Assignment in
Structural Optimization, 2014

Division of Solid Mechanics

The task is to implement and analyze different optimization methods. The theory related to the methods and the results should be presented in a well structured report. References to relevant literature should be included in the report. The methods should be implemented in Matlab and use can be made of suitable subroutines included in the CALFEM toolbox. The developed computer code should be attached as an appendix in the report.

Problem description

In order to test the implementation, an optimization of a simple problem should be performed. The compliance of a beam should be minimized, geometry and boundary conditions are illustrated in figure. The material of the beam is linear elastic, homogeneous and isotropic. Choose material parameters as well as the magnitude of the load.

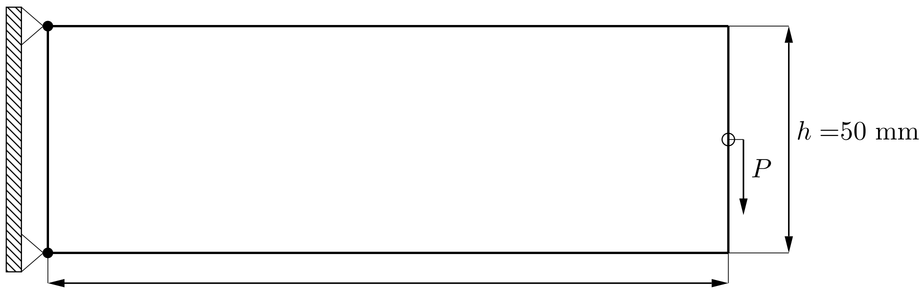

Figure 1: Illustration of the boundary value problem

Problem formulation

The optimization methods that should be considered are:

a) Size optimization. In this task you should design a load carrying structure using a truss design. The geometry for the truss structure is given in the file `geomSO.mat` which can be downloaded from the course homepage. The maximum allowable cross-section area of the bars are $A_{max} = 5mm^2$, the maximum allowed volume of the structure is $V_{max} = 2000mm^3$. Solve the problem for a range of A_{min} values. Evaluate the CONLIN and MMA algorithms.

b) Use the SIMP algorithm to derive an optimal design. You should investigate different discretizations and different initial values. The maximum allowed volume of the structure $V_{max} = 0.5V_{box}$ where V_{box} is the volume defined by the height and width from Fig. 1. The thickness of the structure is $5mm$. Solve the problem for different meshes.

c) Include a filter in the SIMP algorithm. The theory describing the filter that should be used can be found in [1]. Solve the problem for different meshes and different length scale parameters.

Procedure

The analysis is to be performed in CALFEM. A well structured concise report of your findings should be returned to the Div. of Solid Mechanics no later than **2014-03-17 16.00**. The results should be presented in the form of illustrative graphs and tables. Note that it should be possible to generate the results from the information provided in the report, i.e. numerical parameters used should be clearly stated in the report. MATLAB/CALFEM files (appendix) should be well structured and carefully commented. The reader of the report is assumed to have the same knowledge level as the author. It is possible to obtain up to 30 points. The task should be solved in groups of *two* (or *individually*). Keep the report as concise as possible. It is strongly recommended that you keep the report well below 12 pages excluding the appendix containing the code.

Submission

You should submit your report in **PDF** to FHLN01@solid.lth.se. In addition to your report you should also attach your m-files. Moreover, a **paper** version should be handed in to the division of Solid Mechanics.

Hints

When solving Helmholz PDE, the smooth density field $\tilde{\rho}$ will be obtained at the nodal points of the mesh. When relating the field $\tilde{\rho}$ to the stiffness matrices, i.e.

$$\boldsymbol{K}_i^e = (\tilde{\rho}_i)^q \boldsymbol{K}_{0,i}^e \tag{1}$$

then $\tilde{\rho}_i$ should be computed at the center of the element.

References

[1] B. S. Lazarov and O. Sigmund. Filters in topology optimization based on helmholz-type differential equations. *International journal for numerical methods in engineering*, 86:765–781, 2010.