Updates of PIANC Working Group 211: Fender Guidelines

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Summary
This presentation will update the current status of the development for WG211 "Guidelines for the Design of Fender Systems" and the background of key aspects of the new document that will replace WG33 in 2023.

Keywords: Guidelines, Fender Design, Berthing Velocity, Fender Testing

Abstract
WG33 2002 "Guidelines for the design of fender systems"[3] is currently the main reference used worldwide for guidance on fender design. The maritime industry has progressed a long way in design development of fenders, in the last two decades, consequently PIANC has established WG211 to revise and update this document.

Areas of particular focus for WG211 have been:

- Revision of berthing velocity recommendations
- Conversion to probability based design
- More extensive guidelines on fender system design
- New sections for fender manufacture, fender testing, fender maintenance and fender panels

Fender Specification & Testing

Competition incentivises actions to reduce the capital cost of the fender system. Sometimes this may occur without consideration of the performance and durability of the fenders. This increases the risk of low-quality rubber fenders and substandard fender designs being supplied.

It is therefore important to review the specifications and testing recommendations in the present guideline with the aim of ensuring:

- A minimum standard of quality assurance throughout the fendering industry
- Materials used to manufacture fenders are durable and of high standards
- Fender performance design correction factors are established based on a standard procedure that does not leave room for interpretation
- Performance verification for fenders in service
- "Type approval" certificates issued by 3rd party witness agencies use a well defined testing protocol

The increase in the displacement of modern vessels has resulted in the need for fenders to absorb larger berthing energies.

Besides undertaking a bespoke fender design for any given marine facility, it is important to make sure fenders are tested appropriately to verify material quality, performance and durability as claimed by manufacturers in their catalogues.

WG33 covers recommendation for testing, reporting of performance and performance factors (temperature, angular and velocity factors), and verifying the performance of fenders. However, it does not go into detailed procedures for the preparation of fenders for testing, authentication of testing methods, and application of velocity factors during testing. Manufacturers have also undertaken further research into fender materials, performance, durability and impacts of aging which is not captured in WG33 publication.

Another problem with the current WG33 guidelines is that it is not clearly drafted. This frequently results in ambiguity and the interpretation of the guidelines by some manufactures to suit their convenience where needed.

The WG211 guidelines will include the introduction of a new chapter dedicated to testing of fenders which includes the following key attributes:

- Review of recent research by manufacturers and updated guidance in relation to durability and performance, including:
    - fender materials composition influence on performance and performance factors
    - fender durability and causes of failure
    - impact of aging on fender performance[2]
- Review of the recommendation in relation to testing and fender performance, with specific reference to:
    - representative scope of testing
    - consistency of test procedures and compliance of testing facilities
    - representative quality and quantity of samples to be tested
    - independent testing and verification of fender materials and performance

The primary purpose of the testing protocols remains exclusive to its purpose of ensuring that engineering data reported in manufacturers' catalogues is based upon the common testing procedures followed across the industry.

Fender Design

Fender Design in WG211 is in five chapters:

- Basis of Design
- Berthing Energy
- Fender Selection
- Fender System Design
- Fender Response under Moored Conditions

The basis of design will outline the process, explain the principles of probabilistic design and define risk categories used in the selection of partial factors.

The basic energy translational equation will remain unchanged. However, the specified berthing velocity is significantly altered with the influence of vessel size reduced. The measurement programs of WG145[4] and WG211 indicated that vessel size has little influence on berthing velocity. The number of exposure conditions is also reduced from 5 to 3. The proposed velocity specifications are shown in Table 1 below.

Type of vessel	V_B (m/s)		
	Favourable	Moderate	Unfavourable
Cruise & passenger vessels	0.100	0.150	0.250
Vehicle carriers	0.120	0.225	0.275
Coaster, Feeder, Handysize	0.150	0.225	0.300
Panamax, Handymax	0.120	0.225	0.275
Post Panamax, Capesize (small), Aframax	0.100	0.175	0.275
New Panamax, Capesize (large), Suezmax	0.100	0.175	0.250
ULCV, VLBC, VLCC, ULCC	0.100	0.150	0.250

Table 1: WG211 Velocity data[5]

The characteristic berthing velocity represents a probability of being exceeded per berthing manoeuvre per year of 0.02%. The velocities in Table 1 are based on 100 berthing events per annum. These values can be adjusted for higher or lower berthing frequencies.

The measurement programs of WG145 and WG211 have also indicated that vessel berthing angles are much less than commonly used in current design. WG211 will define berthing angles in much more detail based on exposure and the degree of manoeuvring assistance from tugs and/or thrusters.

The recognition of lower berthing angles has highlighted the importance of multiple fender contact on berths with fenders at closer spacings. This is given more consideration in the assessment of the design energy for fender selection. To support calculations for this guidance is provided on the assessment of the bow radius (at the level of the fender contact) and adjustment of the eccentricity coefficient.

A partial energy factor γ_E is applied to the characteristic berthing energy to cover the uncertainty in the berthing energy calculation.

$$\gamma_E = \gamma_{E_{ref}} \gamma_n \gamma_p \gamma_c$$

Where:

$\gamma_{E_{ref}}$	Partial energy factor for 100 berthings pa
γ_n	Correction for actual berthing frequency
γ_p	Correction for berthing without pilot assistance
γ_c	Correction for correlations between design aging[2] variables (if any)

The partial energy factor, γ_E is derived using the following steps:

1. Allocate an appropriate consequence class.
2. Evaluate site specific navigation conditions.
3. Take variations in water displacement of the berthing vessels into account.
4. Determine whether a single fender or multiple fenders absorb the berthing energy.
5. Select reference partial energy factor.
6. Adjust the reference partial energy factor for alternative annual berthing frequencies.
7. Adjust the reference partial energy factor for berthings without pilot assistance.
8. Activate positive effects of correlations between design variables, if any.

WG211 will also include much more detail on fender performance correction factors.

References

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