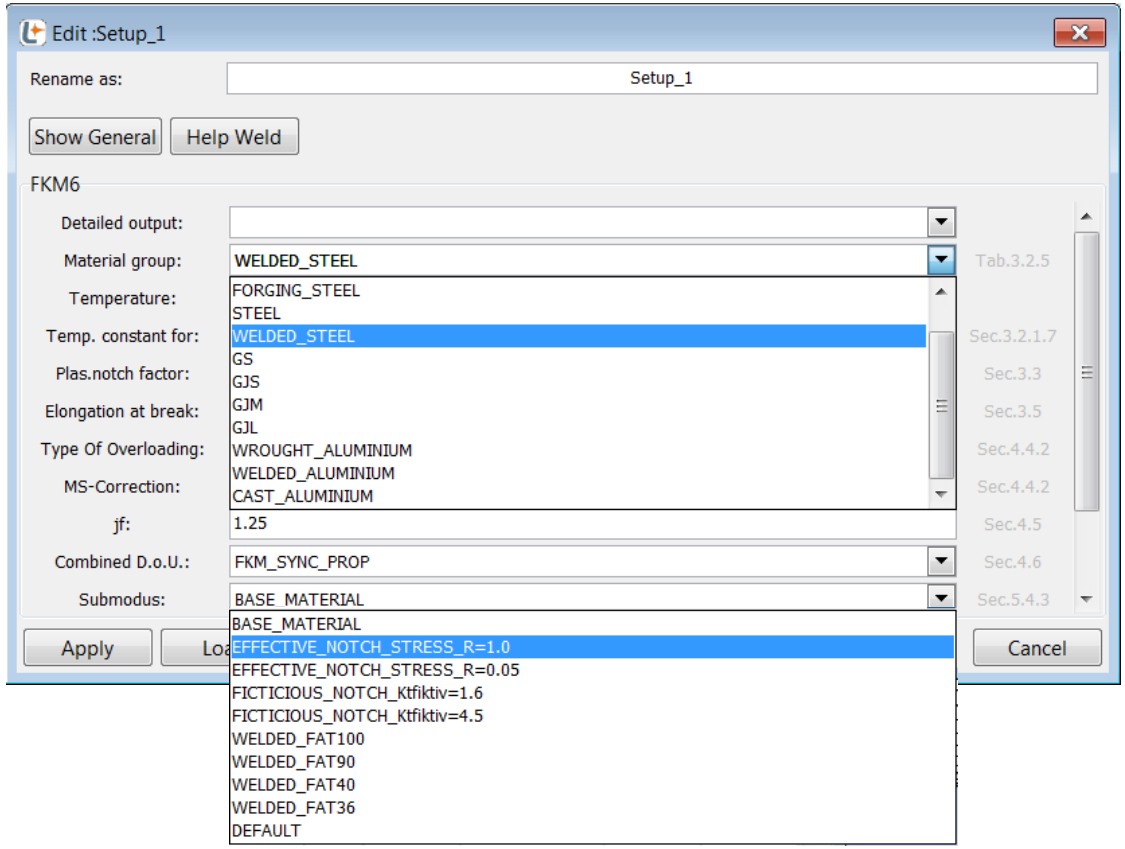
Base material assessment using local stresses

- **GUI: Edit: Setup**
- **Assignment: Base Material**
- **Material group:**
  - CASE_HARDENING_STEEL
  - STAINLESS_STEEL
  - FORGING_STEEL
  - STEEL
  - GS, GJS, GJM, GJL
  - WROUGHT_ALUMINIUM
  - CAST_ALUMINIUM
- **All assessment types supported:**
  - **Static strength**
  - **Fatigue strength**
  - **And mixed types**



Assessment of welded structures using local stresses

- GUI: Edit: Setup
- Assignment: Base Material
- Material group:
  - WELDED_STEEL or
  - WELDED_ALUMINIUM
- Submodus:
  - EFFECTIVE_NOTCH_STRESS_R=1.0
  - EFFECTIVE_NOTCH_STRESS_R=0.05
  - FICTICIOUS_NOTCH_Ktfiktiv=1.6
  - FICTICIOUS_NOTCH_Ktfiktiv=4.5
  - WELDED_FAT100
  - WELDED_FAT90
  - WELDED_FAT40
  - WELDED_FAT36
  - DEFAULT



Weld Assessment Types, Local Stresses

Submodus:

Valid selections for WELDED_STEEL:

