Are rules needed on trailer stability?

Heavy lift specialist Richard Krabbendam asks whether there should be internationally accepted stability criteria established governing the transport of over-dimensional cargo.

It was October 2009 when I addressed the World Crane and Transport Summit in Amsterdam with a paper entitled ‘Rules on trailer stability are needed’. The audience agreed with me that the industry should work on some transportation guidelines concerning stability issues. The strange thing about this is that we do have stability rules in place for ships (from the International Maritime Organization) as well as for cranes, but up to now nothing has been agreed upon regarding stability criteria concerning the transport of over-dimensional cargo (ODC).

Although a committee was established by ESAA (European Schwertransport-Automobilkran Association) and the Specialized Carriers & Rigging Association (SC&RA), and input from various companies has been discussed, there are still no accepted rules concerning stability issues of heavy and oversized loads being transported on hydraulic platform trailer (HPT) units. Let me try to discuss the guidelines, which should be adhered to when stability of a heavy and high load becomes critical.

When a heavy load is being transported, we first have to select the right trailer for the job. Depending on the weight and the size of the object the trailer can be selected on the basis of various criteria, which are all determined by – but not limited to – a number of issues such as:

- Is it a short distance site move or a long haul on public roads?
- What is the road condition? Dirt road, asphalt, any cambers, turns and so on?
- What kind of axle line loads can be accepted on the public roads and bridges?
- How high is the centre of gravity (CoG) of the load above its base?
- What obstacles are expected along the transport route?
- Are there any gradients, cambers, narrow areas, ravines and so on?
- What is the maximum allowable ground load?

Based on that set of criteria a good start to select the right HPT is to take the weight of the load in tonnes and divide that by 25-tonne/axle line in order to establish the required number of axle lines needed. One axle line is
defined as consisting of two axles, each with four tyres on a 3 m wide HPT (see Figure 1, page 71). The number of axle lines must be rounded off to a multiple of four or six, as these trailer units are most commonly in use.

Case study
Let us illustrate this with an example. We want to transport a large and long column weighing 466 tonnes, with a diameter of 7.5 m, a length of 50 m and with transport saddles 30 m apart symmetrical to the CoG of the load (see Figure 2). Dividing the weight of 466 tonnes by 25, we get the number 18.64. The next multiple of four or six-axle lines will be either 20 or 24-axle lines. With saddles at 30 m apart from each other, we cannot place a single 20-axle line, 3 m wide trailer under the load. With a trailer length of 20 m x 1.5 m (axle line distance) the HPT will be 30 m long and the saddles will be on the far ends of the trailer, resulting in an unacceptable bending moment in the trailer frame.

Would a 3 m wide 24-axle line trailer be okay then? Not really, as the trailer is now 36 m long and only 3 m wide. With a diameter of 7.5 m this results in the load having a high CoG above the trailer and consequently with critical stability. What is critical stability? When the theoretical tipping angle between the vertical line through the CoG and tipping lines is less than 8°, we say the stability is critical. With a load as shown in Figure 1, the theoretical tipping angle at a four-point suspension system is \( \text{Arctg} \left( \frac{890}{3577} \right) = 14° \), which is more than 8°, so it is acceptable.

A good rule of thumb is: when the load has a diameter that is twice the width of the trailer, you need to watch out for possible tipping of the load. How can we calculate the theoretical stability angle? To explain that we need to learn a bit more about the suspension system of a conventional hydraulic platform trailer. Although the same principles apply to self-propelled modular transporters (SPMTs) as well, I will limit it to conventional hydraulic platform trailers in this article.

Suspension systems
Hydraulic platform trailers are ideal transport means to equalise the loads between all axles. All axles are suspended by hydraulic cylinders, which are connected to each other by built-in hydraulic oil pipes and valves. Opening and closing the right valves can group the axles in a so-called three or four-point suspension system as shown in Figure 3. The lines between the coloured virtual suspension points are the tipping lines.

Figure 3 shows a 12-axle line platform trailer that can be switched to either a three or four-point suspension system. It is just the opening or closing of one valve that separates group three and four. When the valve is open, the oil can easily flow from the suspension cylinders of point three to axles in point four and vice versa. So when do we use a three-point suspension system, and when is a four-point suspension system applied?

From a mechanical point of view, we know that a three-point suspension system is statically defined, while the four-point suspension system is not. Compare it with a table on three legs where all the table legs will always be supported, even on an uneven
ground surface. When we take a four-legged table on uneven ground it will always wobble between various legs. Most of our tables are equipped with four legs, as it offers the best stability and they stand on an even ground surface.

Only when we need to roll over uneven ground surfaces do we prefer a three-point suspension system, as it equalises the loads between the axles automatically, despite the fact that it is a less stable transport combination. But we have to watch the stability, as it is a lot less than with a four-point suspension system.

From Figure 3 it is obvious that an asymmetrical suspension system offers better stability than a symmetrical three-point suspension system.

As the diameter is too large for a single 3 m wide trailer, we have selected to use 24-axle lines and configure them into two double width trailers (2 x 2 x 6 lines), each with two six-axle lines coupled side by side. In order to cope with the support saddles so far apart, we need to outfit our double width platform trailers with turntables. So a good choice would be to configure the two sets of double width six-axle line HPTs with turntables (see Figure 5). But as you can see in the picture, it seems that they are using a single wide 12-axle line platform trailer at the front and a double width 6-axle line trailer at the rear. All of them are equipped with turntables. Why has the transport contractor selected this combination and not two units, double width with six-axle lines?

Economic reasons

It is for economic reasons that a single 3 m wide trailer was chosen at the front and a double width six-axle line trailer at the rear. The HPTs cannot be moved to the client over public roads as 6.2 m wide, six-axle line trailers, instead requiring 12-axle lines (3 m wide). The transport contractor can load both 12-axle line HPTs on top of each other, as well as the two turntables, and at the client yard they take them apart and assemble one 12-axle line HPT into a double wide six-axle line unit with turntable.

By leaving the other 12-axle line HPT as a single unit, it saves the client the time required to assemble the unit into a double width HPT, and then after the job having to dismantle it again. The stability of the load is guaranteed by the double width HPT combination at the rear. Another advantage is that the longer 12-axle line trailer will point so far forward that the tractor ballast does not interfere with the column head, which could have been the case when a double width six-axle line HPT was selected.

The next article in this series will analyse some examples of trailer transport that have tipped over.

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