Dynamic Torsion Load Tests for Offshore Hoses

An Update to the *Guide to Manufacturing and Purchasing Hoses for Offshore Moorings (GMPHOM 2009)*, section 3.4.10.3

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Oil Companies International Marine Forum
29 Queen Anne's Gate
London SW1H 9BU
United Kingdom
Telephone: +44 (0)20 7654 1200
Email: enquiries@ocimf.org

www.ocimf.org

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Purpose and scope

This information paper provides an update to section 3.4.10.3: Dynamic Test – Torsion Load of OCIMF's *Guide to Manufacturing and Purchasing Hoses for Offshore Moorings (GMPHOM 2009)* and explains the reason for the update. Replacement text for section 3.4.10.3 is provided in section four.

1 Background

The fifth edition of the *Guide to Manufacturing and Purchasing Hoses for Offshore Moorings (GMPHOM 2009)* introduced several performance requirements regarding hose construction, acceptance tests, inspection procedures and technical requirements for prototype hose approval.

In 2016, OCIMF was asked to reassess the dynamic torsion load test requirements in section 3.4.10.3 of *GMPHOM 2009*. Some members and hose manufacturers reported that the test requirements could potentially disqualify hoses that had proven to be reliable in service.

An OCIMF working group was set up to reassess the dynamic torsion test load requirements and consider whether they needed to be updated. The working group concluded that the test requirements should be updated and clarified to cater for stiffer hoses.

As part of the technical requirements for prototype hose approval, a prototype offshore hose must pass the following dynamic tests:

- Bending load (section 3.4.10.1).
- Tensile load (section 3.4.10.2).
- Torsion load (section 3.4.10.3).

2 Torsional stiffness in offshore hoses

Offshore hoses (floating, submarine and reeling) experience twist (sometimes called torsional displacement) when in service, which is induced by either wave or buoy motions or a combination of both. The degree of twist in the hose varies depending on local environmental conditions and hose system design, as well as the hose's diameter, construction and other physical properties.

The load needed to generate a twist depends on the torsional stiffness of the hose, which is dependent on the hose diameter and cross-section construction.

The torsional stiffness of a 12 inch hose is always less than that of a 24 inch hose. The load required to twist a 12 inch hose is less than that required to twist a 24 inch hose to the same deflection. A hose with higher torsional stiffness will twist less than a hose with lower torsional stiffness.

3 Problems with the GMPHOM 2009 test requirements

The dynamic torsion load test in *GMPHOM 2009* does not take into consideration the large differences in torsional stiffness of hoses from different manufacturers that have different hose constructions. Torsionally flexible hose designs can withstand the two degrees/metre dynamic torsion load test requirement, but torsionally stiff hose designs may only withstand a one degree/metre dynamic torsion load test requirement. A twist value of two degrees/metre was used in the *GMPHOM 2009* dynamic torsion load test.

3.1 Offshore hose length and diameter

The *GMPHOM 2009* dynamic torsion load test uses a two degree/metre twist value requirement for both the 300mm and 600mm diameter prototype test hose. The dynamic bending and tensile tests have different load requirements for each diameter.

The maximum shear stress generated during the application of torsion is a growing function of hose radius (diameter) and decreasing function of hose length. This is also demonstrated by analytic models, i.e. Hook's Law and Young's Modulus.

The two degree/metre twist value in *GMPHOM 2009* takes the linear dependency between shear stress and hose length into consideration, but not the linear dependency with the hose radius because the twist value is fixed regardless of the hose diameter.

3.2 Offshore hose design and structure

Offshore hoses with different stiffness properties respond to metocean forces and motions in different ways. As an example, when an offshore floating hose system is subjected to a wave train, the resulting loads and deformation are a function of the stiffness properties of the offshore hoses.

The *GMPHOM 2009* dynamic torsion load test requirements do not account for the differences in mechanical properties between various offshore hose constructions. A torque of up to 8–10 times more may be required to induce the *GMPHOM 2009* twist value on torsionally stiff hose constructions compared to other torsionally flexible hose constructions.

Figure 3.1: *Torsionally flexible construction (left) and torsionally stiff construction (right)*

Table 3.1 shows a qualitative comparison of torsional stiffness between two generic offshore hose constructions.