- **EFFECTIVE_NOTCH_STRESS_R=1.0**
  - Effective notches modeled with radius 1mm
  - Assessments: Static and Fatigue (FKM Sec.3.3.2, Sec.5.4.3)
- **EFFECTIVE_NOTCH_STRESS_R=0.05**
  - Effective notches modeled with radius 0.05mm for thin sheets
  - Assessments: **only** Fatigue (Sec.5.4.3)
- **FICTICIOUS_NOTCH_Ktfiktiv=1.6**
  - Assumes mild notches in combination with FAT class 225/160
  - Assessments: **only** Fatigue (Sec.5.4.3)
  - Reduces the permissible values by the global factor of 1.6
  - Can be used to assess areas where the solid element results represent structural stresses
- **FICTICIOUS_NOTCH_Ktfiktiv=4.5**
  - Assumes mild notches in combination with FAT class 630/250
  - Assessments: **only** Fatigue (Sec.5.4.3)
  - Reduces the permissible values by the global factor of 4.5
  - Can be used to assess areas where the solid element results represent structural stresses
- **WELDED_FAT100 and WELDED_FAT90**
  - Can be used to assess areas where the solid element results represent structural stresses (Tab. 5.4.3)

Weld Assessment Types, Local Stresses

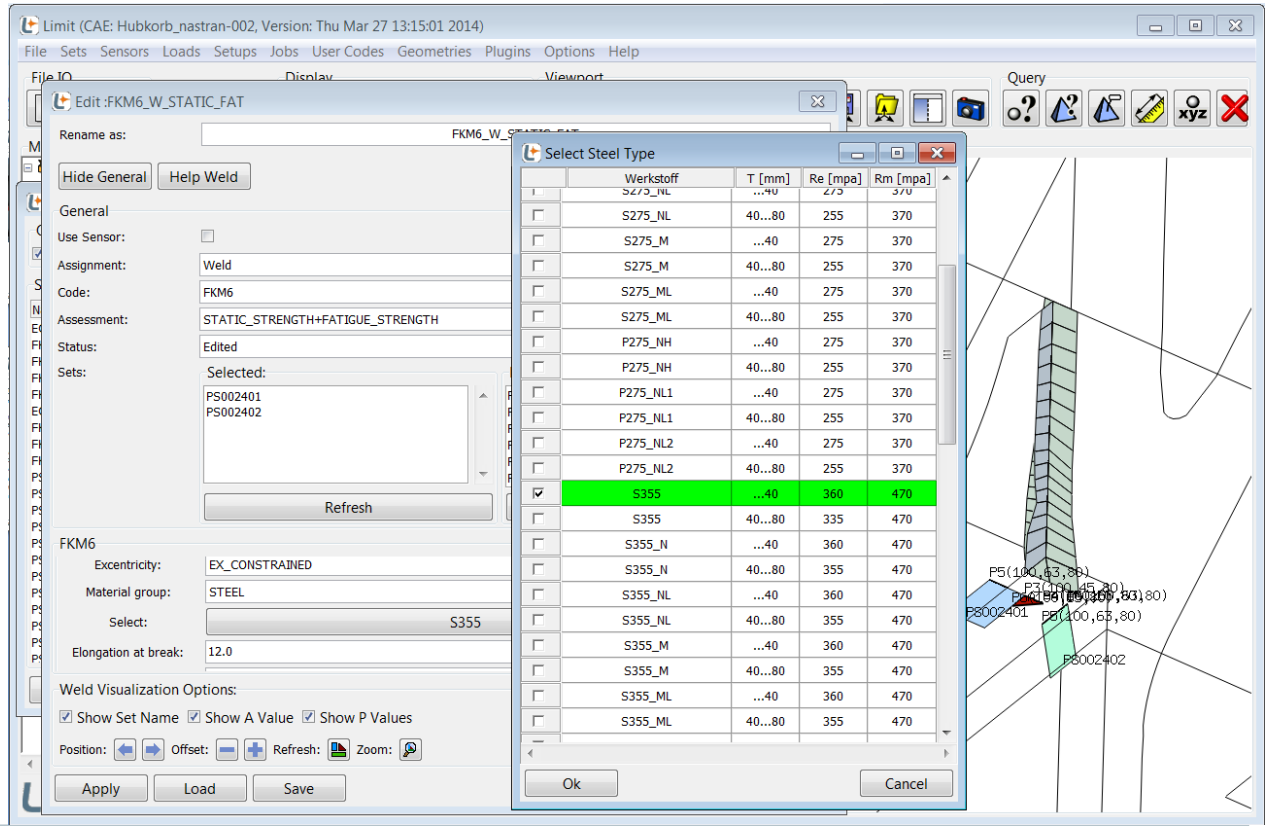
Submodus:

