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Eliminating error

A new concept in handling mega-ships

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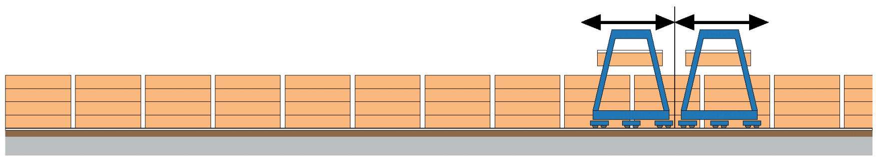
Bigger ships mean more moves per call, which in turn means a logical requirement for additional berth capacity, or so conventional wisdom would state. This article contends that upgrading berth capacity alone in order to tackle mega-ships will lead to congestion throughout yard facilities. I believe that additional capacity can be achieved whilst avoiding the spectre of congestion by improving the efficiency of each quay crane at a berth and by increasing the number of quay cranes on one ship.

The NGICT concept

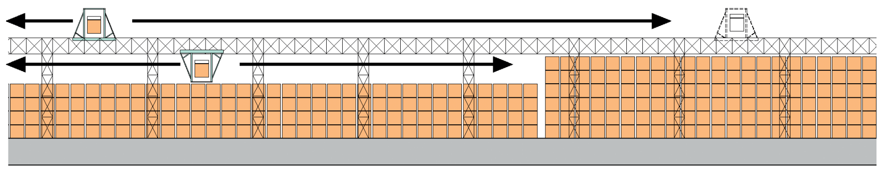
Because the new generation integrated container terminal (NGICT) concept is so expansive and there's limited space with which to explore the many facets and nuances of the concept in this article, this piece touches only the main characteristics of this new concept and focuses on the stack area in most detail. This is because increasing the speed of stack operations is a direct challenge for every terminal in the world.

The main characteristics of the NGICT concept are as follows:

- Narrow ship-to-shore (STS) crane modules on high positioned rails which are able to work in adjacent bays of a ship
- A fixed support-structure in the STS area with waterside columns around 30m behind a quay wall
- The STS area and the stack area are fully integrated. This reduces the travel distance between these two areas for each container
- The STS area crane modules put containers on top of a two-directional AGV which operates parallel to a quay until the designated stack lane has been reached. At this point, the two-directional AGV drives over a short distance in a perpendicular direction until a container is underneath stack overhead bridge cranes
- The special stack overhead bridge cranes can pass each other in one



