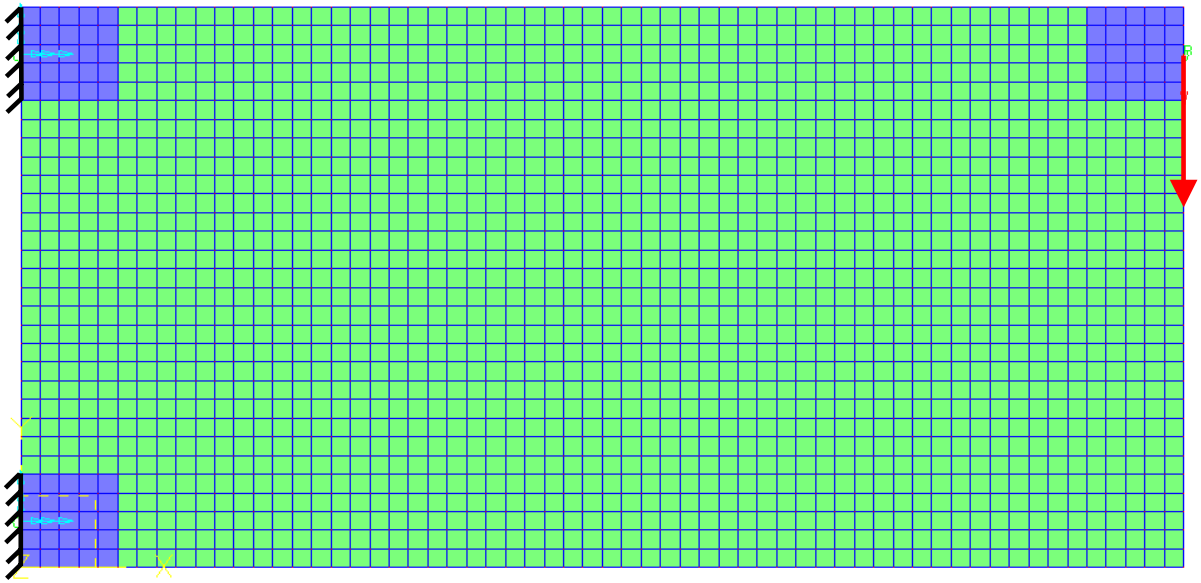
Topology Optimization

ENGINEERING CENTER STEYR
GmbH & Co KG

FEMFAT User Meeting, 13th May 2005

Topology Optimization

Example: FE-Model Biegebalken



F= 200N

oscillating, N= 1.000.000

1800 shell elements 5x5x10mm

- **design area, 1725 elements**
- **frozen area, 75 elements**

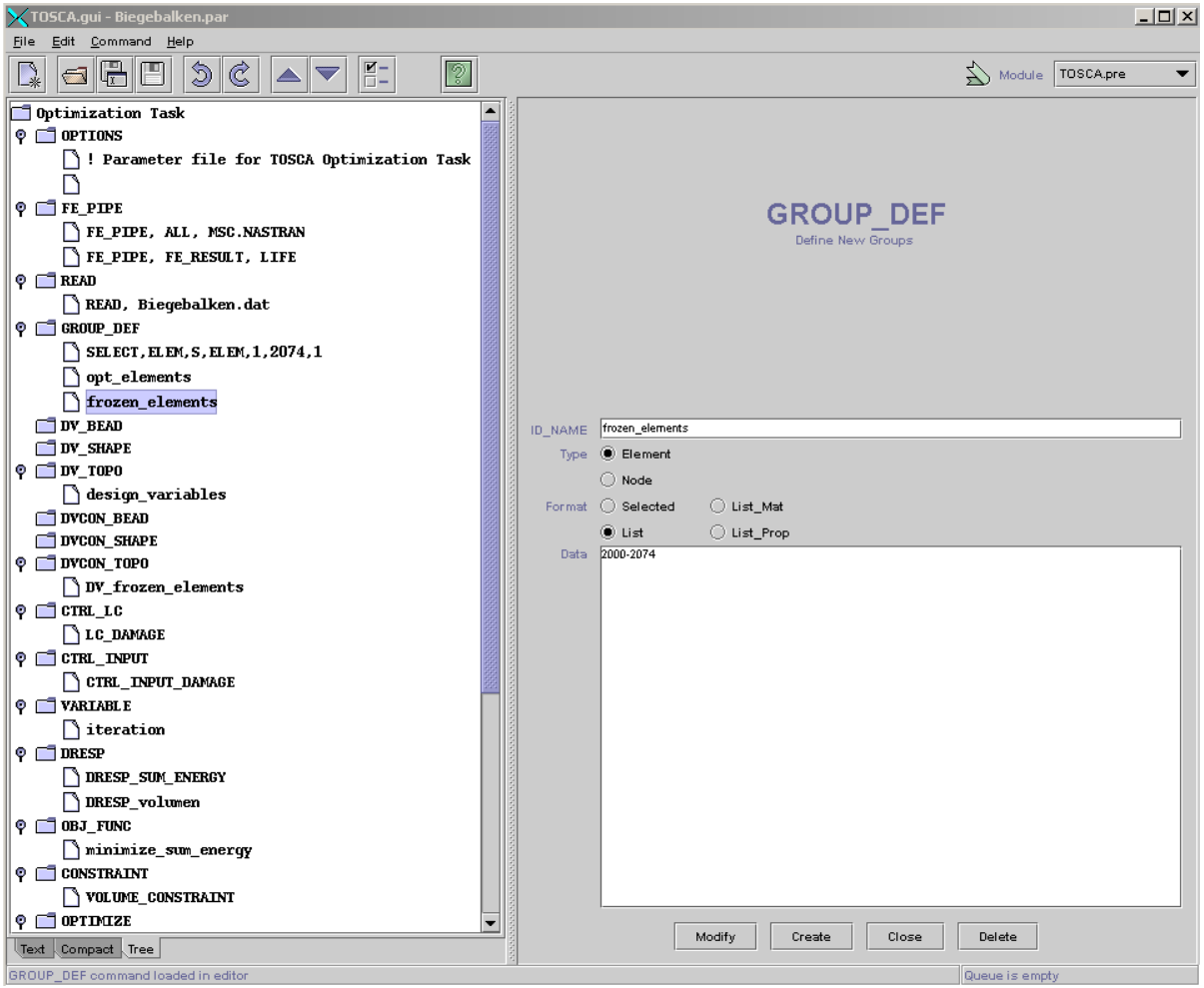
Topology Optimization

Workflow

- FE-Modell ⇒ Biegebalken.dat ✓
- Parameter File ⇒ TOSCA.gui