Possibilities for WELDED_ALUMINIUM:

- **EFFECTIVE_NOTCH_STRESS_R=1.0**
  - Effective notches modeled with radius 1mm
  - Assessments: **only** Fatigue (Sec.5.4.3)
- **EFFECTIVE_NOTCH_STRESS_R=0.05**
  - Effective notches modeled with radius 0.05mm for thin sheets
  - Assessments: **only** Fatigue (Sec.5.4.3)
- **FICTICIOUS_NOTCH_Ktfiktiv=1.6**
  - Assumes mild notches in combination with FAT class 71/63
  - Assessments: **only** Fatigue (Sec.5.4.3)
  - Reduces the permissible values by the global factor of 1.6
  - Can be used to assess areas where the solid element results represent structural stresses
- **FICTICIOUS_NOTCH_Ktfiktiv=4.5**
  - Assumes mild notches in combination with FAT class 180/90
  - Assessments: **only** Fatigue (Sec.5.4.3)
  - Reduces the permissible values by the global factor of 4.5
  - Can be used to assess areas where the solid element results represent structural stresses
- **WELDED_FAT40 and WELDED_FAT36**
  - Can be used to assess areas where the solid element results represent structural stresses (Tab. 5.4.3)

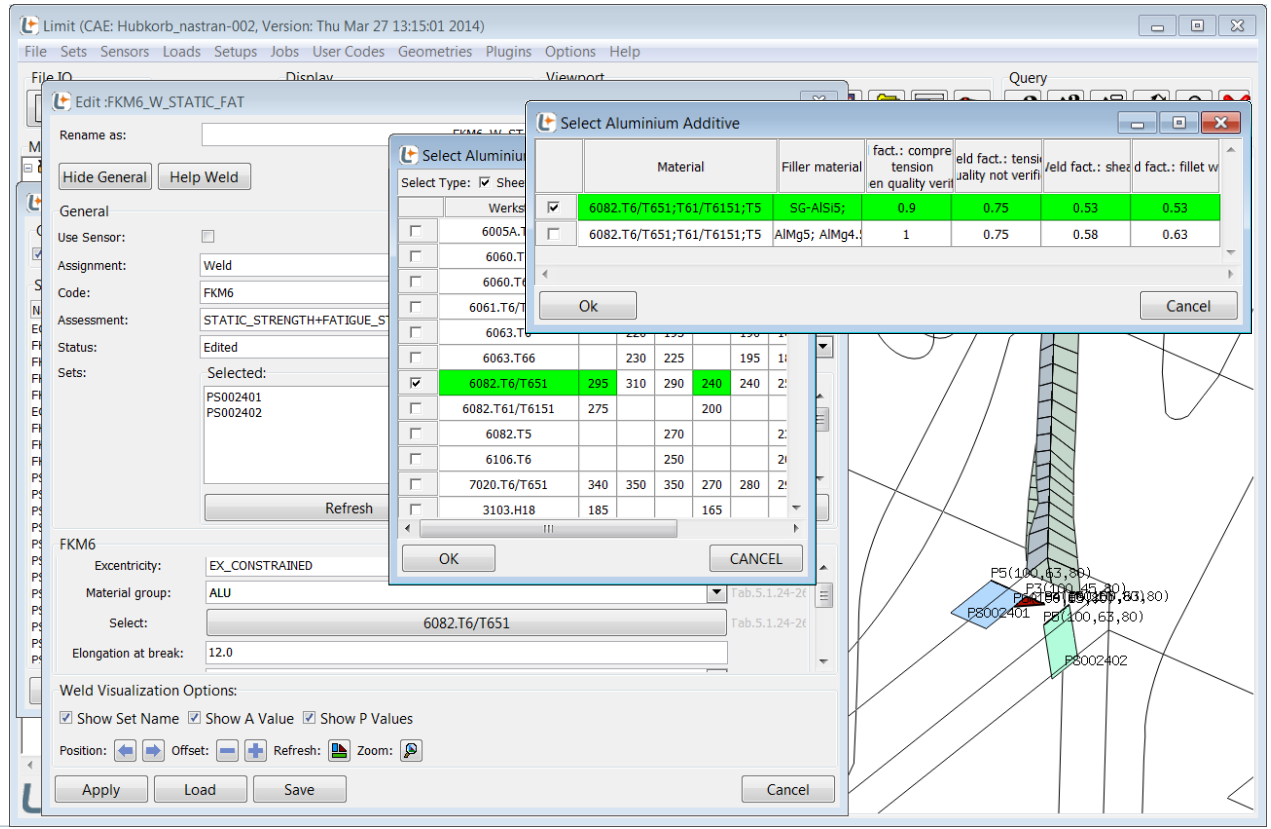
Assessment of weld structures using nominal or structural stresses

