Installating and using the SIMP problemtype for GiD and testing the topology optimization benchmark in 2d

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1 Introduction

This document contains the instructions to install the program for the use of SIMP method and the versions: SIMP-SVC and SIMP-SC which are implemented using the library FEMT. The program receives as entry the tests of a benchmark[2], which includes the design domain, border conditions, material properties and meshes. The benchmark tests were generated using the GiD software, nevertheless, the execution of the program is not necessary on GiD, it can be executed as line commands. Attached to this document are: the source codes of the methods, the makefile for their compilation and the necessary files for the problemtype execution, and the benchmark[2] tests. The instructions are exemplified for aN ubuntu 14.04 LTS operative system.

2 Instructions

2.1 FEMT instalation and the SIMP problemtype

- Download the last version of FEMT and installing it, following the instructions on the link. The FEMT installation generates a folder named FEMT-<version>/.

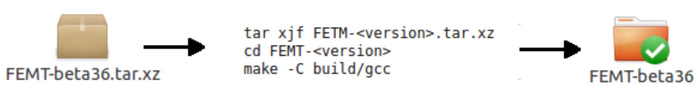

Fig. 1. Installing FEMT

– Download and uncompress the SIMP.tar.gz file attached to this document. Into this folder there are the folders Methods/ and Benchmark/. The folder Methods/ contains SIMP_build/, SIMP_codes/ and SIMP_problemtype/, which have the necessary files to execute the program.

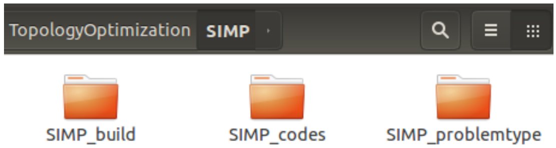

Fig. 2. Content of Methods/ folder

It is necessary to copy and to paste the following folders in the indicated directories:

- Go to the directory Methods/SIMP_build and copy the folder SIMP/ in the directory FEMT-<version>/build/gcc/
- Go to the directory Methods/SIMP_codes and copy the folder SIMP/ in the directory FEMT-<version>/source/GiDProblemTypes/
- Go to the directory Methods/SIMP_problemtype/ and copy the folder SIMP.gid/ in the directory FEMT-<version>/gid/problemtypes/

– Compile the codes using the makefile in the directory FEMT-<version>/build/gcc/SIMP/.

2.2 Using the SIMP program as a GiD problemtype

– Copy and paste the folder FEMT-<version>/gid/problemtypes/SIMP.gid/ in the problemtypes folder of GiD(which is usually in the directory GiD<version> /problemtypes)

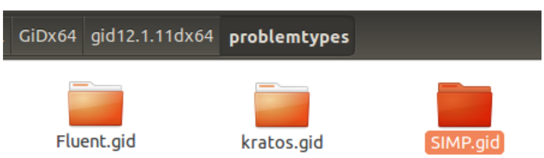

Fig. 3. SIMP problemtype in GiD

– Execute GiD and open any of the test of the Benchmark/ folder (uncompressed before):