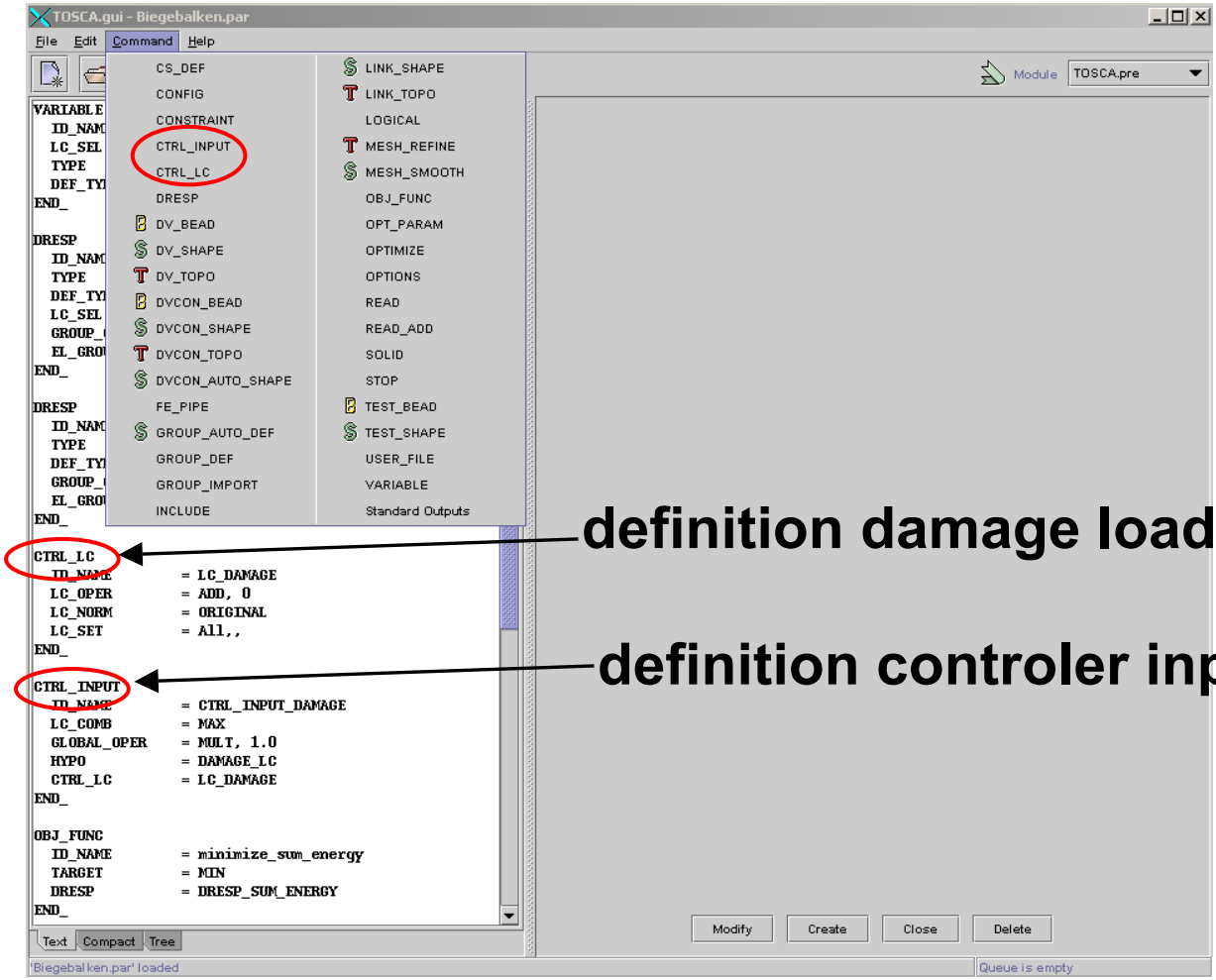
Topology Optimization

Group Definition



Topology Optimization

Definition loadcases and controler input



definition damage loadcase

definition controler input

Topology Optimization

Definition controler input

```
  GROUP_OPER      = Sum
  EL_GROUP        = opt_elements
END_

CTRL_LC
  ID_NAME         = LC_DAMAGE
  LC_OPER         = ADD, 0
  LC_NORM         = ORIGINAL
  LC_SET          = All,,