STACK LENGTH 200 / 500M



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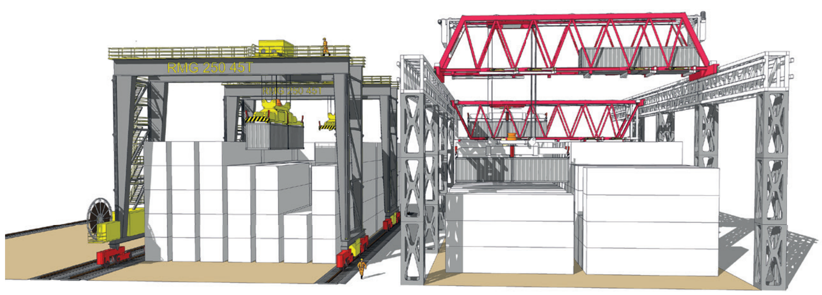
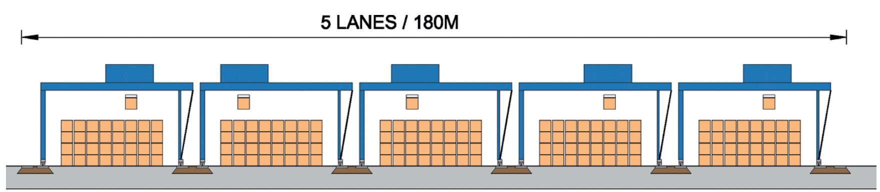
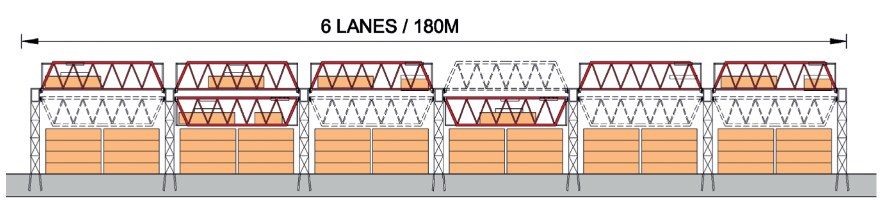
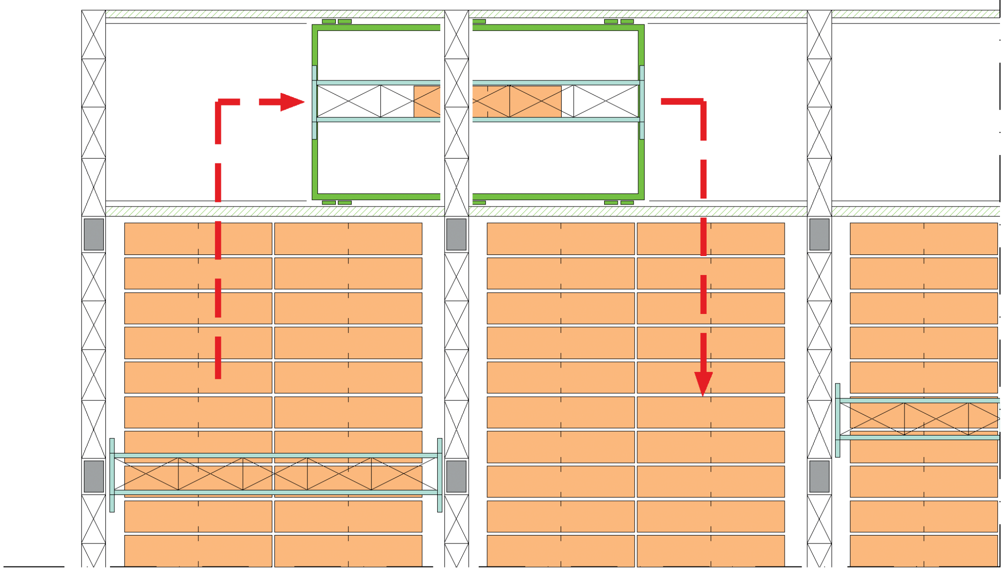


