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Bullets on the move

To illustrate some of the skills and techniques described in previous The Knowledge articles, MARCO VAN DAAL presents a case study of a major moving and lifting project

The day the bullets came to town

In this series of The Knowledge articles, this is the first case study. Originally these studies were intended to be included at the end of the series of technical articles but this project was so unique and impressive it was decided to not withhold it.

The project comprises the transport of eight giant bullet tanks manufactured in the European country of Belgium and transported to Denmark where they were placed on an unconventional sand bed foundation.

Between the origin in Belgium and destination in Denmark the bullet tanks were transported from the factory onto a barge by means of a roll-on roll-off (ro-ro) operation. The barge sailed to Rotterdam in the Netherlands where the bullets were offloaded using a floating crane onto self propelled modular transporter (SPMT) that carried the bullets to a temporary storage facility.

When the heavy lift vessel arrived in Rotterdam, the bullets and two sets of SPMT went to Denmark where the transport over a 6.5 km route to their final destination took place. Each bullet was placed on a sand bed with the use of two crawler cranes in tandem lifts. The focus of this article is the transport in and the lifting operation in Denmark. The operation from Rotterdam to the final destination in Denmark was undertaken by Royal Wagenborg from the Netherlands.

About the tanks

These were not your average bullet tanks, these were huge, not only in weight (325.5 tonnes) but also in size. They were 38.5 metres long by 8.7 m wide and, loaded on the SPMT, 12.6 m high.

With the bullet tanks Wagenborg had to cross a town between the port and the job site. This was as much of a challenge as it was an opportunity to show how well prepared the team was and how professionally this part was executed. The route was painstakingly analysed and every traffic light, street light, road sign, tree and any other obstruction was documented and identified for (temporary) removal. All eight bullets were transported through town in sets of two on alternate days and, with the assistance of the local authorities, this went flawlessly and was every bit as impressive as the lifting operation.

The transport

For the transport in Denmark, Wagenborg opted for a double 16 axle line Scheuerle SPMT with two power packs of 350 kW each, which resulted in loads as follows:

TRANSPORTERS: 32 axle lines * 4 tonnes/ axle line + 2 PPU * 7.2 tonnes/PPU = 142.4 tonnes
BULLET TANKS: 325.5 tonnes
TOTAL WEIGHT: 467.9 tonnes
AXLE LINE LOAD: 467.9 tonnes / 32 axle lines = 14.6 tonnes per axle line
Axle load:14.6 tonnes per axle line / 2 axles = 7.31 tonnes / axle

With a maximum axle line load of 32 tonnes (including self weight) this put the transporter at 14.6 tonnes / 32 tonnes = 52 % of its capacity in static condition (no dynamic forces taken into account).

As for the ground pressure, always a controversial topic, the shadow area below the transporters was taken to determine this. The total shadow area was as follows:

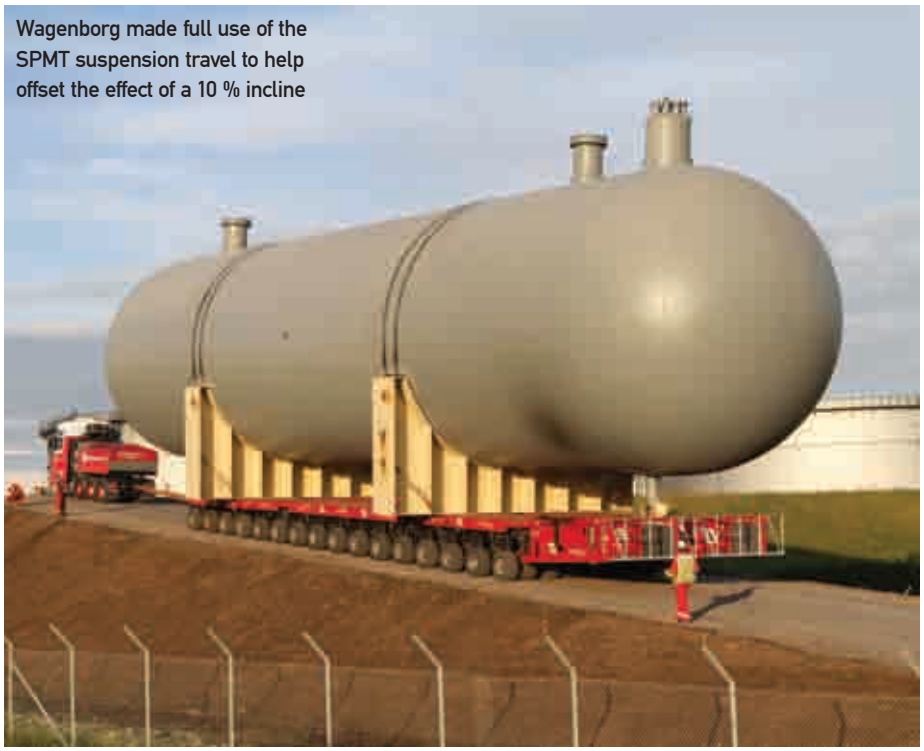
2 x SPMT x Length x Width = 2 x (16 x 1.4 m) x 2.43 = 108.86 square metres.
Ground pressure = total weight / shadow area = 467.9 / 108.86 = 4.30 tonnes per square metre.

The use of a double wide SPMT combination ensured transverse hydraulic stability angles of 11.9 degrees and transverse structural stability angles of >

ABOUT THE AUTHOR

Marco van Daal has been in the heavy lift and transport industry since 1993. He started at Mammoet Transport from the Netherlands and later with Fagioli PSC from Italy, both esteemed companies and leading authorities in the industry. His 20-year plus experience extends to five continents and more than 55 countries. It resulted in a book *The Art of Heavy Transport*, available at: www.khl.com/books/the-art-of-heavy-transport/

Van Daal has a real passion for sharing knowledge and experience – the primary reason for the seminars that he frequently holds around the world. He lives in Aruba, in the Dutch Caribbean.