END_

CTRL_INPUT
  ID_NAME         = CTRL_INPUT_DAMAGE
  LC_COMB         = MAX
  GLOBAL_OPER     = MULT, 1.0
  HYPO            = DAMAGE_LC
  CTRL_LC         = LC_DAMAGE
END_

OBJ_FUNC
  ID_NAME         = minimize_sum_energy
```

requiers FEMFAT onf_601 resultfile

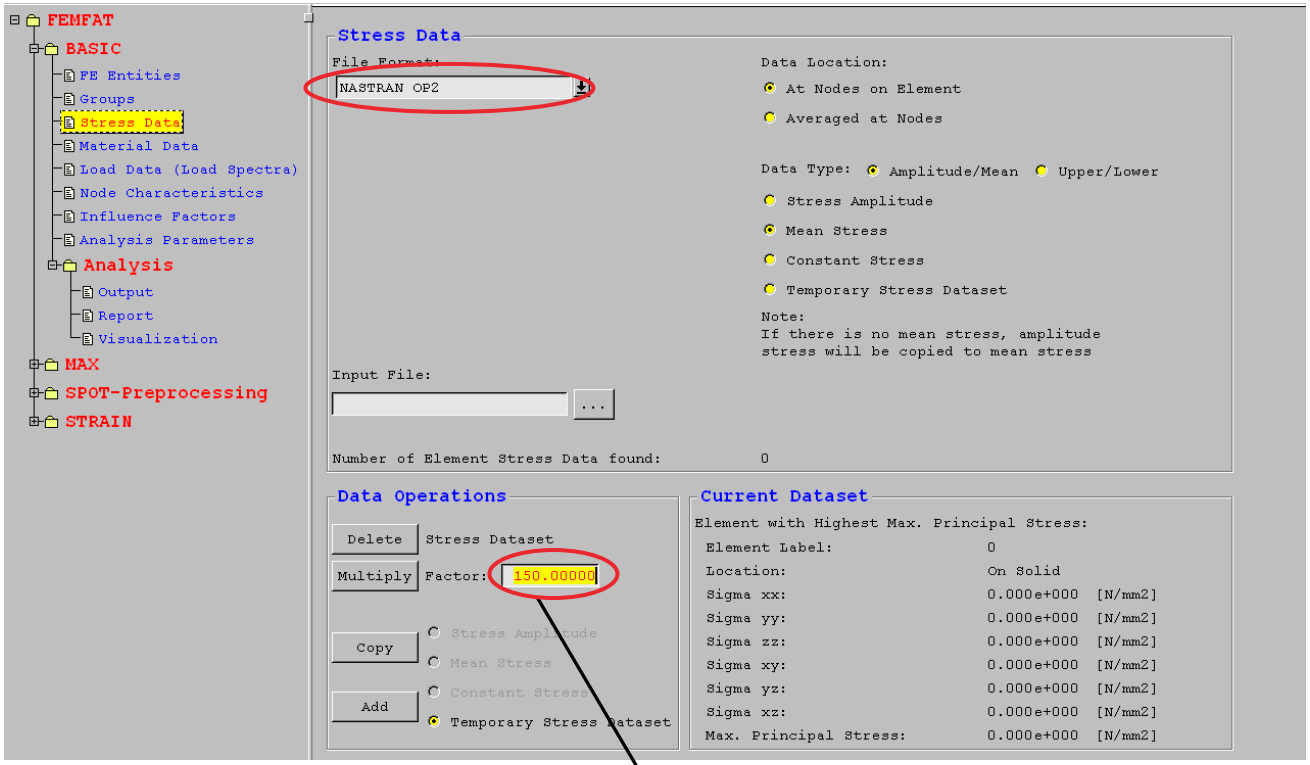
Topology Optimization

Workflow

- FE-Modell ⇒ Biegebalken.dat ✓
- Parameter File ⇒ TOSCA.gui ⇒ Biegebalken.par ✓
- FEMFAT job File ⇒ FEMFAT gui

