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Optimization of the Gap Shape in Axial Sliding Bearing

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Generalized optimization procedure is used for the shape optimization of the gap between the sliding surfaces of a Mitchell-type axial sliding bearing. The generalized optimization technique is applicable for the shape optimization of linear second order partial differential equations. These types of differential equations are the governing equations of several problems in the engineering and designer science.

The Reynolds-equation, which is the theoretical basis of the journal- and sliding bearings, is in the group of available equations for this generalized shape optimization. The numerical solution of the Reynolds-equation is made by using the technique of finite differences. The nodal values of the shape function in the journal bearing are the variables in the optimum searching procedure. Changing systematically these variables during the optimization procedure, we can find the shape of the gap function which gives minimum friction coefficient.

The basis of the optimization is a Genetic Algorithm based on an optimum searching algorithm for general nonlinear objective functions under general nonlinear constraints. Many structural changings in the algorithm give the possibility to avoid the danger of local optimums and to increase the speed and efficiency of the searching procedure. A hierarchy system was created for the classification of the constrains. The constraints needing longer computation time and higher computer capacity are evaluated only after the fulfillment of "light" constraints which need lower computation time and less computer storage capacity.

As a numerical example the optimization of the gap shape inside a Mitchell-type axial sliding bearing is presented. The gap shape giving the minimum friction coefficient is given by a figure. Further developments are possible by applying splines in the optimization process.

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Optimum Design of Welded Stiffened Box Sections

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In order to develop safe and economic structures, all important aspects of design, fabrication and cost should be considered. In the course of optimum design the six unknown dimensions of a square box section with longitudinal L-shaped stiffeners are taken into account.

Optimum design is the search for better solutions which minimize the cost function and fulfill the design constraints.

The square box section was tested under uniaxial compression.

The unknown dimensions b, t, b_s, t_s, h_s and n_s should be optimized in order to minimize the cost function.

The cost of a structure is the sum of the material, fabrication, transportation, erection and maintenance cost.

The cost function can be expressed as:

$$K = K_m + K_f = k_m V + k_f \sum_i T_i$$

where K_m and K_f are the material and fabrication costs, respectively, k_m and k_f are the corresponding cost factors, r is the material density, V is the volume of the structure, T_i are the production times.

The optimal dimension which minimize the whole cost function and fulfil the design constraints, are computed by using the Rosenbrock direct search mathematical programming method. This method is a direct search, one without derivatives. The developed computer program enables the calculation of more structural versions and the significant decrease of the cost function.

FE Analysis of Geometrically Nonlinear Static Problems with Follower Loads

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Consider an elastic body loaded by traction p inward normal to the instantaneous surface. The goal is to determine the critical value of p for certain problems. The critical value of p is understood to be the smallest value of p at which the bifurcation occurs on the fundamental equilibrium path.

The problem is essentially geometrically nonlinear, for this reason the principle of virtual displacements in incremental formulation is applied to seek the solution. Numerical examples have been solved by the Newton-Raphson algorithm on the base of the linearized incremental formulation using hexahedral elements with uniform p -extension ($p=5$). Applying a given value of p , the equilibrium iteration is started from a suitable, on the other hand arbitrary kinematically admissible configuration in order to find the present configuration within a prescribed tolerance.

In the case of follower loads it is a characteristic question how to take into consideration the change of the vectorial surface elements. Due to the change one has a non-symmetric contribution to the tangent stiffness matrix. Numerical results demonstrate that the number of equilibrium iterations is decreased at least by one magnitude when the non-symmetric contribution to the tangent stiffness matrix is included. For a dead load, the contribution to the tangent stiffness matrix due to the change of the scalar surface element is not evaluated generally.

The numerical experiments were performed on the following example. A circular ring in the reference configuration is loaded by uniform inward radial pressure p . Knowing that the first buckling mode is symmetric, symmetry boundary conditions were imposed on the edges that lie on the axes of symmetry. The II. Piola-Kirchoff stress tensor was related to the Green-Lagrange strain tensor by Hook's law. The theoretical critical load was found for Bernoulli type beam by M. Levy, J. Math. pure et appl. (Liouwill), S.3 (1884), p.3.

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