Ensuring the continued safety and efficiency of ships transiting channels requires designers and naval architects to better understand the handling and manoeuvrability of both existing and new generation ships in shallow and restricted waters. In particular, PIANC, the World Association for Waterborne Transport Infrastructure, wishes to provide the best possible advice on the issues of horizontal and vertical dimensions relating to shipping channels and manoeuvring areas.

Consequently, PIANC recently published 'Harbour Approach Channels – Design guidelines', a report from its Working Group 121 (previously MarCom Working Group 49). This report provides guidelines and recommendations for the design of vertical and horizontal dimensions of harbour approach channels, manoeuvring and anchorage areas within harbours, along with defining restrictions to operations within a channel. It includes guidelines for establishing depth and width requirements in addition to vertical bridge clearances.

The report supercedes and replaces the
Historical context
The design of approach channels and fairways was first considered by PIANC in a report published by Working Group 2 of the PIANC International Oil Tankers Commission (IOTC) in 1972. Some years later, this work was reviewed by Working Group 4 of the PIANC International Commission for the Reception of Large Ships (ICORELS) in a report published in 1980. The subject was most recently considered by the joint PIANC-IAPH Working Group PTC II-30 in co-operation with IMPA (International Maritime Pilots Association) and IALA (International Association of Marine Aids to Navigation and Lighthouse Authorities).

Updated guidelines
In 2005, Working Group 121 (WG121) was created with 20 members from 12 countries, including three members from the previous Working Group 30 (WG30). It was to review, update and, where appropriate, expand on the design recommendations as presented in the WG30 report of 1997. In doing so, the Working Group considered recent developments in simulation and other design tools, along with the sizes and handling characteristics of new generation vessels. In addition, further attention was given to the design of the vertical dimensions of channels than had previously been provided.

The overall report was completely restructured to present the vertical and horizontal aspects separately, with conceptual and detailed design techniques presented in each main chapter.

The new report can be purchased from the PIANC website or for PIANC Members, it can be downloaded free of charge at http://www.pianc.org/edits/articleshop.php?id=2014121.

Methodology
Aims and objectives
The aim of the updated guidelines was to provide the best international practice for the design of approach channels that was available to the port engineering community. The goal was to produce a practical set of guidelines, which are easy to understand and apply. However, as with the previous version of the guidelines, their use still requires proper engineering judgement.

The main objectives of WG121 were to review, update and, where appropriate, expand on the design recommendations on vertical and horizontal dimensioning as presented in the WG30 report of 1997. Recent developments in ship design, better understanding of ship manoeuvrability and behaviour in waves, and further research in ship simulation and modelling required a comprehensive update to the 1997 report.

The Working Group paid particular attention to:

- Vertical motions of ships in approach channels (due to squat, wave-induced motions, dynamic effects, etc.);
- Air draught for vertical clearances under bridges, overhead cables etc;
- Horizontal dimensions of channels and manoeuvring areas;
- Simulation of ships in channels;
- New and future generation ship dimensions/manoeuvring characteristics;
- Wind effect on ship navigation and manoeuvring;
- Human errors and project uncertainties;
- Environmental issues, and
- Safety criteria, assessment of levels of risk and appropriate clearance margins.

All sizes of approach channel for commercial shipping were considered, as the problems of catering for small coasters in a small port may be as great as those for a large tanker at an oil terminal.

Revised report
The new WG121 guidelines update the conceptual design techniques presented in the previous WG30 work for both
horizontal and vertical dimensions. The horizontal dimension guidelines include revised and updated allowances for channel width design, along with providing mention of Spanish ROM and Japanese MLIT standards, which need to be applied in those particular countries. The vertical dimension sections were also revised and updated with additional methods and examples to illustrate the techniques. The new guidelines provide:

- Conceptual design empirical methods:
  - Channel width – sum of ship beams, modified version of previous WG30 method;
  - Channel depth – new initial estimate method and ‘intermediate’ calculation methods;
- Guidance on detailed design methods;
- Emphasize that results of conceptual design empirical methods are not a final design;
- Expect conceptual design to be conservative, and;
- Optimise using detailed design methods described in the guidelines.

Much of the effort of WG121 was focused on detailed design guidelines, and in particular, probabilistic design and risk aspects, reflecting the requirements of modern engineering design principles.

The vertical dimension guidelines include further discussion and examples for predicting vertical ship motions due to waves that include deterministic, statistical and probabilistic methods. They also include sections on squat and muddy channel beds, which have been updated based on recent research and developments. In addition, with recent accurate (PDGPS) measurements of ship squat and calibrated theories, squat can now be predicted with more accuracy and this information is incorporated in the new guidelines.

Another aspect was the recent development of Post and Ultra-Post-Panamax container vessels (with capacities of up to 18,000 TEU), large car carriers, and QFlex- and QMax-size LNG carriers. These vessels have specific characteristics (high windage, larger bulbous bows, wider transom sterns, minimal parallel mid body/flat of side, etc.), which may require specific risk mitigation measures that can have an impact on access channel design and operation. The new guidelines take these new design changes into consideration.

Furthermore, the use of advanced numerical models of wave propagation and ship response to waves, along with ever realistic ship manoeuvring simulation, have become common practice in port engineering design. The new guidance includes more details and examples of their use.

Capacity simulation models can also be used to evaluate the safety of port infrastructure and are described with an example. Today, there is a more continuous range of tools available, so that each type of simulator/simulation can be used in different stages and detail of channel design.

Recent developments have led to a more integrated approach for environmental aspects for channel design. In the previous approach, the conceptual design was first completed and was then used as the basis for the Environmental Impact Assessment (EIA). After completion of the EIA, detailed design was undertaken, which led to long and interrupted design periods. Now, the EIA study is integrated with both the conceptual and detailed design stages, which leads to a faster design process, with environmental aspects being taken into account throughout the engineering design process.

Conclusion

The new WG121 harbour channel design guidelines provide best practice recommendations for the design of horizontal and vertical channel dimensions, and for manoeuvring area dimensions within harbours. These include consideration of many factors, including design vessel operational limits, risk, economic and environmental considerations, support craft requirements, and aids to navigation.

About the author

Dr Mark McBride is the manager of the Ships Group at UK-based HR Wallingford and has over 25 years of experience in port and maritime design related work. He has been involved in numerous projects regarding the design of approach channels, turning circle and manoeuvring areas, berth locations, ship mooring analysis, and operational simulation studies examining optimisation of transportation networks, berths and storage facilities. He was the Chairman of PIANC Working Group 121 which produced the report described in this paper. In addition, he is the author of many technical papers on port operations, ship navigation and mooring-related topics.

About the organisation

PIANC is the World Association for Waterborne Transport Infrastructure. It provides a forum where professionals around the world join forces to provide expert advice on cost-effective, reliable and sustainable infrastructures to facilitate the growth of waterborne transport. Established in 1885, PIANC continues to be the leading partner for government and the private sector in the design, development and maintenance of ports, waterways and coastal areas. As a non-political and non-profit organisation, PIANC brings together the best international experts on technical, economic and environmental issues pertaining to waterborne transport infrastructures. Members include national governments and public authorities, corporations and interested individuals.

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