Topology Optimization

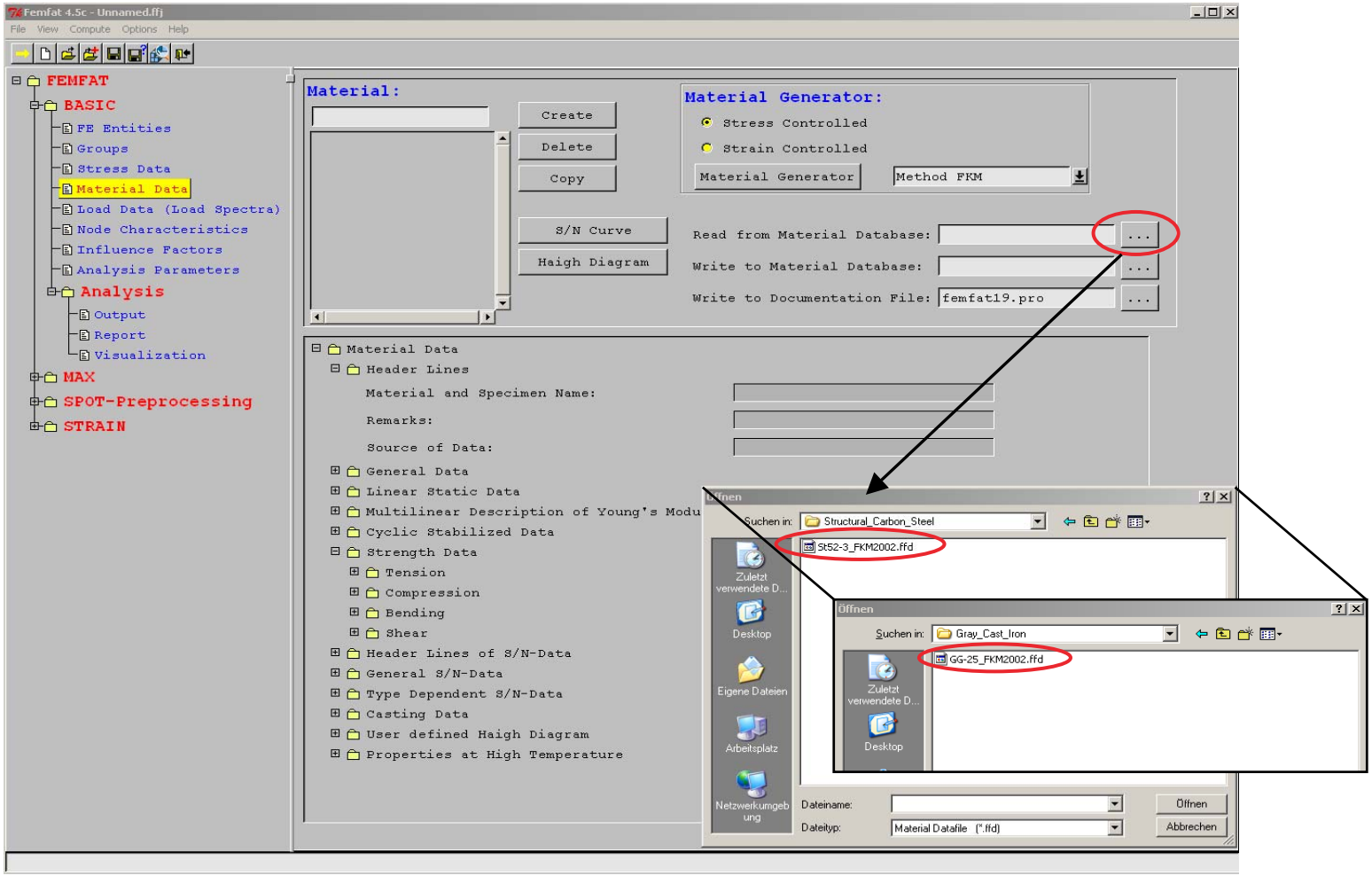
- **According actual stress results read from actual op2 – file**



