The University of Iowa
College of Engineering
53:236 Optimization of Structural Systems
Fall Semester 2004

Assignment #4: Due: 11/09/04

DSA Assignment:

The objective of this assignment is to check the accuracy of design gradient computations produced by an analysis and sensitivity analysis program. To do this, we will use the program IDESIGN written by Professor J.S. Arora and his students here at University of Iowa. (The manual for IDESIGN will be distributed to you in class.) This program has the option of computing design gradients by central finite difference techniques as follows:

$$\frac{d\mathfrak{I}}{db_i} = \lim_{\delta b_i \to 0} \frac{\mathfrak{I}(\mathbf{b}_0 + \delta b_i \mathbf{e}_i) - \mathfrak{I}(\mathbf{b}_0 - \delta b_i \mathbf{e}_i)}{2\delta b_i}$$

Since this tends to be extremely expensive, finite difference gradients are typically not used in actual optimization computations. However, finite difference gradients can be used to check the accuracy of design gradients computed via more efficient methods, such as adjoint sensitivity analysis, or direct differentiation techniques.

It is recommended that you set up a very small test problem involving only four to eight finite elements. For this test problem, use IDESIGN to check the design gradient expressions computed by FENDAC for the following functions:

a) the linear elastic strain energy functional under force-controlled loadings; and
b) the linear elastic strain energy functional under displacement-controlled loadings.

For both of these cases, check the sensitivity expressions at $b_{0i} = 0.5; \quad \{i = 1,2,\ldots,NDV\}$. In addition, you should check the sensitivity expressions for:

1. the pure Voigt mixing rule;
2. the pure Reuss mixing rule; and
3. the powerlaw mixing rule with p=2.5

Details:

1. The executable version of IDESIGN to be used is found on the ECSS HP-UX system at: /usr/ui/class/examples/cee5330/53_236/hw4/IDESIGN
2. To employ the Voigt-Reuss mixing rule, set *imix=1* in the FENDAC data set. The value of α is entered as *pglob* in the IDESIGN data set.

3. To employ the powerlaw mixing rule, set *imix =0* in the FENDAC data set. The value of *p* is related to the value of *pglob* as follows: $p = 1 + 3(1-pglob)$
4. The input data format for the special version of IDESIGN which you'll be using is identical to the input format for SLP described in the BESTOP manual.