Isogeometric Layout Optimization of Shell Structures Using Trimmed NURBS Surfaces

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A new method is presented which allows determining the optimal segmentation of shell structures built from precast patches. The geometry is described by Non-Uniform Rational B-Spline (NURBS) surfaces and is integrated into the finite element method applying the isogeometric analysis technology and most sophisticated own implementations of isogeometric shell elements. The goal of the method is to find the segmentation, for which the stress resultants in the boundaries of the segments are minimal. The method consists of three steps. In the first step, the stress resultants of the shell structure are computed. This can be done with an isogeometric shell analysis considering one or more load cases. In the second step the parameter space of the shell structure is roughly divided into a certain number of segments using NURBS curves. This step is equivalent to the action of splitting/trimming the NURBS surface, which describes the shell model. In the last step the NURBS curves in the parameter space of the shell model are adapted such that the stress resultants for these curves get minimized. The result of the method is the description of the original shell model with optimal trimmed NURBS surfaces. Thus the result of the method is again a Computer Aided Design (CAD) model and can be used directly for further applications. The method can be used for the segmentation of shell structures which should be built out of precast concrete components.

The procedure is fully integrated into the CAD program Rhino3D which is an important issue for practical application and will be demonstrated by the contribution as well. The success of the method will be demonstrated by illustrative benchmark examples.

To summarize, the presented methodology combines the isogeometric analysis of shells, latest developments for the trimming of NURBS-surfaces, CAD-FEM integration, optimization of layout of shell segments made from fiber reinforced concrete.