150 for steel
50 for gray cast iron

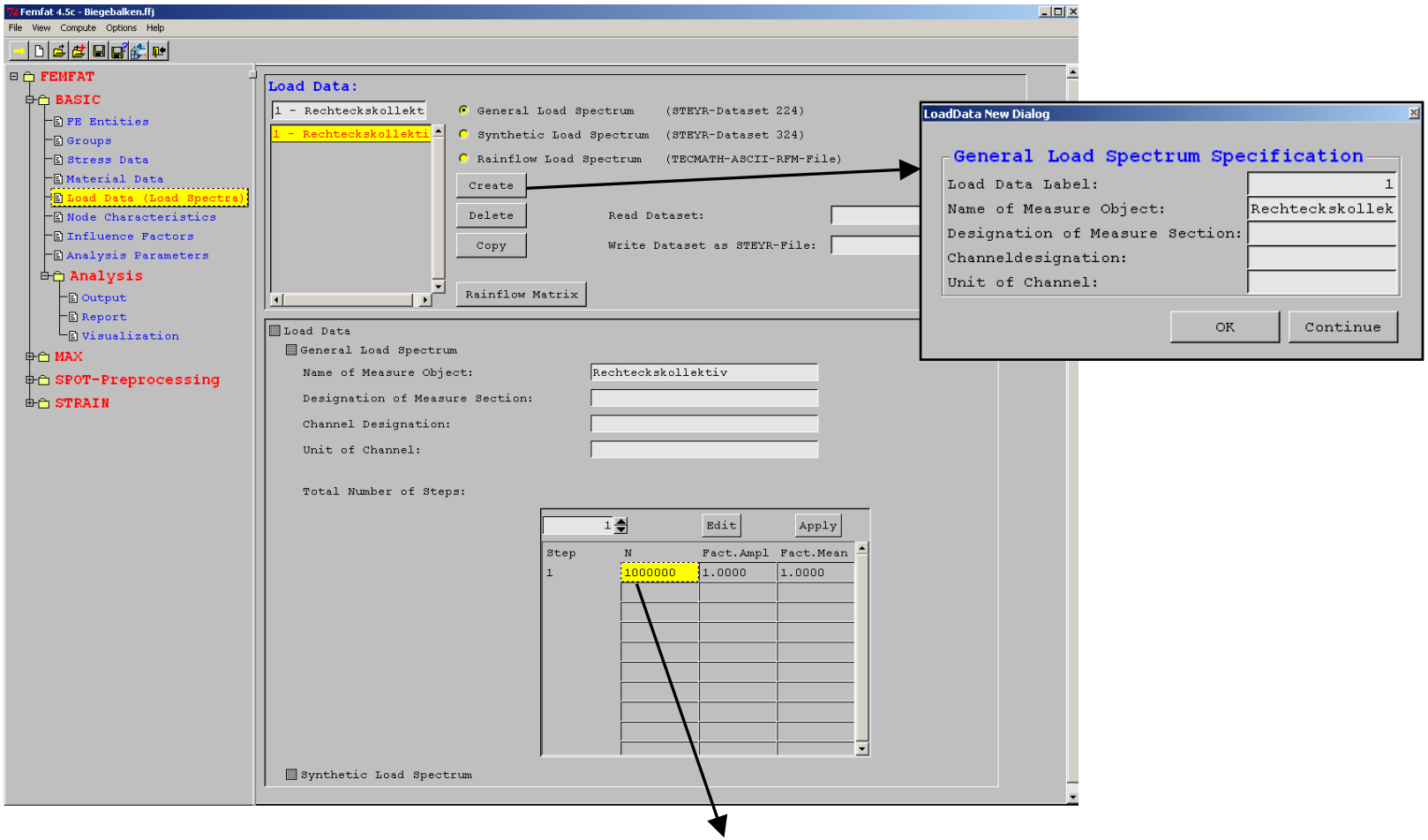
Topology Optimization

- **Material: FEMFAT material dataset .ffd imported**



Topology Optimization

- **Load: generate collective load**



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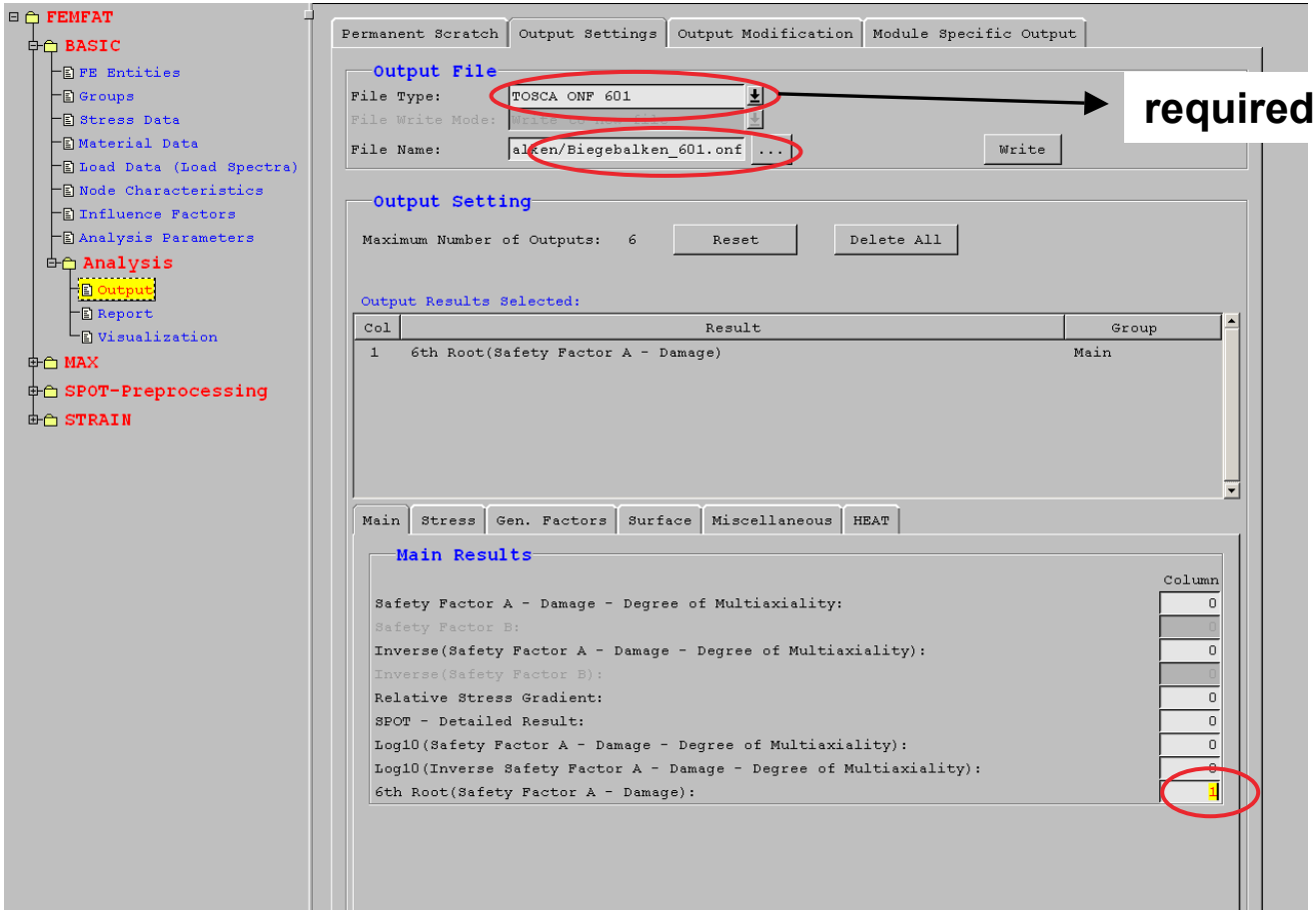
- **Output: results have to be written in onf600 or onf601-format**



