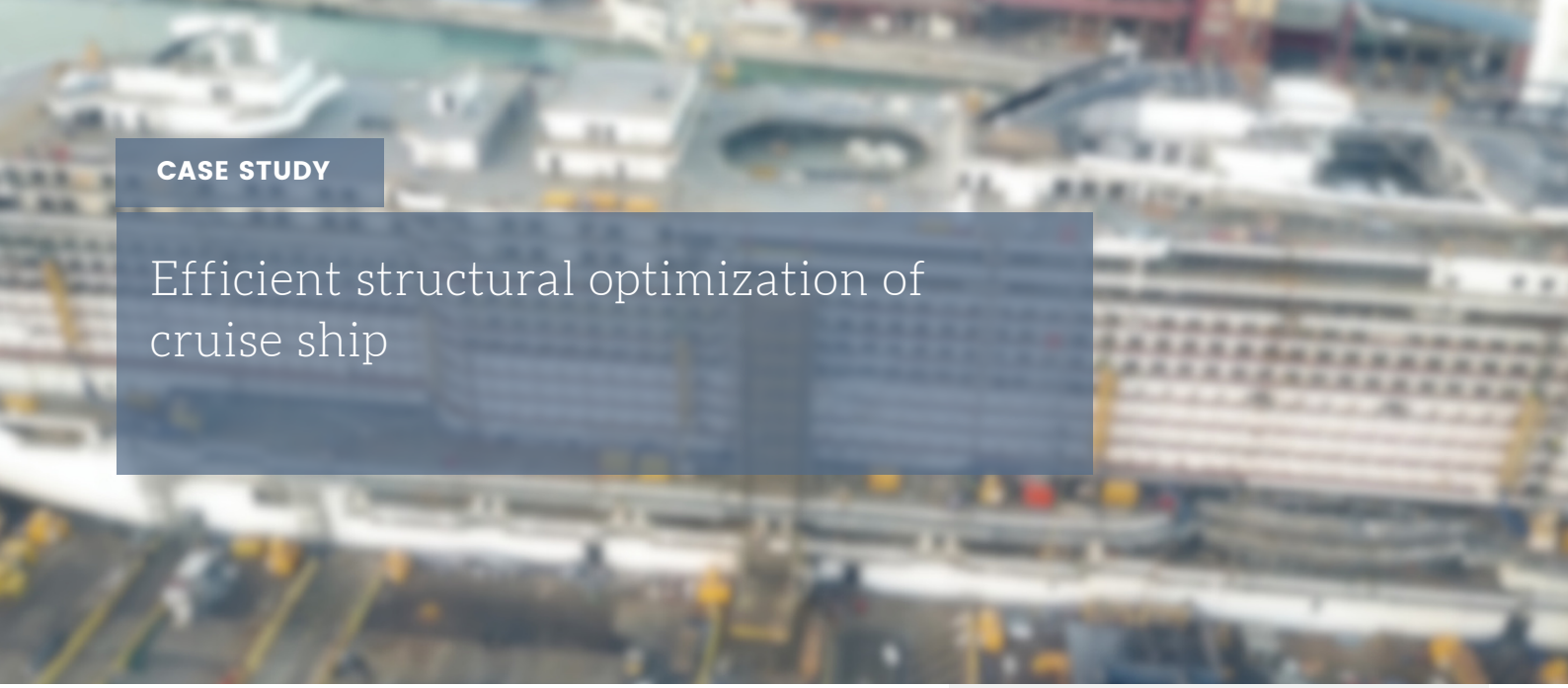


CASE STUDY

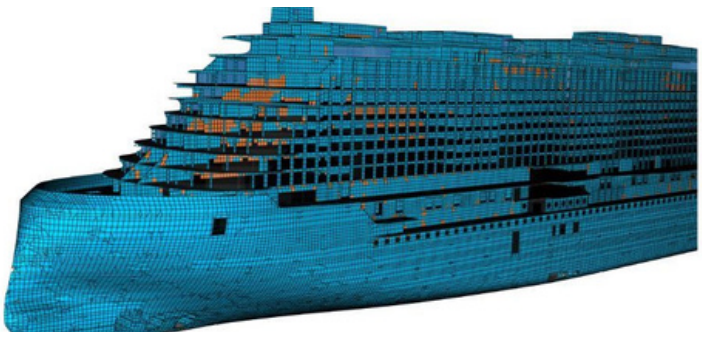
Efficient structural optimization of cruise ship

OBJECTIVES

This project provided an optimization pipeline for the structural design phase of passenger cruise ships hulls.
The resulting semi automated pipeline is able to reduce costs and steel usage, while respecting regulatory, safety and manufacturing constraints.

ACTIVITY

The hull model is parameterized by the thickness of its steel plates, grouped by structural role; the validation of a design entails a Finite Element Analysis (FEA) and post-processing of the results, taking up to 1 hour of designers' time.
The construction of a data-driven surrogate model based on the commercial FEA solver NASTRAN, built by coupling reduced order modeling and machine learning, provides an approximated result in just 1 second. At the preliminary cost of a reduced number of full FEA simulations, the subsequent surrogate proves accurate enough to cheaply evaluate a large number of configurations, so that only the most promising candidates are then validated and used to further increase its accuracy.
Multi-objective and Bayesian optimization select configurations with the best trade-offs between competing criteria (e.g. lighter mass, versus resistance to deformation) or including problem-specific constraints,

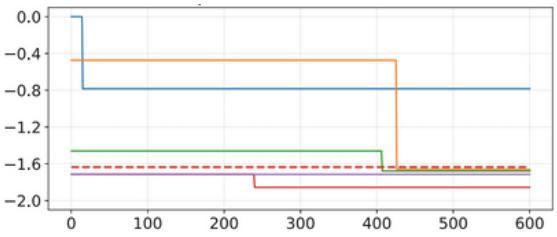


Goals

- Reducing use of material so descreasing the total mass
- Reducing fuel consumption
- Reducing time for designing

Benefits

- 16.5% less material
- 60% less time for design phase



RESULTS

Starting from the initial prototype of an actual cruise ship hull, the automated pipeline was able to reduce the total mass and cost by 6.5% and 6% respectively, corresponding to 16.5% of the quantity explicitly controlled by the 76 parameters.
The entire process took only a third of the time an expert designer would have required, for the same result.