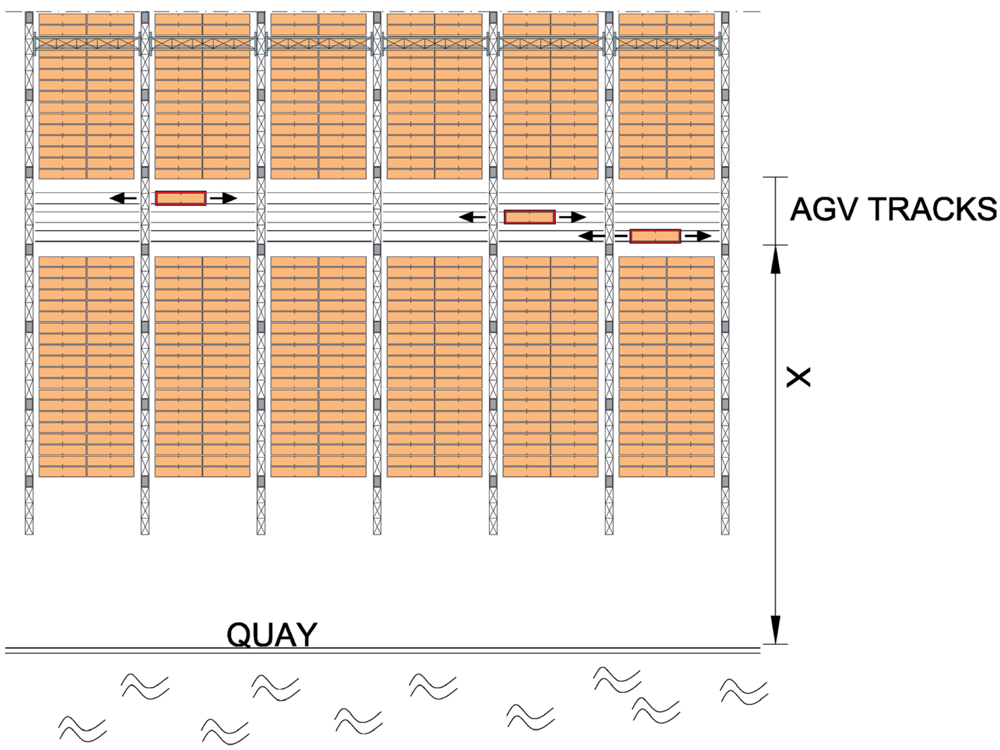


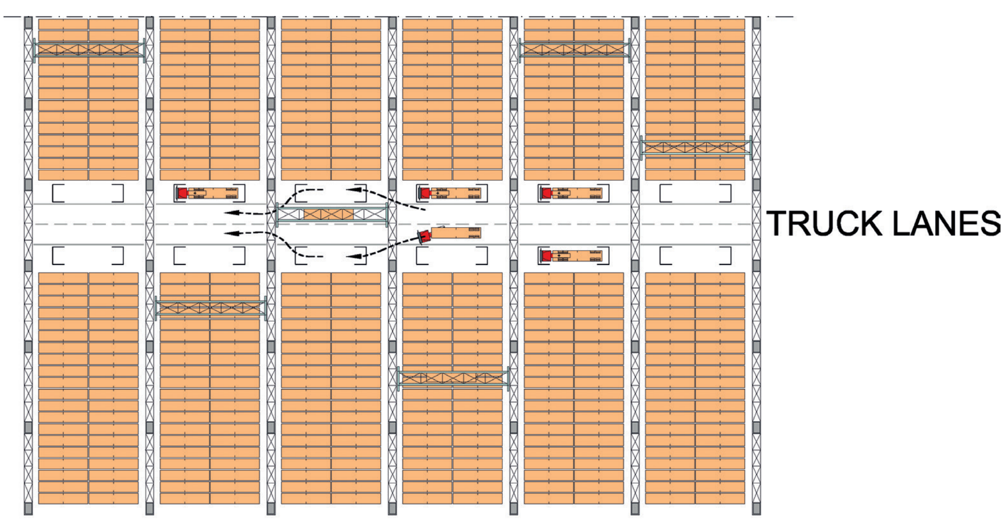
RMG'S STACK DENSITY 1500 TEU/HECTARE
STACK 1 OVER 4 PERPENDICULAR TO THE QUAY



OHC'S STACK DENSITY 1900 TEU/HECTARE
STACK 1 OVER 4 PARALLEL TO THE QUAY




AGV TRACKS
X
QUAY


TRUCK LANES

and the same stack lane and drive perpendicular to the quay from an STS area to a truck and train area. This way no other horizontal transport devices at ground level are needed

Stack operations: overhead bridge cranes

As automation becomes the key driver for efficiency in container terminal operations, it is important to remember that innovation began initially with RMG's and, at a later stage, RTGs. Although OHBCs (overhead bridge cranes) at that time were equal in multi criteria comparisons to RMGs, they did not become the standard and dropped out of sight. Only a few terminals in the world have chosen an OHBC configuration since automation, and after this, the OHBC case has not been easy to argue.

Since that time, there has been no development in the OHBC-system at all, and in the meantime, the RMG and RTG cranes have reached a very high level of automated technology. Nowadays, at many automated terminals, stack operations are carried out with RMGs that are generally aligned perpendicular to the quay. Each stack lane has two RMGs running on the same set of rails on ground level. The length of stack lanes vary between 250 and 400m, and the stacking height is 1-over-4, or 1-over-5.

OHBC vs RMG

Despite this optimal state-of-the-art process, we cannot close our eyes to the logistical disadvantages which occur in the case of variations in workload. In all studies, the RMG and the OHBC have had the same problem; they cannot pass each other in the same stack lane. Since we have solved that problem by inventing an 'upper-OHBC' and an 'under-OHBC', which are able to pass each other in one and the same stack lane, it thus becomes possible to double the stack performance and to follow production changes between water side and land side demands.

