MARITIME

SHOPERA Workshop WP2&4:
Summary of proposed Criteria and Assessment Procedure

Duisburg, 2015-03-16&17

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2015-03-16&17

[10 min]

Additional SHOPERA Manoeuvrability Criteria

Groups of Criteria	Functional Requirements	Criteria	Environmental Conditions
In extreme weather, open sea	*Weather-vaning in bow seaway*	1. *Keep heading in bow to bow-quartering waves*	*Severe [to extreme]*
In increasing storm, coastal waters	*Any manoeuvre, in wind and waves from any direction*	2. *Keep course in waves and wind from any direction* 3. *Keep speed of at least [4.0] knots in waves and wind from any direction*	*Moderate*
At low speed, restricted areas	*Course-keeping at low speed*	*Course-keeping at reduced speed in strong wind* 4. *in shallow water* 5. *In shallow water near channel wall or bank* 6. *In shallow water during overtaking by a quicker ship*	*Strong wind, strong current, no large waves*

Additional Criteria for Manoeuvrability: Summary

1. Keep heading in bow to bow-quartering waves: severe waves and wind
2. Keep course in waves and wind from any direction: moderate waves and wind
3. Keep speed of at least [4.0] knots in waves and wind from any direction: moderate waves and wind
4. Course-keeping at reduced speed in shallow water: strong wind and current
5. Course-keeping at reduced speed in shallow water near wall or bank: strong wind and current
6. Course-keeping at reduced speed in shallow water during overtaking by a quicker ship: strong wind and current

Assessment Procedure:
Full Scale Trials / Model Tests / Numerical Simulations

- *IMO Manoeuvrability Standards* are evaluated in full-scale trials => **impossible in adverse weather conditions**
- Direct evaluation of criteria in transient model experiments with self-propelled models in irregular waves and wind => **impractical at the present technology state in industry**:
  - Scale effects (wind forces, rudder forces)
  - Statistical predictions require many seaway realisations => too expensive
  - Only few facilities exist world-wide => impractical for routine design
  - Verification by the Administration is impossible => impractical for approval
  - Large variability of results (depending on steering time history) => impossible to verify results in marginal cases
- Direct numerical simulation of manoeuvres in waves => **not mature enough yet for routine design and approval**
- Alternative procedure: separate simple model tests / numerical simulations / empirical formulae for different effects

Assessment Procedure

$$X_s + X_w + X_d + X_R + T = 0$$
$$Y_s + Y_w + Y_d + Y_R = 0$$
$$N_s + N_w + N_d + N_R = 0$$

Calm-water	Wind	Wave drift forces	rudder forces	thrust => power

- Oscillatory wave forces and moments can be neglected, because their time scale is much shorter than time scale of manoeuvre
- Solution of steady equilibrium equations in horizontal under influence of time-average forces (wind, waves, manoeuvring, rudder, propeller …)
- Any contribution can be defined individually, independently from other contributions, with different methods: simple empirical formulae, numerical methods, model experiments, …
- Designers have freedom to choose methods depending on particular project needs
- Administrations can check "suspicious" contributions separately, instead of requiring full re-evaluation program
- Rule developers can replace/update any outdated method, formula or model for any component when necessary without revising the Guidelines

Analogy to MSC.1/Circ.1200

- The sense of the proposed practical assessment procedure is similar to *Alternative Assessment of the Weather Criterion*, ref. MSC.1/Circ.1200 and MSC.1/Circ.1227 (not hydrodynamically, but methodologically!)
- Note that capsize tests at zero forward speed in beam seaway (=Weater Criterion) are much easier to do than transient manoeuvres in seaway (both conditions control & statistics)
- Still, more accurate and more efficient procedure is used, based on series of separate simpler tests in well-controlled conditions to define separately different contributions in the analytical model:
  - drift in beam wind (=> steady equilibrium heel angle),
  - roll decay in calm water (=> roll damping),
  - roll in regular beam waves (=> effective wave slope),

  results of which are put together in a simple mathematical model
- As *Alternative Weather Criterion* procedures are accepted by the industry, this analogy allows to hope that the proposed procedure will be accepted as well

Example of Proposed Approach
for Course-Keeping and Minimum Advance Speed Criteria

Contribution	Compo-nents	High-Level	„Level 2" (MS Excel)	„Level 1" (pocket calc.)
Calm-water	X, Y, N	model tests [CFD]	*semi-emp. formulae*	simple emp. formulae
Wave drift forces	X,Y,N	model tests *[potential methods] [CFD]*	*semi-empirical formulae for RAOs*	simple empir. formulae direct for irregular waves
Wind forces	X,Y,N	model tests [CFD]	*semi-empir. formulae*	empirical data [Blendermann or Japan method]
Shallow, bank, overtaking	Y,N	model tests [potential methods] [CFD]	*semi-empirical formulae*	*empirical formulae*
Rudder forces	X,Y	model tests [CFD]	semi-empirical method	empirical method
Propeller model	T -> J,n,P_D	model tests potential methods CFD	open-water propeller curves	*simplified methods difficult (change of prop. point in waves)*
Engine	PD available	*static model?*	*static model?*	static model (engine diagramm)
Putting forces together	X,Y,Z	equilibrium in horizontal plane		*equilibrium in horizontal plane: reduced number of cases*

Conclusions

ToDo:

- Level 1 methods
- Level 2 methods
- Specifications for model tests: for contributions where ITTC procedures do not exist or should be updated
- Try to get through IMO Level 3 numerical methods for as many contributions as possible (difficult!)

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