- **STEEL**
- **GUI: Edit: Setup**
- **Assignment: WELD or WELD_GLOBAL**
- **Material group: STEEL**
- **Push bar next Select**
- **Choose a material from table (see FKM, Tab. 5.1.24)**



Assessment of weld structures using nominal or structural stresses

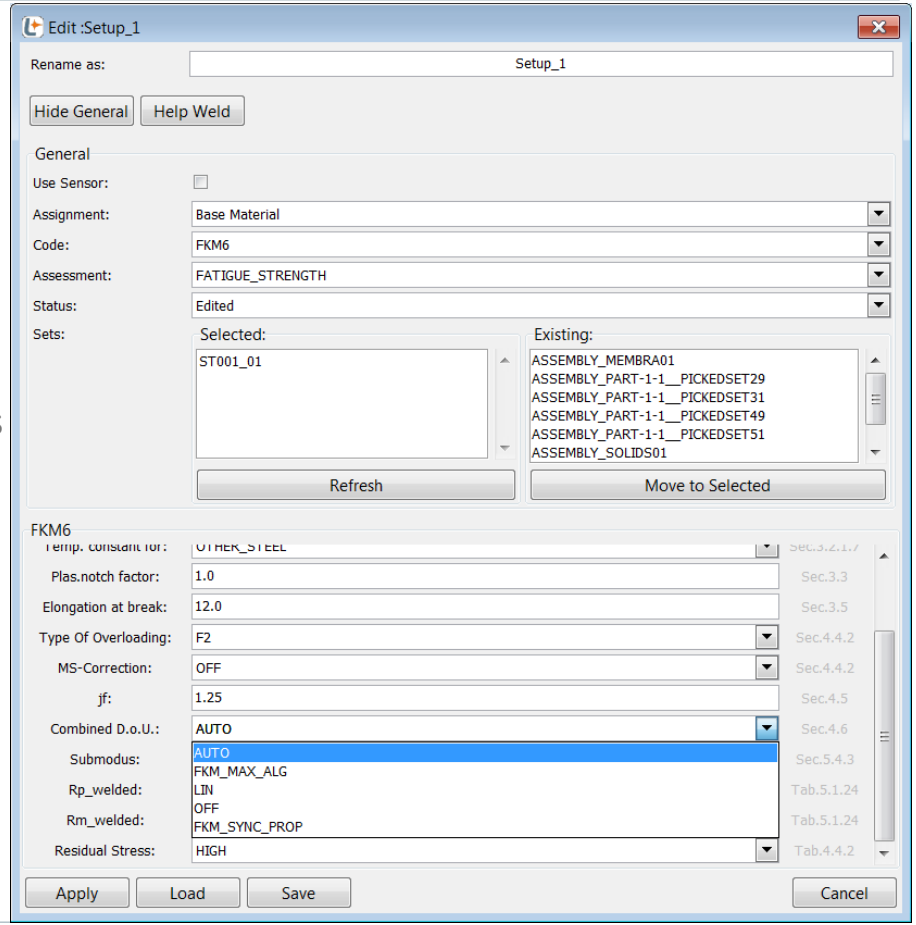
- **ALUMINIUM**
- **GUI: Edit: Setup**
- **Assignment: WELD or WELD_GLOBAL**
- **Material group: ALU**
- **Push bar next Select**
- **Choose a material from table (see FKM, Tab. 5.1.25)**
- **Press OK and choose filler material (see FKM, Tab. 5.1.26)**