For example, in one stack lane, two OHBCs are working at the water side and one OHBC at the land side. In long stack lanes, more than three or four OHBCs could be installed to achieve higher performance and a better distribution of the workload. As said before, the special OHBCs are made in two models, one with a so-called 'under frame work' and one with an 'upper frame work'.

The rails for the 'upper OHBC' and for the 'under OHBC' are connected to one common girder and supported by common columns (see Figure 2). The height of the columns can be adjusted to the number of stacking layers of containers. By the trussed-frame, the weight of an OHBC is much lighter than the weight of a usual overhead crane and therefore much faster and energy saving. Above that, a trussed-frame affords the space to carry a container completely inside a crane.

Each OHBC can be equipped with an extra support system across the bottom members that makes it possible (by using one spreader) to carry two 40ft containers at the same time. Another advantage of the system is that it offers maximum redundancy because the 'upper OHBC' is able to carry the 'under OHBC' in case of a breakdown, and the other way round. This level of flexibility would result in a higher performance for the whole stacking process.

A standard OHBC costs less than 50% of a standard RMG, while its weight is approximately 15% to that of an RMG. Furthermore, the travelling speed is higher, the energy consumption is lower, and last but not least, the stack density is much higher.

Structure

The support structure for an OHBC, consisting of standard steel columns and trussed girders including piled foundations, is built uniquely due to an inventive and integrated modular design which is very economical. The stack density is almost 30% higher than in the case of RMG's.

Cost benefit

For a 'block' within the stack area that consists of 6 stack lanes (180m wide and 300m long) with two OHBC's per stack lane (12 in total), the investment will be at least 20% lower than a traditional configuration with 10 RMG's in an equal area. The savings on operational costs per TEU are much higher.

Placement

Positioning an OHBC in another stack lane can be done by a 'shunter' at the end of a stack lane. Due to the ability to vary the number of OHBC's over the length of one stack lane, we found that even on a terminal with a high transhipment rate there is no need to choose side-loaded systems parallel to the quay (unless other factors are more determined). In case of very high transhipment rates, an extra one directional AGV transport lane parallel to the quay across the perpendicular stack lanes will be sufficient (see Figure 5).

The distance between the quay and an extra lane, and the number of AGV tracks in this lane, will follow from the logistical calculations. All movements in this extra lane reduce the movements in the STS area. Also, the total transport distance of a container will be much less than in case of a side-loaded RMG system.

Another important advantage of the OHBC configuration is that truck loading can be fully integrated within perpendicular stack lanes so the driving direction can be parallel to the quay without any backward driving at all. Therefore, coupled combinations of 3 x 20ft are also possible (see Figure 6).

Conclusion

Although in this article I have confined myself to stack operations, it may be clear that with a higher performance in stack operations, it will be possible to achieve a higher productivity of STS cranes as well. Simulations carried out by TBA Netherlands have shown the industry that the productivity of a current STS crane working with two-directional AGV's could increase productivity by almost 70%, while the number of AGV's per quay crane can be cut down by 50%. This very positive effect shows that the implementation of the NGICT stack configuration on existing terminals can lead to much higher performance. However, the utmost profit of the OHBC configuration will be achieved when the stack area is fully integrated into the ship-to-shore area, which is one of the main principles of the NGICT-concept.

About the author

Frans Koch, founder of the Koch Consultancy Group (1994), forms together with his son Mathé, the general management of the team of engineers and architects in the Netherlands who constitute Koch Consultancy Group. Both Frans and Mathé are both registered designers and hold a PMSE in structural engineering.

About the organisation

KOCH Consultancy Group
Engineers & Architects

Koch Consultancy Group consists of Raadgevend Ingenieursburo F. Koch B.V., Allant Architecten B.V. and Koch Projectmanagement, a local multidisciplinary organisation of consultants, architects and engineers. Its portfolio concentrates on projects in favour of industry, harbour and marine structures, civil works, buildings, energy production plants and wind turbines.

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