required for optimization

Topology Optimization

Workflow

- FE-Modell ⇒ Biegebalken.dat ✓
- Parameter File ⇒ TOSCA.gui ⇒ Biegebalken.par ✓
- FEMFAT job File ⇒ FEMFAT gui ⇒ Biegebalken.ffj ✓
- TOSCA configuration File ⇒ TOSCA home path

Topology Optimization

TOSCA configuration File

```
# ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
######  NASTRAN ######
  if (${fe_solver} eq "nastran") {
     $ENV{"tosca_interface"} = "${tosca}/nastran";
     if ($Client->isWin) {
        ${fe_solver_exe} = "D:/FEMFAT-SCHULUNG/Topo_Opti/Gray_Cast_Iron/nastran_start.bat";
        ${fe_solver_call} = "${fe_solver_exe} ${modelname}.${inp_ext} notify=no old=no";
     }else{
        ${fe_solver_exe} = "/sc301/ffischer/OPTIMIERUNG/EXAMPLE_BIEGEBALKEN_TOPO/GRAY_CAST_IRON/nastran_start";
        ${fe_solver_call} = "${fe_solver_exe}";
# ${modelname}.${inp_ext} batch=no notify=no old=no";
     }
     ${res_ext} = "xdb";
     ${solver_add_call} = "";

     add_move_per_iter_list("first_last", "SAVE.f06", "*.f06");
     add_move_per_iter_list("ever", "SAVE.f04", "*.f04");
     add_move_per_iter_list("ever", "SAVE.xyz", "*.xyz");
     add_move_per_iter_list("ever", "SAVE.mnf", "*.mnf");
     add_move_per_iter_list("ever", "SAVE.mtx", "*.mtx");
     add_move_per_iter_list("ever", "SAVE.txt", "*_cut.txt");
     add_move_per_iter_list("first_last", "SAVE.${res_ext}", "${modelname}.${res_ext}" );

     add_copy_solver_info_list("ever", "SAVE.${inp_ext}", "${modelname}.${inp_ext}");
# ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
```

NASTRAN Configuration

FEMFAT Configuration

```
# ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
######## FEMFAT ######
  }elsif (${life_solver} eq "femfat") {
     ${life_interface}  = "${tosca}/femfat";
     ${life_ini}        = "tosca_femfat.ini";

     if ($Client->isWin) {
       ${life_solver_exe} = "D:/FEMFAT-SCHULUNG/Topo_Opti/Gray_Cast_Iron/femfat_start.bat";
     }else {
        #UNIX Version
        ${life_solver_exe} = "/sc301/ffischer/OPTIMIERUNG/EXAMPLE_BIEGEBALKEN_TOPO/GRAY_CAST_IRON/femfat_start";
     }
     add_move_per_iter_list("first_last", "SAVE.601_dma", "${modelname}_601.onf");
     add_move_per_iter_list("first_last", "SAVE.pro", "${modelname}.pro");

     if(${fe_solver} eq "nastran"){
        add_move_per_iter_list("first_last", "SAVE.op2", "*.op2");
     }

     $life_solver_call = "${life_solver_exe}";

  }
# ~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
```

