



## PIANC InCom/MarCom Joint Working Group 215

# Accidental Impacts from Ships on Fixed Structures (Update of InCom WG19) Terms of Reference

### 1. Background

Since PIANC report InCom WG 19, Ship Collisions due to the Presence of Bridges, was published in 2001, experience in the analysis and design of structures that may undergo vessel impact has been obtained on a wide range of projects. This has not just been bridges – studies into impacts of buildings, river walls, jetties and other structures in harbours and inland waterways have been undertaken. Methodologies have also become more advanced and probabilistic methods of deriving impact probabilities and forces have been developed.

In the recent past and now, new techniques and methods are being developed and used to assess impact probability, impact energy and structural response, but there is no widely used consistent approach for vessel impact studies. Wider implementation of technologies such as Automatic Identification System (AIS) and 'big-data' now provide a dynamic and constantly growing database of vessel trends and movement patterns. Furthermore, reports of impact events globally are readily available and often contain detailed accounts of the event. Finite element models are now computationally efficient to conduct time-history analyses of vessel-structure impact.

There is therefore a need to update the WG19 report, and it is proposed to extend the previous ToR to cover accidental impacts from ships on fixed structures in general.

### 2. Objective

The objective of the WG is to develop a guidance document for the assessment of ship impact on fixed structures in harbours and inland waterways, including but not limited to quay walls, bridges and bridge piers, offshore wind farms, and temporary structures (e.g. cofferdams). This will include suitable guidance for designers on

acceptability criteria and methods to assess the likelihood of vessel impact as well as the corresponding energy and/or force.

### **3. Scope**

PIANC WG151 Design of Lock Gates for Ship Collision (2014) considers accidental impacts of ships colliding with lock gates, and this is in many ways similar to the more general problem of accidental impacts with other structures in inland waterways and harbours. The design approaches recommended in WG151 are relevant to this new WG, but it is not intended that the WG should repeat or revise the work of WG151.

The scope of the WG will include the following:

- A review of current practice, codes and standards (possibly including gap analysis)
- Review of methodology adopted in PIANC WG151 Design of Lock Gates for Ship Collision (2014)
- Collation of impact reports from around the world (possibly to update vessel aberrance probabilities and consequences of impacts)
- Methods for obtaining site specific data and for developing site specific vessel impact risk assessments
- Guidance on developing impact energy for any given return period using probabilistic methods
- Approach to risk assessment for a major structure (e.g. a multi-span sea crossing) versus individual structural elements
- Analysis of vessel speed restrictions due to environmental or other factors and their influence in the probability and effects of impact
- Discussion on vessel deformation characteristics for a range of common vessel types
- High level guidance on finite element approaches and super-element concepts to modelling vessel impacts
- High level guidance on key uncertainties such as vessel deformation characteristics, impact location, vessel impact velocity, mass and direction and the use of simulation methods to assess these
- Guidance on the design of impact protection and restraint systems including elastomers, floating fenders, plastically deforming structures and embankments
- Statistical methods for assessing aberrance
- Application of the impact force (considering bulbous bows and bow flare)
- Assessment of non-massive and flexible structures
- Behaviour of soils subject to very short-term high forces
- Application of dynamic amplification factors for pseudo-static and dynamic impact calculations

- Consequences of vessel impacts including economic impacts (including closure of ports and waterways due to ship sinking) and how these relate to acceptability criteria
- Case histories of relevant project examples (in an appendix).

#### **4. Existing Documents to be Reviewed**

Eurocode 1-7, AASHTO and DNV 204 provide recognised guidance in this area. It is recognised that they are not mutually compatible but they do contain requirements applicable to certain countries. Acceptability criteria are provided in a wider range of codes and standards.

Documents to be reviewed, referenced and integrated where necessary should include:

- PIANC WG 19 (2001), InCom, Ship Collisions due to the Presence of Bridges
- PIANC WG151 (2014) Design of Lock Gates for Ship Collision
- Eurocode 1 Actions on Structures, EN 1991-1-7– General actions – Accidental actions AASHTO, LRFD Bridge Design Specifications
- DNV-RP-C204 (2010) Design Against Accidental Loads
- Published articles on the topic over the last 20 years (e.g. FEA, Super-Elements (H Le Sourne) )
- Recent project case studies / reports which have incorporated novel or 'best practice' ship impact assessment techniques
- Impact reports from media and other sources including the type of vessel and consequences of impact.
- Reports on the effects of vessel speed restrictions on navigational safety.

#### **5. Intended Product**

The report is intended to be a guidance document containing discussion on approach and recommended best practice for vessel impact analysis, for owners and designers of fixed structures in inland waterways and ports. It will reference and be used in conjunction with relevant country-specific standards and research methods. It is intended that it becomes a globally referenced document used by all those conducting vessel impact assessments.

#### **6. Working Group Membership**

The WG should ideally include designers, operators and asset owners of ports, inland waterways and bridges (e.g. port, river and highway authorities), researchers, and accident investigation agencies such as the U.K. Maritime Accident Investigation Branch. Also contact will be set with IMO due to the implications in navigation safety.

## **7. Relevance to Countries in Transition**

The report will be of value in protecting the interests of developed countries and countries in transition, and will particularly assist decision makers in the assessment of risk to existing and proposed maritime and waterway infrastructure.

## **8. Climate Change**

Relevant effects of climate change should be considered; these may include sea level rise and its effect on the height of load application, increasingly extreme weather and the potential for uncontrolled impacts from vessels which have broken their moorings.