EngOpt2018 - 6th International Conference on Engineering Optimization
Instituto Superior Técnico, Lisbon Portugal • 17-19 September, 2018
Editors: H.C. Rodrigues, J. Herskovits, C.M. Mota Soares, et al.

Abstract ID 1033

SURROGATE BASED SHAPE OPTIMIZATION OF LIGHTENING HOLES IN AIRCRAFT FUSELAGE BEAMS

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Keywords: Aircraft Structure,Finite Element Analysis,Lightening Holes,Structural Shape Optimization,Surrogate Models

Abstract: Weight saving from aircraft structures has always been important in aircraft industry. Introducing flanged lightening holes to the primary aircraft structures (e.g., wing ribs, fuselage frame webs, and fuselage longerons) is a way to achieve weight savings. Cutting a hole on the structure leads to a weight reduction but diminishes its strength. Therefore, forming the edge of the hole as a flange is a common practice to regain the strength of the structure. In this study, lateral metallic beam from the upper deck of Turkish Light Utility Helicopter (TLUH) with a predetermined geometry, loading, and edge conditions is considered. Since sharp edges would cause undesirable stress concentrations, the lightening hole geometry is considered to be an ellipse. The radii in the two axes of the ellipse, the curvature coefficient, and center-to-center hole distances are taken as design variables. The optimal values of these geometrical properties are sought by minimizing the structural weight as the objective function, while maintaining the structural strength and stability at certain levels. Since structural responses are computed through computationally expensive finite element analyses, surrogate based optimization approach is followed. In this study, polynomial response surfaces, Kriging and radial basis functions are considered as potential surrogate models. Kriging models with linear trend function is found to be more accurate than other surrogate models to predict the structural responses of interest. In preliminary design, the geometries of the all lightening holes are assumed to be identical. The optimization resulted in 6.9% weight reduction compared to the initial design, without sacrificing structural strength or stability. In the final paper, the geometric properties of the holes are not assumed to be identical and further weight savings will be investigated.