Topology Optimization

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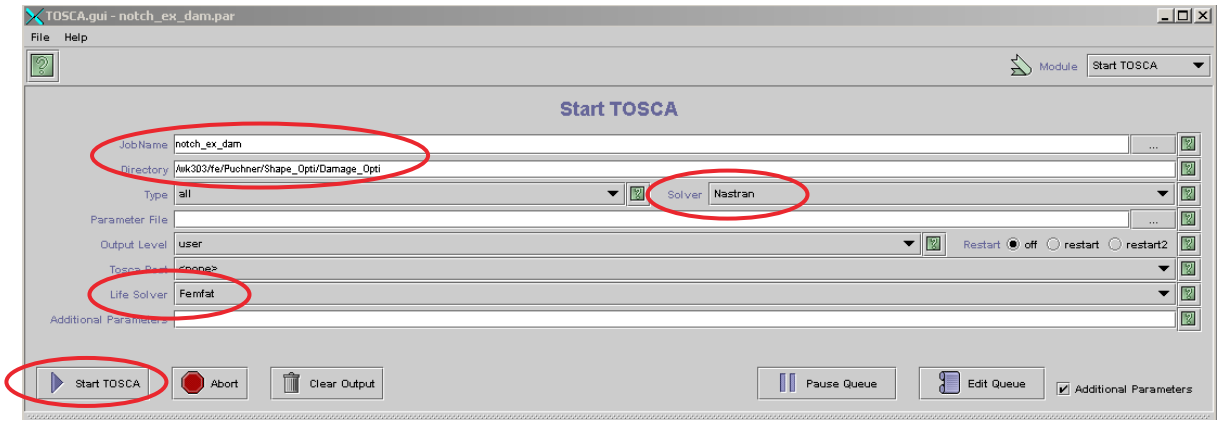
- FE-Modell ⇒ Biegebalken.dat ✓
- Parameter File ⇒ TOSCA.gui ⇒ Biegebalken.par ✓
- FEMFAT job File ⇒ FEMFAT gui ⇒ Biegebalken.ffj ✓
- TOSCA configuration File ⇒ TOSCA home path ⇒ Biegebalken.cfg ✓
- Start optimization