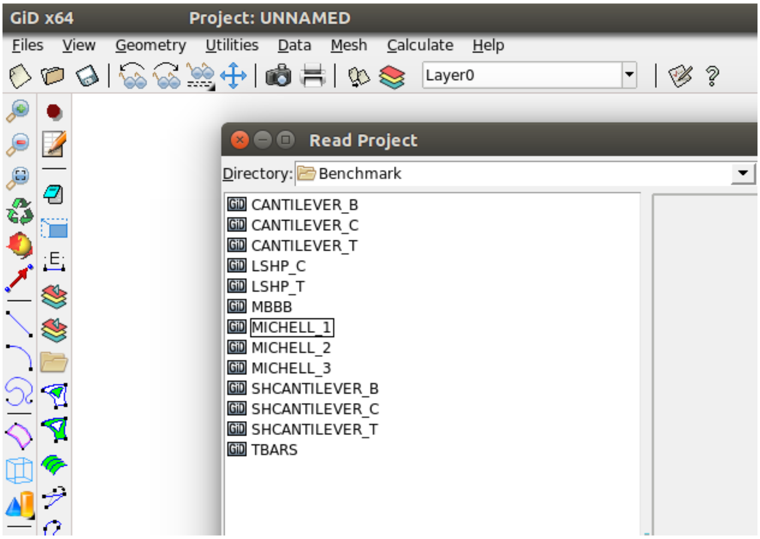

Fig. 4. Open a benchmark test on GiD

– All the tests are pre-loaded with the parameters values reported in the benchmark paper. In the menu Data → Problem_data → Structure_optimization are shown the following options (for a detailed description of these options see [1]):
  - Maximal iterations: for the methods SIMP and SIMP-SVC.
  - Thickness empty material: thickness for empty material elements (known as x_{min} in [1]).
  - Parameters p, $ratio$ and m for the SIMP and SIMP-SVC methods.
  - Save: a) material, saves the evolution of the material distribution, b) displacements, saves the evolution of the displacements on the structure, c) stress, saves the evolution of the stress on the structure, in addition the vonMises stresses, d) sensitivities, saves the evolution of the sensitivities(compliance derivatives) on the structure, e) filtering, saves the evolution of the filtered sensitivities on the structure.
  - Optimization method: SIMP, SIMP-SVC or SIMP-SC.

- Volume constraint: vfor compliance poblems, valid only for SIMP and SIMP-SVC.
- Security factor constraint: for volumn problems (known as stress constraint in [1]), valid only for SIMP-SC.
- Epsilon convergence: to determine convergence depending on the chosen method.
- Historic variance convergence: number of consecutive values to calculate a convergence by variance. Valid for SIMP-SVC.
- Maximal global iterations: SIMP-SC is a set of consecutive executions of the SIMP-SVC with a volume adjust intermediate. This parameter is the maximal iterations of the global counting accumulated for all the SIMP-SVC executions.

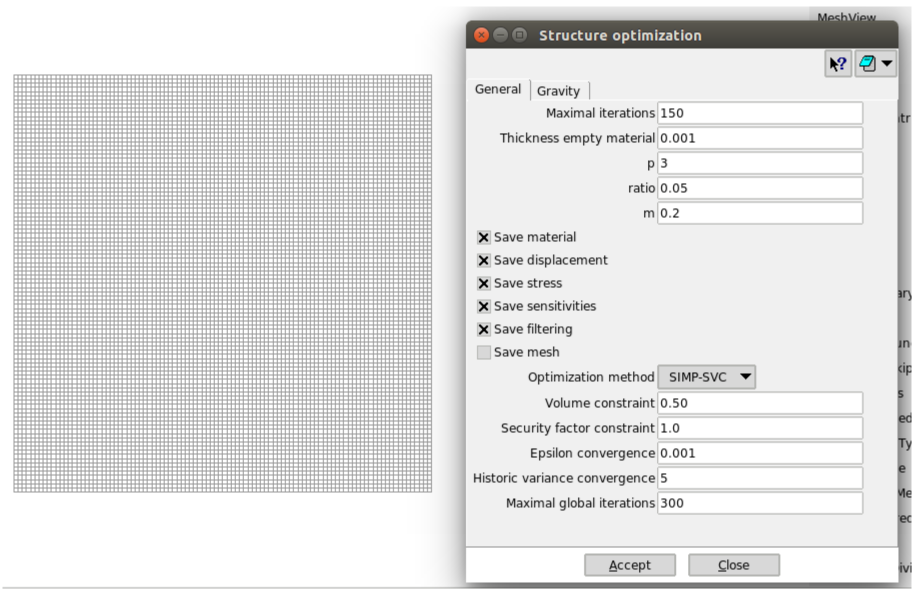

Fig. 5. Configuring tests in GiD

– Execute SIMP in the menu Calculate → Calculate.

2.3 Using the SIMP program with command lines

– Copy and paste the folder Benchmark/ in the directory FEMT-<version>/gid/problemtypes/SIMP.gid/ as follows:

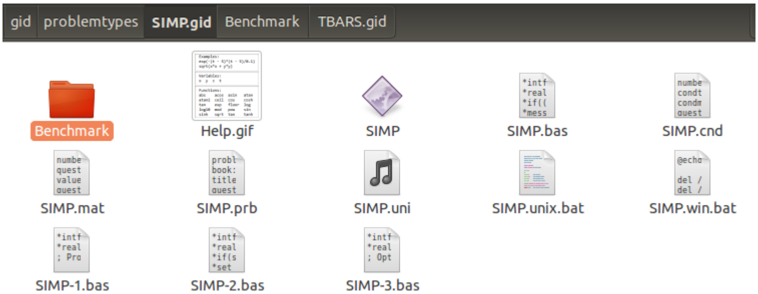

Fig. 6. Benchmark in problemtype folder

– In the direction FEMT-<version>/gid/problemtypes/SIMP.gid/, execute the program in a terminal as follows:

```
./SIMP SIMP Benchmark/<test-name>.gid/<test-name>
```

The following is an example of execution in terminal:

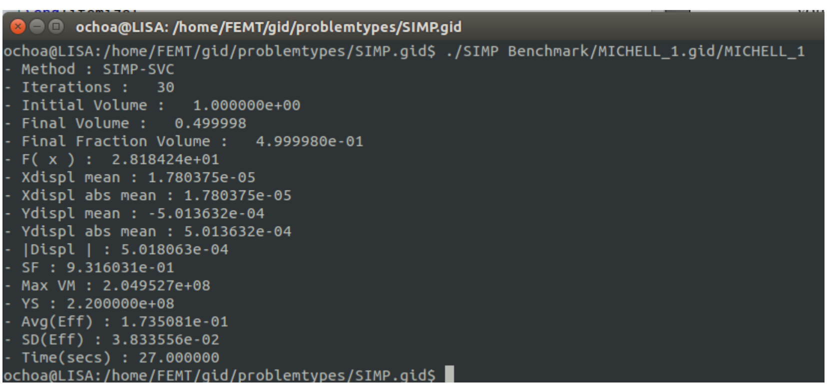

Fig. 7. Output data in terminal execution

2.4 Post-process data

Executions generate he following files:

File	Description
<test-name>.GID.dat	Contains the evolution of the objective function, volume and security factor through the iterations. Finally it save the information shown in figure 7
<test-name>.displacements.dat	Contains information about displacements on the conditioned nodes with external forces.
<test-name>.post.res	Contains all the elemental and nodal information about material distribution, displacements, stresses, vonMises, sensitivities and filtering of each iteration of the execution. GiD uses this file to show the post process as shown in figure 8

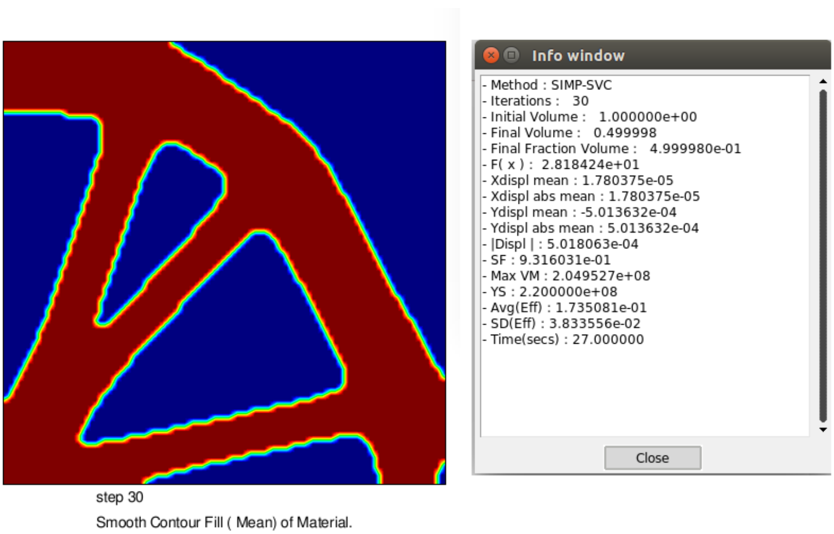

Fig. 8. Post-processing in GiD

References

1. Valdez, S. I., Botello, S., Ochoa, M. A., Marroqun, J. L., & Cardoso, V. Topology Optimization Benchmarks in 2D: Results for Minimum Compliance and Minimum Volume in Planar Stress Problems. Reporte interno CIMAT. 2016.
2. Valdez, S. I., Botello, S., Ochoa, M. A., Marroqun, J. L., & Cardoso, V. Topology Optimization Benchmarks in 2D: Results for Minimum Compliance and Minimum Volume in Planar Stress Problems. Archives of Computational Methods in Engineering, 1-37.