Summary

The significant adverse contribution of the construction industry to greenhouse gas emissions and natural resource depletion has to be reduced. Regarding jetty platform structures, this challenge can be faced by designing for reusability, a promising concept for environmental impact reduction. However, this principle is not yet being widely implemented, leading to the absence of reusable jetty structures. This research aims to identify the feasibility of designing a jetty platform for reusability and the contribution of reusability to the environmental impact reduction of jetty platform structures.

A jetty, that is being constructed in the port of Rotterdam during the execution of this research, was taken as a reference structure. By creating a design according to the Design for Disassembly requirements, while fulfilling similar functions as the reference jetty, a concept of a reusable jetty platform design was created. A numerical prediction model was created in the SCIA Engineer software so that the global behaviour and robustness of the structure were found when using simple connection solutions. Next, demountable connections were designed based on existing configurations from other applications. The practical aspects of assembly and maintenance were assessed through an interview with a maintenance expert from Port of Rotterdam. Furthermore, a brief study was done to investigate the possibilities of modularity and applicability to other jetties in the port. To quantify the environmental impact reduction, a life cycle assessment was performed, in which the impact of the reference structure was compared to that of three reusable structure variants: the reusable design, the modular reusable design and the modular reusable design using concrete with a lower impact.

Due to the use of simple connections in the reusable jetty design, discontinuities in the displacements are found between elements. These cause limitations in the flexibility of placing the superstructure and may cause deformations in pipelines when those are placed on the platform. Therefore, a solution was presented to mitigate the discontinuities. Also, the reusable jetty has to be constructed with a larger crane than is conventionally used, which may cause hindrance to the surroundings. However, the duration of construction will be reduced. The results of the life cycle assessment show that the initial impact of each reusable variant was larger than that of the reference jetty. However, already for reusing once in the structure’s lifetime, this investment can be compensated when compared to replacing the reference jetty with a new structure. When assuming a structure is reused or needs replacement once during its lifetime, a tipping point was found when 24 to 44% of the structures are being replaced or reused, at which the investment is compensated. When not constructing the platform entirely directly, but adapting it when future requirements become more certain, potentially no investment is needed to be made.

From the results, it can be concluded that reusability contributes to lowering the environmental impact of the jetty platform when it needs replacement or reuse at least once during its lifetime or when the given percentage of the structures are being reused once during this time. Thus, reusability can be applied to reduce the environmental impact of jetty platform structures.