Summary

Transport of containers from port to port is done by container vessels. For the transfer of containers from vessel to shore quay cranes are used. A quay crane transfers containers from all locations at the vessel to shore. However, vessels for the transport of containers have different dimensions and capacities. Capacities of these vessels ranges from 0 to 14,000 TEU. In between these boundaries, vessels vary in capacity. The variety in capacity can be divided in classes. Eight classes are assumed, in which all container vessels can be divided. The minimum container width of vessels in this report is determined. The smallest container width is seven containers. This means for the first seven locations in the beam, hosting takes place for every arriving container vessel. Hoist locations located further away from the quay are not liable to the hoisting of containers from vessels with the smallest container width. The most outer point of the beam of the quay crane is only used for hoisting containers from vessels in the largest class. This outer point has a hoisting percentage of 0.02 %, which shows it is relatively low in use for the hoisting of containers. The hoist location of containers in the beam, based on the arrival of container vessels is not taken into account by standards like the NEN.

Based on the assumed container width of vessels and data from Dynaliners, the percentage of containers hoisted at a specific location in the beam can be determined, which leads to percentages of hoisting, for twenty different locations in the beam of the quay crane. The hoist of containers leads to forces and moments within the beam. These forces are important for the determination and design of the crane, because a force which is too high can lead to fatigue.

For the design of a quay crane, the load spectrum has to be determined. The load spectrum characterizes the extend of load of an element hoisted by a quay crane during work time. This load spectrum together with the class of utilization leads to the crane group of the quay crane. If utilization class C is assumed, described in NEN 2018, the number of cycles to fatigue lies in between six hundred thirty thousand and two million cycles. If the load spectrum is assumed to be two, the quay crane is divided in crane group five according to NEN 2018. The division in a crane group class is necessary to determine the group factor, which is important for the evaluation of the load combination. This load combination is the sum of the force due to its own weight, multiplied by a factor called the dynamic response factor and the force due to the load, multiplied by the group factor.

This load combination is the total load on which a quay crane has to be liable by the NEN 2018. The load on the quay crane leads to stress in the beam. The beam is a construction with under tubes and upper tubes, which are attached with each other by diagonally placed I profiles. The load combination on the quay crane leads to stress in all these components. If the stress in these components is determined, based on load combination at different location in the beam, stress based on the hoist location is determined.

If for all hoist locations the stress in one cycle is determined the minimum stress and maximum stress in a cycle of a specific hoist location can be determined. The difference between the minimum stress and maximum stress divided by the actual stress which is 90 MPa, gives the proportion. If this proportion has exponentiation of three or five, based on the number of cycles and the stress, the total number of cycles to fatigue can be determined of a hoist location. The number of cycles to fatigue has to be divided by the maximum of two million cycles. Two million is the number of cycles to fatigue based on the crane group. With previous calculation the damage per cycle is determined at a hoist location. Now the number of cycles to fatigue at a location in the beam can be determined. This is done if one is divided by the sum of the damage per cycle and multiplied by the hoist percentage of all hoist locations.

If for the important locations in the beam the number of cycles to failure is determined, based on the hoist percentage, the lowest number of cycles to fatigue can be determined. If this is determined for the location above the front legs, the first, fourth, ninth, fourteenth and fifteenth hoist location the lowest number cycles to fatigue in these important locations can be compared. The lowest number of cycles to fatigue is determined, which has a value of nine hundred thousand cycles to failure located in the construction profile above the first hoist location.

With a minimum number of cycles of 1,250,000, the second minimum number of cycles to fatigue is also in the construction profiles located at one third of the distance between the front leg and the point of attachment between hanging and the beam. The third minimum of cycles to fatigue is also 1,250,000 and is located just behind the point of attachment in the upper tube. If the hoist percentages are not taken into account, the minimum number of cycles to fatigue changes to four hundred fifty thousand. The top three of minimum number of cycles determined with the hoisting percentage show that the percentages of hoisted containers at a specific location have a considerable influence on the minimum number of cycles while it is not taken into account by the standards.