

PHILOSOPHY: NEW PIANC (WG 153) METHODOLOGY FOR THE DESIGN OF MOORING HOOKS AND SUPPORT STRUCTURES



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The Problem:

- For new design or to upgrade an existing terminal, the question always comes up: What should the capacity of the tie-downs and supporting dolphins be, subject to the maximum mooring loads?
- This problem is being addressed by the PIANC WG 153 group. A final position will be announced by the end of 2014.

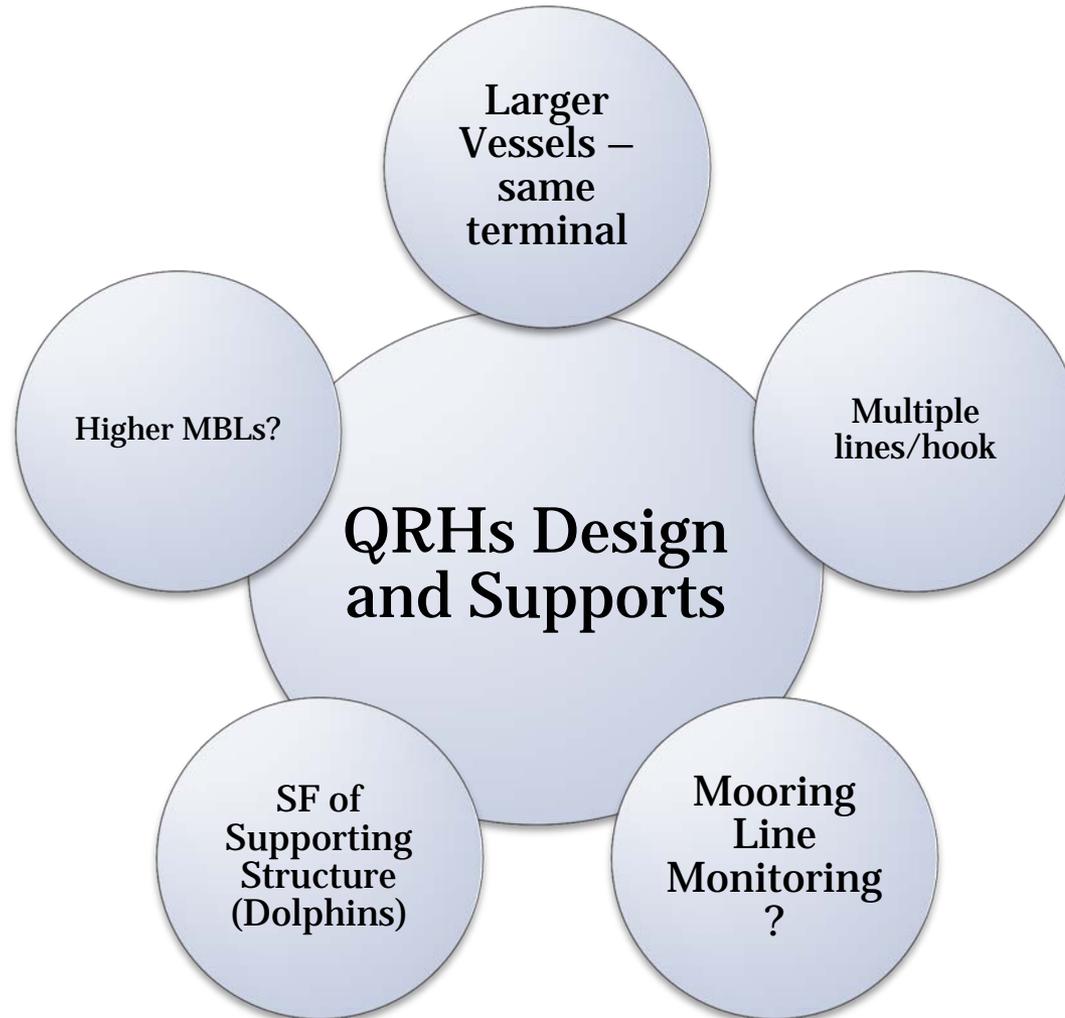




Current Status

- What's in the literature and being used by engineers?
- What makes sense, considering the range of vessel's mooring line minimum breaking strengths (MBLs), etc.
- What's different for new versus existing terminals? How should vessel growth with time factor into this, with possible higher MBLs?
- Should MBLs or SWLs be used for the determination of tie-down loads?

Variables to Consider



Current Status – MOTEMS Equation

- From the MOTEMS, Section 3103F10.1:
- *“All hooks and supporting structures shall withstand the Minimum Breaking Load (MBL) of the strongest line, with a safety factor of 1.2 or greater.”*
- The conservative equation is provided:

$$F_d = 1.2 \times MBL \times [1.0 + 0.75 (n-1)]$$

F_d = Minimum factored demand

MBL = Minimum Breaking Load of the strongest lines

n = Number of lines on the hook assembly; One mooring line/hook

What Additional Safety Factor for the supporting dolphin/structure?