Wagenborg made full use of the SPMT suspension travel to help offset the effect of a 10 % incline

12.2 degrees, sufficient to carry out the transport in a safe manner.

Once the transport reached the site location the gross vehicle weight (GVW), comprising the transporters and the bullets, of 467.9 tonnes embarked on the last challenge, a 10 % slope leading up to the final resting place of the bullets. Wagenborg's engineers determined that for this last stretch a tractive effort was required as follows:

GVW * (rolling resistance + incline) = 467.9 * (4% + 10%) = 65.5 tonnes

Note: the rolling resistance on a flat and dry asphalt road measures approximately 3 %. The site road was a well compacted sand road, but a sand road nevertheless, so an increased conservative rolling resistance of 4 % was assumed.

The Scheuerle SPMT used was 4 x 6 axle lines and 2 x 4 axle lines, making 32 axle lines in total. Each 4-axle line unit and each 6-axle line unit comes with 4 drive axles, for a total of 24 driven axles on this transport combination.

Plan showing a multi-point turn to negotiate urban streets

With an average traction of 5 to 5.5 tonnes per axle, a conservative total of 24 * 5 = 120 tonnes of tractive effort was available, which was more than sufficient for this climb.

Power capacity

The required power pack unit (PPU) capacity is often a subject of debate; driving, steering and pumping can all take place at the same time and all draw power from the PPU. In addition, a slipping axle (for whatever reason) takes a large portion of the PPU power. As a safe rule of thumb it can be stated that every 10 axle lines require approximately 75 kW. With 32 axle lines this transport would require a minimum of 240 kW.

The actual combination used two PPUs of 350 kW each, again more than sufficient for its purpose. Nothing was left to chance, however. As part of the risk analysis Wagenborg assumed a worst case scenario where one PPU would fail and the 10 % climb would have to be made with one PPU. Theoretically, even one PPU of 350 kW would be able to complete this transport but to be absolutely certain that this incline would be completed all eight times without any hiccups, a prime mover was attached to the front of the SPMT using a sling and a specially fabricated bracket. The prime mover, capable of generating an additional 16 tonnes of raw pulling force gave that sense of security that the client appreciated.

An operational detail during the climb, as shown in the pictures, was that the transporter deck was lowered at the front and raised at the rear to offset some of the 10 % incline.

The lift

For the lifts of the eight bullets Wagenborg mobilised two of its largest lattice boom crawler cranes to Denmark along with all the required rigging and a boat load of crane mats. They were a 400 tonne capacity Liebherr LR 1400 and a 350 tonne capacity (Terex) Demag CC 2200, both equipped with main boom and superlift ballast.

The CC 2200 was set to a lift radius of 19 m, which gave a capacity of 188 tonnes or 69.6 % of the chart once the superlift tray was lifted off the ground. The Liebherr lifted its end of the bullets at 20 m radius, which gave it a capacity of 177 tonnes or 72.1 % of its chart once the superlift tray was floating. Combined capacity was 188 plus 177 = 365 tonnes to lift the 301.5 tonne (325.5 minus two saddles of 12 tonnes each) bullets, plus hook block and rigging.

For the lift operation itself the bullets were manoeuvred in front of the foundation where the rigging was attached. The bullets were belly slung with nylon

Wagenborg Liebherr LR 1400, in the foreground, and (Terex) Demag CC 2200 lattice boom crawlers, placing one of the eight bullet tanks on its unconventional sand foundation

belts to facilitate a quick turnaround. The rigging layout was cleverly designed in such a way that it could all be hooked up and attached at ground level without the cumbersome use of man baskets or man lifts.

The bullets were then lifted from their saddles to sufficient height to clear the foundations and sand beds and both cranes walked to the far end of the sand bed foundation to lower the first bullet in its final place.

The carefully laid out crane mats, hundreds of them, ensured that the ground pressure imposed by the cranes never exceeded 10 tonnes per square metre.

Worth mentioning is the fact that the operator in the Demag crane was performing the lift blind as he was working from behind a foundation wall that completely blocked his view. Dry runs and clear communication with agreed terminology made even this part of the project go smoothly. At a rate of two bullets a day, this part of the project was completed in just four days.

Smart thinking

To make this project a bit easier to execute, the engineering and fabrication departments at Wagenborg worked together and designed some add-ons on for the transporters. First, they designed a fold-up platform for the PPUs. This allows the operator to stand on it during transportation but, in tight turns, he can step off the platform, fold it up (without taking it off) and continue the transport.

The other clever thing they came up with was a mini superlift tray. You might think that this is nothing out of the ordinary but it is more the application than the manufacturing. This mini superlift tray is yet another sign of how well prepared this project was.

Once the bullets were set down, the superlift tray also sat on the ground. It would take multiple trips back and forth to bring all superlift ballast back to its origin. The mini superlift tray was part of the original superlift tray during the lifting operation. When the bullet was disconnected, the crane rotated 180 degrees and picked up the mini superlift tray from the original superlift tray. With 100 tonnes of the total of 190 tonnes, the crane once again rotated 180 degrees back and connected the original superlift tray. Now that the crane carried 100 tonnes in its main hook, it could boom down sufficiently to let the original superlift tray float and the entire superlift arrangement was taken to its origin in one shot. A well planned and well executed project. ■

NOTE: Every effort is made to ensure the accuracy of the contents of these articles. If you find any mistakes, a brief notification and explanation would be appreciated.