Summary

In 1973 EMO invested in two bulk ship unloaders with a capacity of 50 tons. Nowadays the unloaders serve for more than 35 years, by which it will be unsure how long the bridges still can serve safely. To ensure the safety and reliability of the ship unloader a finite elements model will be made which can describe the critical points in the steel structure of the bridges. This model can be used to calculate the current state of fatigue of the cranes.
The input of this model starts by collecting the actual loads on the trolley and bridge. A plan to measure the required values is made in which as many as possible existing sensors and strain gages can be used. The plan consist of the use of the sensors on the trolley as the strain gages in both direction in the load axes at the front of the trolley and data as grab height, trolley location and slewing angle. On the bridge itself some strain gages will be placed to verify the loads on the trolley and to measure the effect of the wheel load in the triangular suspension.

The installation of the data logger and the few new strain gages will be outsourced to ensure no technical problems of the ship unloaders and to get reliable results. Due to this outsourcing the measure data would not be available within the time domain of this study and the analysis of that data therefore is not included. This report do include an advice how to analyze the data.

The report continues with a study to the dynamic load factors on the trolley and bridge. This dynamic load factor is the ratio between the static load of a filled grab and the dynamic peak load of the hoisting movement.
A rough estimation of the load factor is about 1.3. This values is based on a static load of grab plus load and a peak load of the static load plus the maximal vertical acceleration of the grab and an extra addition of 10% to include friction and cohesion.

From the norms the dynamic load factor for a bulk ship unloader like these two should be built with a load factor between 1.5 and 2.2. The large gap between the values can be caused by differences in the definition of the load factor and by technical systems that reduce load peaks.

The load factors calculated from collected data of Techno Fysica and EMO resulted in a less spread list of load factors. An export of the grab load out of the operating system of the crane resulted in a load factor of only 1.28. Digitized graphs of Techno Fysica of the strain in the frontal legs of the trolley resulted in a load factor of about 1.88 by the trolley on the bridge. The last method that was used to calculate the load factor was a mass-spring model of grab and trolley and resulted in a load factor of 1.36. The input of this model is based on the measured dat of load case F (Techno Fysica b.v., 1998).

TABLE 1: VERSCHILLENDE HIJS FACTOREN

Norm	Load factor ψ
EN 13001	1.5 – 1.7
NEN 2018	1.9
DIN 15 018	1.9 – 2.2
EN 15 011	1.8 – 2.8
3.4 – from Grab load	1.28
3.6 – from Trolley load	1.88
3.7 – from Simulink model	1.36

The dynamic load factors described in the norms are in general higher than the calculated values. An exception is the load factor from the strain in the frontal legs of the trolley, which is maximal 2.7 if only one strain gages is analyzed at a time. However the stress will be very low and fatigue is no issue in the trolley.
More likely is the load factor from all strain gages together. Then the maximal load factor is 1.88 and the average load factor is only 1.4.

From the calculated load factor it can be assumed the norms prescribed a higher load factor, which was expected. An indication of the load factor cannot be made because of the rough and inaccurate measure data.