Does this equation satisfy ASD or LRFD for the supporting structure?

Other Equations (British Standards)

- **Normal Condition:** (per British Standard Section 3.2.3.2)

$$\text{For } N=1, \quad UL = SWL$$

$$\text{For } N>1, \quad UL = 0.6 \times n \times SWL$$

- **Extreme Condition:** (per British Standard Section 3.2.3.3)

$$\text{For } N \geq 1, \quad UL = SWL + 0.8 \times SWL \times (n-1)$$

n = Number of mooring lines (one per each QRH)

UL = Unfactored Load

SWL = Safe Working Load of the individual quick release hook (QRH)

Other Equations Commonly Used

$$F_d = SWL + 0.50 \times (n-1) \times SWL$$

(Maybe use a factor of 0.60 instead of 0.50)

(MBL can be substituted for SWL)

- Others?

What is better - using MBL or the Safe Working Load (SWL) of the hook?

- MBLs can change, even within a vessel class, a sort of “mooring line inflation”. Once the structure is designed, QRHs expensive to modify.
- SWL – once in place, the SWL of the hook assembly does NOT change. Usually a SF of 1.25 or higher is applied as a “proof load” on the hooks.
- For the hook SWL, the design value should always be equal to or higher than the MBL.



Which MBL to Use to Size SWLs of QRHs? Recommendations of the PIANC WG 153

- Based on all mooring analyses, considering maximum metocean limitations and surge/sway limits, the following procedure was adopted by the WG 153, for each class of vessel calling on the terminal:
 - USE VESSEL WITH HIGHEST MBLs TO DETERMINE SIZE (CAPACITY) OF HOOKS.
 - SWL SHOULD BE EQUAL TO OR HIGHER THAN THIS HIGHEST MBL.
 - USE VESSEL WITH THE LOWEST MBLs TO DETERMINE THE NUMBER OF HOOKS.

PHILOSOPHY of PIANC WG 153

- SWLs are always equal to or slightly higher than MBLs. For example, if the MBL was 130T, then a SWL of 150T might be selected.
- The issue of which vessel's MBLs was discussed at length, and the logic is that using the highest MBL would provide the highest SWL values. Lesser values for the same class of vessel may require more mooring lines, and thus more hooks.
- This procedure will facilitate the strongest MBLs and accommodate the lowest values of MBLs which may conservatively require more hooks.

Dolphin Design: Capacity and Demand

- *Contradicting the existing MOTEMS equation, the philosophy is that mooring and breasting loads should be treated the same.*
- **Breasting loads** = vessel wind/current/wave forces pushing against the fender system/dolphin.
- **Mooring Loads** = induced by mooring line loads pushing in multiple directions into the hook assembly and into the dolphin.
- **Conclusion** - Both forces should be treated in the same manner – using the global safety factors associated with mooring loads. For MOTEMS, that would mean 1.0 x maximum load for ASD, and 1.6 x maximum load for LRFD. This approach treats mooring and breasting in the same manner.
- Vertical loads may be significant.

MBL or SWL?

- MBLs can change even in with the same vessel class
(growth/inflation – cannot be accurately predicted)
- SWLs are installed, and in–place, cannot be changed.
- Using the SWL is more reliable and constant, proof tested to usually at least 1.25 x actual SWL.
- **Recommend: Use SWL in the equation, not MBLs.**

What is the design capacity of the tie-down (bolts) to the dolphin?

- The final equation may be similar to:
- $F_d = SWL + 0.50 \times (n-1) \times SWL$
n = total number of hooks on the assembly
Factor is 0.50, some suggest 0.60

A final decision on the equation will be made by the end of this year.

Multiple Lines on a Single Hook (Existing terminals) - NOT Recommended

- If both lines are up to 55% MBL, could overstress the hook.
- If one line needs to be taken off, is difficult
- If there is a line monitoring system, this doesn't work.
- If both lines are not in the same service (approx. same distance/location) then hook is being pulled in 2 directions
- Appropriate combination equation for multiple hooks – no basis
- *Note: This recommendation does not apply to insurance lines.*



SUMMARY/CONCLUSIONS

- QRHs and SWL based on the strongest MBL of each vessel class calling on the terminal.
- Number of hooks based on the minimum MBL of the specific class of vessel calling on the terminal.
- SWL recommended for the multiple hook equation.
- Dolphin design/capacity based on actual loads with appropriate load factors.
- Recommend that existing terminals with larger vessels satisfy the same demand/capacity procedures.



Comments/Questions??

If you have any thoughts about these recommendations, please let me know:

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