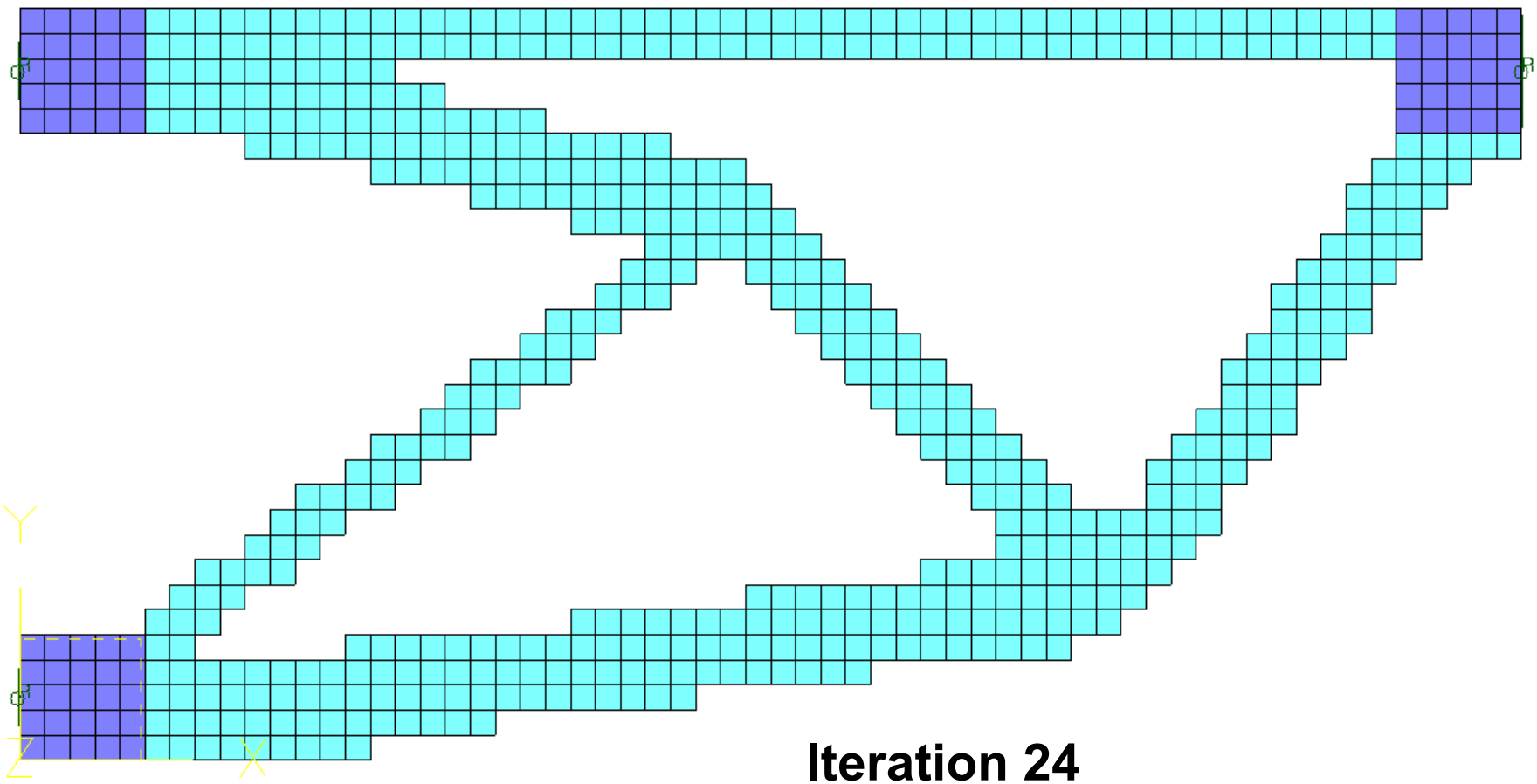
Topology Optimization

Start optimization



Topology Optimization

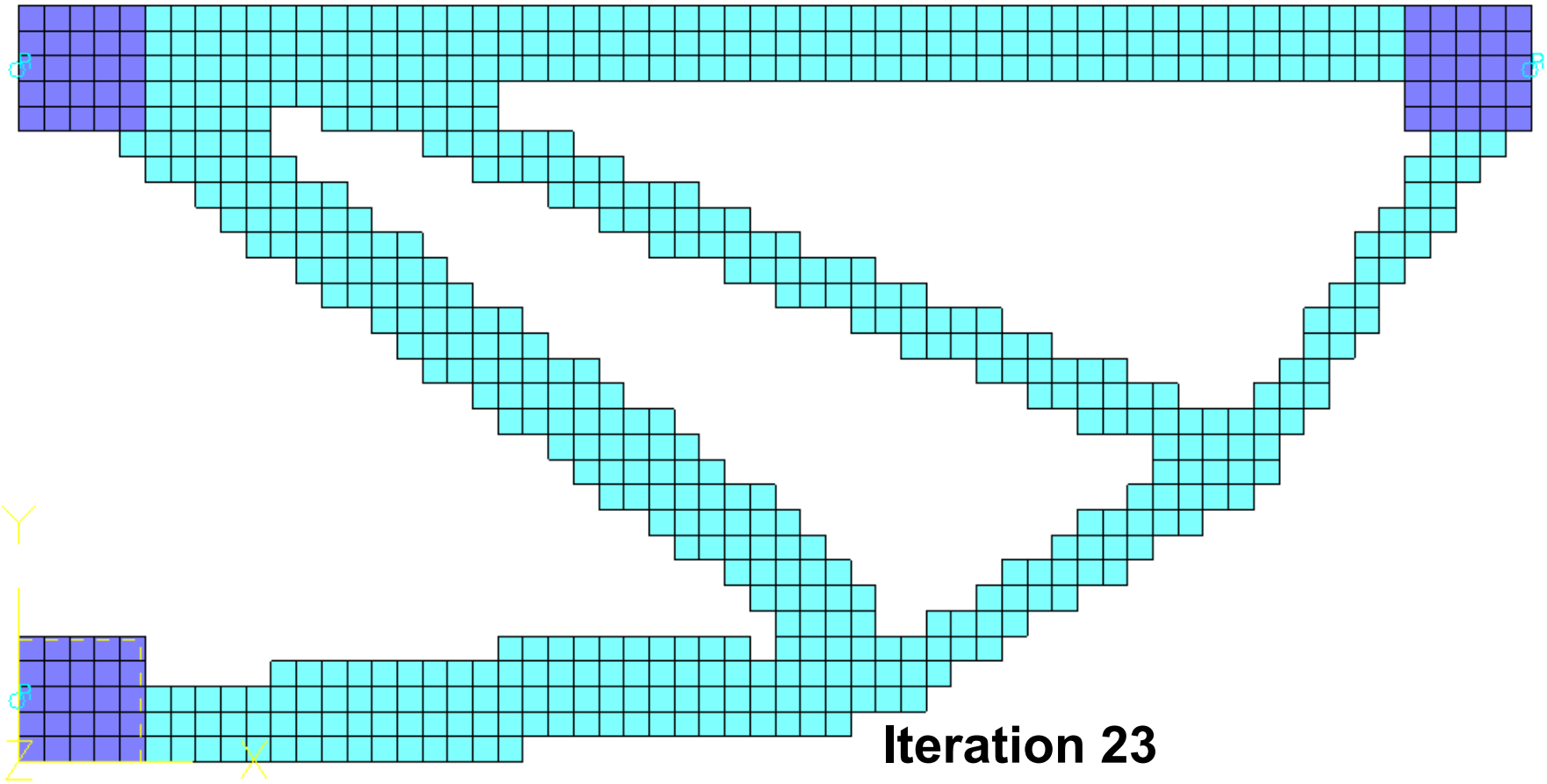
Result optimization with St52_3



Iteration 24
30 % Volume of Startmodel

Topology Optimization

Result optimization with GG-25



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