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Two types of stability

In his 40th article in this series of technical articles MARCO VAN DAAL discusses stability and moving centres of gravity during the execution of specialized transport projects

Last month we demonstrated that the (combined) centre of gravity moves about during the execution of a transport and that this CoG should remain inside the stability area to warrant the safe execution of the transport.

Hydraulic stability is guaranteed as long as the CoG is located inside the stability area that is found by connecting the centres of each of the suspension groups by the tipping lines. You may understand that when the CoG moves about within the stability area, one side and-or end of the transporter will be exposed to an increased part of the weight of the load while at the same time, the other side and-or end is experiencing a decreased part of the weight of the load.

This shifting can be extrapolated to the extent that the increased load exceeds the capacity of the transporter axles (suspension group) on that side or end of the transporter. In other words, parts of the transporter could be mechanically overloaded. We saw this demonstrated last month as well when showing the negative effects of a 4-point suspension configuration.

Apparently there is, besides the hydraulic stability, another type of stability. This is indeed the case and it is called the structural stability or structural capacity.

What is the difference?

Hydraulic stability is a measure of how close the CoG is to the tipping lines of the stability area. Once the CoG has crossed any of these tipping lines, you have lost control of the load and it will tip over. See Figure 1 for an example of what happens when the CoG moves outside the stability area.

The structural stability is a measure of how close an axle (or axle group) is to its structural limit (structurally overloaded).

It should be noted that when a transporter is structurally overloaded it does not necessarily mean that is will sustain structural damage. Many transporters nowadays have safety features to avoid this. One of those features is that before a transporter is structurally overloaded, the oil pressure in the suspension groups will exceed the safety valve setting and oil will be vented into ambient. Not a good situation »

FIGURE 1

FIGURE 2

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 leading companies 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-infostore.com/books Van Daal has a real passion for sharing knowledge and experience and holds training seminars around the world.

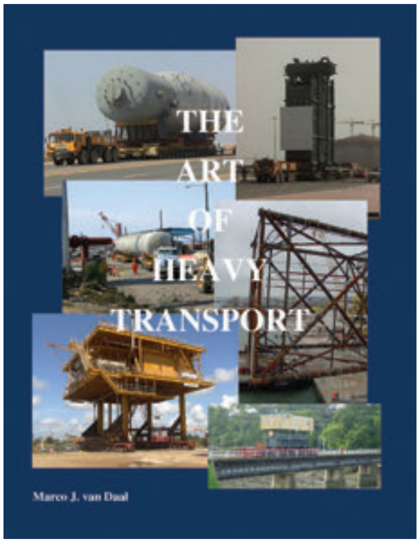


FIGURE 3

to be in (oil spill, environmental hazard, etc) but the alternative is to structurally damage the transporter running the risk that the load will be lost. See Figure 2 for an example of what can happen when the transporter is structurally overloaded.

Knowing that there are two types of stability, the next logical question would be, which one will be reached first? From an engineering and also from a practical point of view, we would want to know this because once we know which stability limit will be reached first (the limiting factor) there is no need to calculate the other stability, as it will never be reached.

In my book *The Art of Heavy Transport* (see Figure 3, available at: https://iti-bookstore.myshopify.com/products/the-art-of-heavy-transport) there is an chapter devoted to explaining and calculating which stability will be reached first and under what conditions. I will spare you the mathematical background and suffice with the conclusions.

In the case of a transporter set up with a 4-point suspension configuration (see Figure 4), the stability in both the transverse as well as the longitudinal direction follows the logic detailed below:

IF ($W_{tot} < 0.5$ * *transporter capacity*)
THEN H limiting factor
and
IF ($W_{tot} > 0.5$ * *transporter capacity*)
THEN S limiting factor
Where; $W_{tot} = W_{load} + W_{transporter}$
H = Hydraulic stability
S = Structural stability

When the weight of the load plus the weight of the transporters (W_{tot}) is less than 50 % of the transporter capacity, the hydraulic (H) stability is the limiting factor in both the transverse and the longitudinal direction.

