Summary

Because of the recent introduction of standards like the new European crane standard EN13001 [18] which require evaluation of a lot of load cases, a suitable way to check for buckling is required. This cannot be done using FE-modeling, as direct calculation of the buckling risk is time consuming and not directly compatible with the method prescribed in standards. The buckling check is concentrated on plate buckling, because global buckling of the structure can easily be checked with a FEM simulation. Lots of structures use plates in their construction, often in the shape of hollow beams. These plate are likely to buckle, which has to be prevented. To keep the overall weight of the structure down the plate stiffening should be optimized.

The assignment is divided in three parts:
Find a method to determine the sizes of the plate fields and the beam lengths (from a FEM model):
To increase calculation speed a FEM model of a crane is usually constructed using beam elements. Using this model the stresses in the cross sections of the beams are found. The disadvantage is that the walls of a beam element are incapable of buckling. To check for buckling shell elements can be used but this increases calculation time significantly. The design norms use the stress distribution in the cross section to do a buckling check based on quick calculations. The input needed are the sizes of plate fields and the beam lengths. This means a method has to be found that finds the locations of the stiffeners and the edges of the plate. No such method exists.

Find a method to translate the stiffness of the surrounding structure into the sub model
It was evaluated to what extend the stiffness of the surrounding structure is used for calculation using the design norms. It turned that the only relevant support condition is whether a plate is supported on three or four edges. To get this information to the sub model a method like in the first assignment is needed.

Find optimization rules/methods to prevent buckling in the most efficient way.
Optimization was defined as making the structure strong enough, but as light as possible. The found optimizations methods can be divided into two categories, improve the calculation of the buckling factor limit and optimize the aspect ratios of the plate by placing the stiffeners at their optimal location.
The first method lowers the safety factor which allows for a lighter construction, but it can also make the plate stiffener assembly more venerable to imperfections and effects that could previously be ignored. Another disadvantage is that the calculations are no longer approved by the design norms, which can be a problem.
By optimizing the aspect ratio of the plates they can be made thinner whilst still complying with the design norms. The stiffeners can also be designed according to design norms, but because they are placed at their optimal location less can be used or the stiffened plat can be lighter. The disadvantage is that the optimal solution differs per load case.