Combined Degree of Utilization

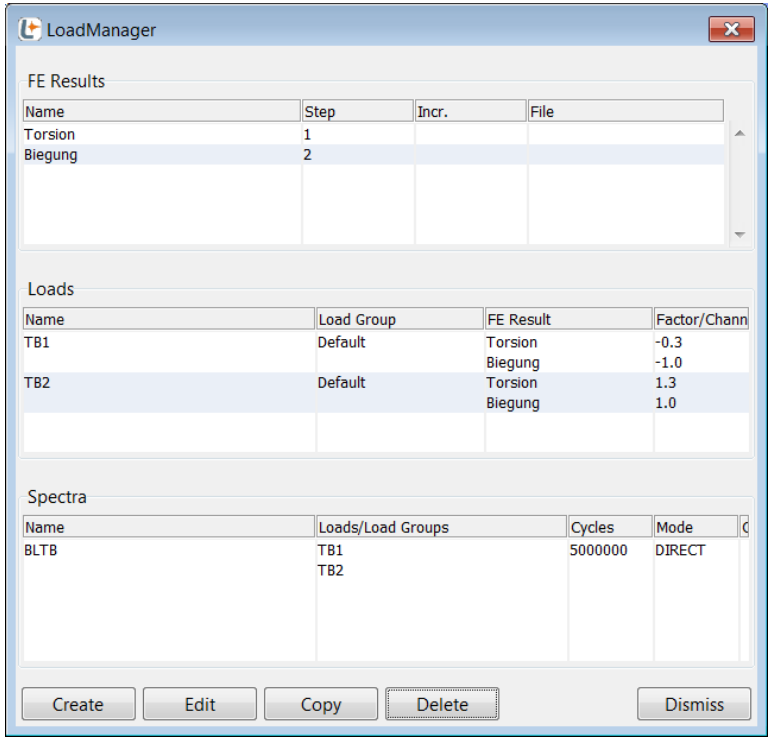
Combined degree of utilization

- **GUI: Edit: Setup**
- **Assignment: Fatigue**
- **Combined D.o.U**
  - **AUTO** (default): In this case LIMIT checks, whether the signs of individual stress amplitudes can be used or not. This is done on the basis of the load cases responsible for each amplitude. If normal stresses origin from the same load cases, signs are taken as calculated by FEA.
  - **FKM_MAX_ALG**: will give highest possible degree of utilization after altering signs. i.e. worst case with respect to signs.
  - **OFF**: deactivates combined criteria
  - **LIN**: linear summation of all DoU (CAE addon, not part of FKM)
  - **FKM_SYNC_PROP**: deactivates checks and uses signs of amplitudes in the combined DoU as calculated by FEA.



Combined degree of utilization

- **E.g. synchronous torsion and bending of a shaft**
- **Following steps in the LoadManager are possible:**
  - Create FE Results
    - Two individual FE load cases
    - Torsion and Biegung
  - Create Loads
    - Linear combination of two FE Results
    - TB1 and TB2
    - This way limit will always assume synchronous loads



Forcing synchronous or proportional loading

- **Two ways of always forcing synchronous or proportional scenarious:**
  - Only two load cases used or
  - Activating option Criteria = CRIT_LC_PAIR in JobManager
    - In this case all loads are assessed pairwise
    - Will take longer, but all stress components will result from same two loads!
    - Not as conservative as default setting (Criteria = SPECTRUM).

Non proportional loads

Simultaneous occurrence of maximum amplitudes

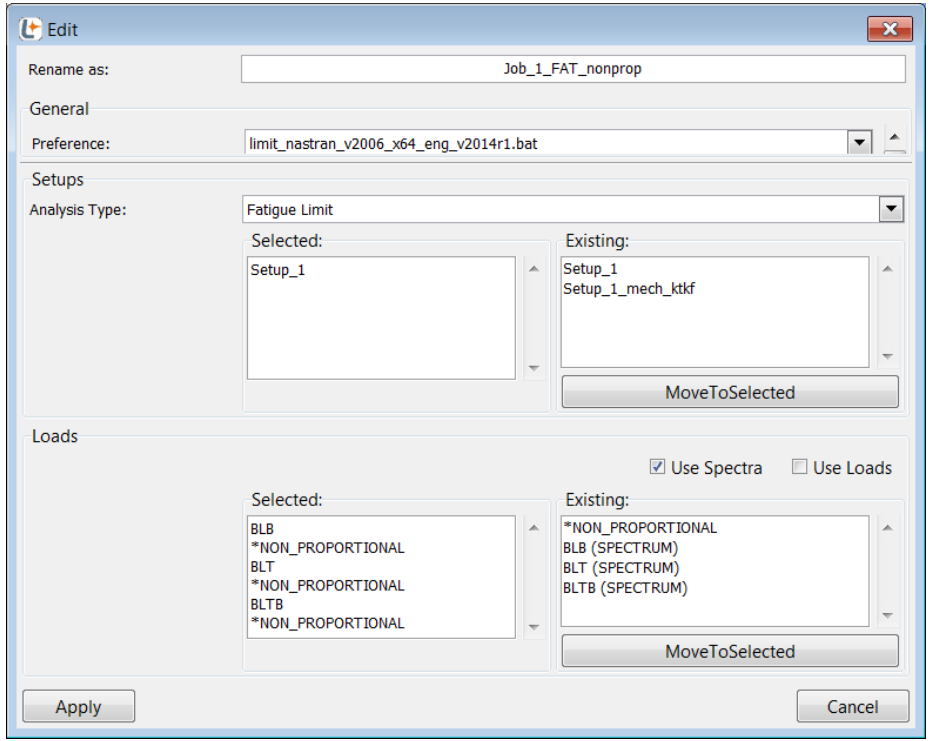
- FKM Chapter 4.6.2.2
- Define a spectrum for each non proportional load group
- Select the spectra in the JobManager and introduce the flag *NON_PROPORTIONAL
- LIMIT will perform separate fatigue assessments for all spectra and will add the combined degrees of utilization over all spectra (see next page).
- E.g. text output for the critical element (last lines):

```
FKM-GUIDELINE:
 LIST OF COMBINED DEGREES OF UTILIZATION OF NON-PROP. LOADS
 ASSESSMENT POSITION:  1
            (SPECTRUM_#,     DoU):
                      1,  0.71511
                      2,  0.61119
                      3,  0.98258

 TOTAL DoU:   2.3089
```