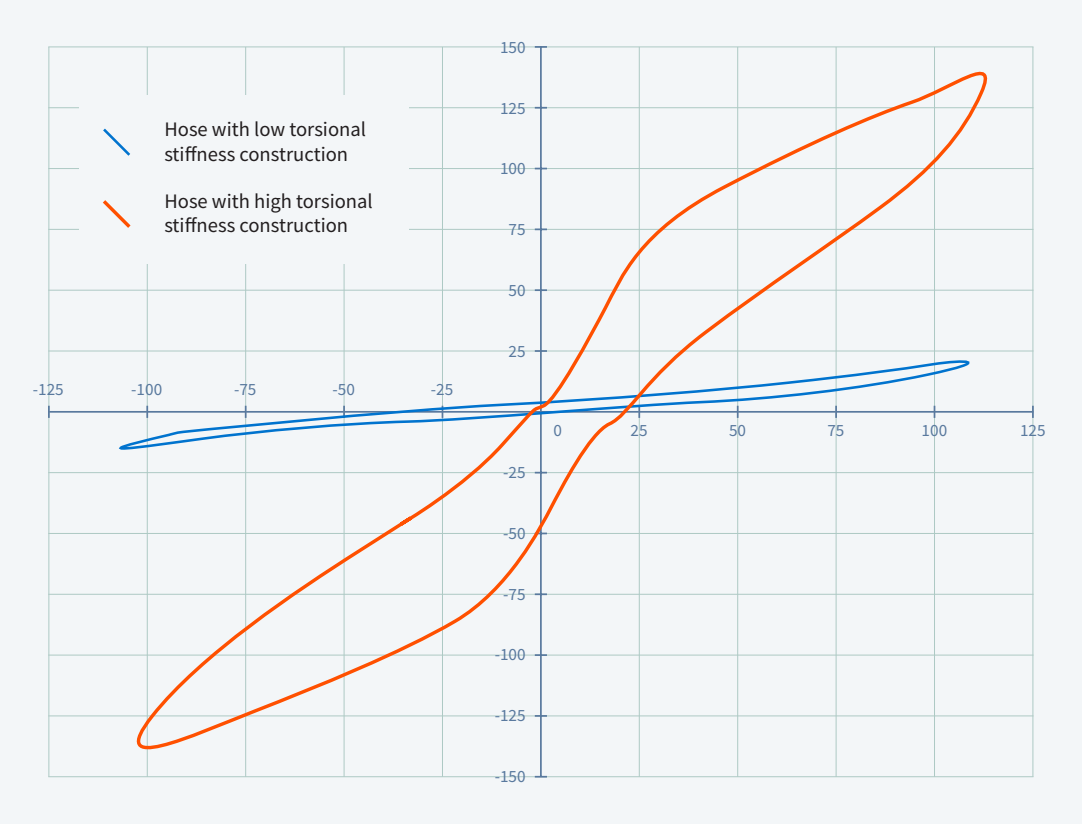

Table 3.1: *Qualitative comparison of torsional stiffness for different hose constructions*

3.3 Offshore hose dynamic torsion load test mode

The dynamic torsion load test in *GMPHOM 2009* does not define a load/torque and requires the prototype hose to be twisted both clockwise and anti-clockwise, regardless of the torque applied. The dynamic torsion load test should be conducted with the hose in displacement mode.

4 Update to GMPHOM 2009, section 3.4.10.3

The following text replaces section 3.4.10.3 of *GMPHOM 2009*.

---START OF SECTION 3.4.10.3---

3.4.10.3 Torsion Load

When undertaking the test, a torque should be applied to the hose to induce a twist of one or two degrees/metre in both the clockwise and anti-clockwise directions. Hose manufacturers should determine the actual twist value to be applied to the prototype hose after considering the design and construction of the hose, its diameter and torsional stiffness.

Dynamic analysis may help purchasers and manufacturers better understand the actual degree of twist to be expected in service for a specific hose construction at a specific terminal under design conditions. If dynamic analysis determines that higher twist values can be expected than were qualified during prototype approval, then the purchaser may request additional qualification tests.

Conduct the dynamic torsion load test with the hose in displacement mode.

Bore (mm)	Number of Cycles	Frequency	Torsion
600 mm	25,000	min 1 cycle/min	± 1–2 deg/metre
300 mm	25,000	min 1 cycle/min	± 1–2 deg/metre

Table 11: Dynamic Test – Torsion Load

The Prototype Certificate, as required by Section 3.3: Prototype Document Package, should also indicate which twist value (one or two degrees/metre) has been applied to meet the dynamic torsion load prototype test. The specific twist value (one or two degrees/metre) should also be indicated in each hose technical drawing prepared by the hose manufacturer.

---END OF SECTION 3.4.10.3---

A voice for safety

Oil Companies
International Marine Forum
29 Queen Anne's Gate
London SW1H 9BU
United Kingdom

T +44 (0)20 7654 1200
E enquiries@ocimf.org