Likewise, when the weight of the load added with the weight of the transporters (W_{tot}) is more than 50 % of the transporter capacity, then the structural (S) stability is the limiting factor in both the transverse and longitudinal direction.

In the case of a transporter set up with a 3-point suspension configuration (see Figure 5), only the stability in the transverse direction follows the logic below:

IF ($W_{tot} < 0.5$ * *transporter capacity*)
THEN H limiting factor
and
IF ($W_{tot} > 0.5$ * *transporter capacity*)
THEN S limiting factor
Where; $W_{tot} = W_{load} + W_{transporter}$
H = Hydraulic stability
S = Structural stability

In words, when the weight of the load plus the weight of the transporters (W_{tot}) is less than 50 % of the transporter capacity, then the hydraulic (H) stability is the limiting factor in the transverse direction only.

Likewise, when the weight of the load plus the weight of the transporters (W_{tot}) is more than 50 % of the transporter capacity, then the structural (S) stability is the limiting factor in the transverse direction only.

In the case of a transporter set up with a 3-point suspension configuration, only the stability in the longitudinal direction follows the logic below:

IF ($W_{tot} < 2/3$ * *transporter capacity*)
THEN H limiting factor
and
IF ($W_{tot} > 2/3$ * *transporter capacity*)
THEN S limiting factor
Where; $W_{tot} = W_{load} + W_{transporter}$
H = Hydraulic stability
S = Structural stability

In words, when the weight of the load plus the weight of the transporters (W_{tot}) is less than two thirds of the transporter capacity then the hydraulic (H) stability is the limiting factor in the longitudinal direction only.

Likewise, when the weight of the load plus the weight of the transporters (W_{tot}) is more than two thirds of the transporter capacity then the structural (S) stability is the limiting factor in the longitudinal direction only.

FIGURE 4

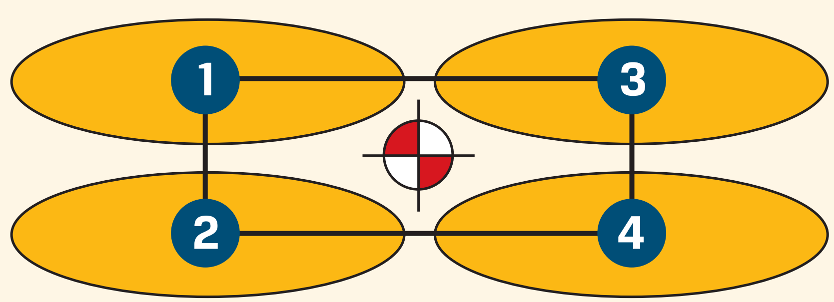
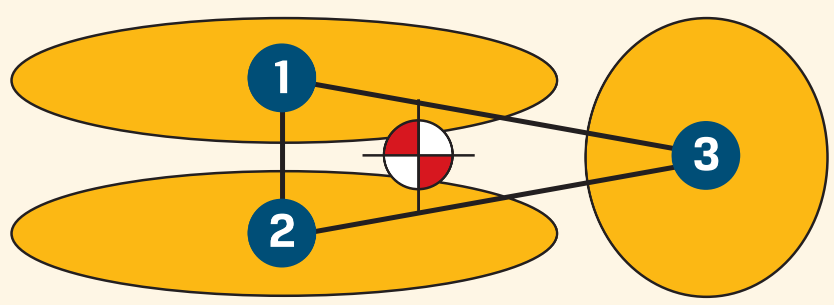


FIGURE 5



Limitations

The above theory is only valid for cases where the suspension is set up in such a way that each suspension group contains an equal number of axles. For 4-point suspension configurations this can only be the case if the number of axles (not axle lines) is divisible by four (4). For 3-point suspension configurations this can only be the case if the number of axles (not axle lines) is divisible by three (3).

A further limitation is that the CoG should be located in the centre (for a 4-point suspension) or centroid (for a 3-point suspension) of the stability area.

The theory cannot be applied to 1.5 wide (3-file) configurations. ■