Simultaneous occurrence of maximum amplitudes

- JobManager
- Loads > Use Spectra
- Place *NON_PROPORTIONAL after each spectrum
- Run the analysis



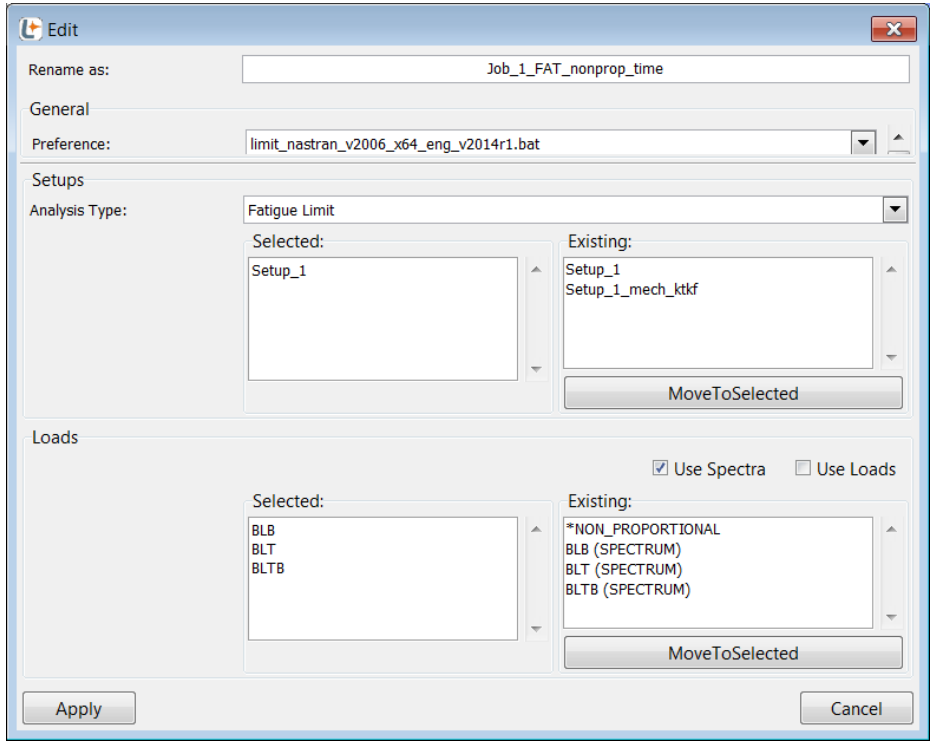
Non proportional loads

Time delayed occurrence of maximum amplitudes

- **FKM Chapter 4.6.2.2**
- **Define a spectrum for each non proportional load group**
  - Constant amplitude spectrum
  - Variable amplitude spectrum
- **Select MINER_ELEMENTARY in Edit:Setup**
- **Select all spectra in the JobManager (see next slide)**
- **Load spectra are added with respect to load cycles**
- **Run the analysis**

Time delayed occurrence of maximum amplitudes

- JobManager
- Loads > Use Spectra
- Run the analysis



End

Last slide!