PIANC
The World Association for Waterborne Transport Infrastructure

Inland Navigation Commission
InCom WG 255

STRUCTURAL RE-ASSESSMENT OF EXISTING (IW) HYDRAULIC STRUCTURES

PROPOSED TECHNICAL WORKING GROUP

TERMS OF REFERENCE

1. Definition of the problem

Hydraulic structures (1) are usable infrastructure assets that historically have been designed for a long service life.

As the statistics show, a high percentage of hydraulic structures have exceeded their service life of 100 years, therefore the planned service life of structures to consider today, should be determined with care and not simply be based on the predicted obsolescence. The need for re-assessment comes when modifications may affect the structures (such as new loads, heavier trucks, ...)

Nevertheless, structural re-assessments are necessary for existing hydraulic structures (lock – concrete wall/floor, gate, weir, quay wall, ..), because some structures show damage, others have changed their boundary conditions in the course of time, and others were built according to earlier standards, where changes and new developments were made (conceptual ageing).

In many cases, normative safety of these (old) existing structures can no longer be verified with the current standards developed for new structures. From this discrepancy that structures can no longer be verified numerically, i.e. they are "unsafe", and the fact that they have been operated safely for decades in some cases, there is a need to use procedures to re-assess existing IW hydraulic structures (1).

The safe and economical preservation of structures, especially those with a high cement content or steel, by means of adapted assessment procedures preserves the "gray energy" contained within the structures, and thus significantly serves climate change mitigation (circular economy).

(1) *The WG will focus on evaluating structural (concrete/steel components) of the infrastructure rather than electro-mechanical parts* (i.e. actuators, rack and pinion, cable, articulation, etc.).

2. Objectives

The WG report will provide guidance to assess existing IW hydraulic structures.

The objective of the WG is to gather concepts and ideas for a verification methodology for existing hydraulic structures as best practice, no matter which concept (global, semi-probabilistic or probabilistic) is fulfilled.

Secondly, describing the main differences to the current construction method and/or code, and how these had been derived, would be helpful/welcome.

Identified methods may be used either for IW hydraulic structures or for Maritime structures, which often obey the same structural principles.

3. Earlier reports or literature to be reviewed

The existing PIANC report of WG 140 (PIANC 2015) deals with the semi-probabilistic design concept for new hydraulic structures and could be a basis for review.

Eurocode has edited a technical specification (TS) for existing structures, CEN/TS 17440 (2020), mainly for buildings, and is going to convert this TS to a formal code.

In Germany there are some specific guidelines for the verification of hydraulic structures, like (BAW-TbW 2016) for existing massive structures and (BAW-TbVS 2018) for existing hydraulic steel structures. Similarly, USACE (2020) gives some guidelines in the US.

Some road and railway administrations had worked out specific guidelines for the verification of i.e. bridges and adjacent structures, which could promote ideas for a re-assessment concept.

4. Scope of work

The proposed scope of works is to:

- Review existing PIANC literature and external sources of information related to structural assessment, with emphasis on applications for (IW) hydraulic structures, for new structures as well as for existing structures. The latter literature should be the more relevant,
- Collect assessment concepts, methods and ideas for hydraulic structures and discuss the differences to the adjacent design concepts and methods,
- Collect and report generic case studies of assessments of IW structures that achieve safety,
- Establish how SHM (PIANC 2023, WG 199) can be used for that purpose,

The WG will not formalize new codes but will issue recommendations and best practices.

5. Matters to be Investigated

The report will compile verification examples for existing navigation/hydraulic structures (and only existing structures, no new structures).

Some of the issues to be investigated include:

- Defining actions (hydraulic, geotechnical, meteorologic, accidental, etc.), their safety factors and perhaps their distributions,
- Defining resistances (steel, concrete, soil, etc.), their partial safety factors and perhaps their distributions. Concrete structures and steel structures must be differentiated.
- Discuss the risk of renewing old structures by keeping as backbone old structure, old material, or/and old foundation.
- Defining limit states for the verification of navigation/hydraulic structures,
- Defining methods to use the strength reserves on the structure,
- Identify technologies to re-assess the onsite material properties (as strength), to update the durability,
- Identify any relevant methods.

5. Intended product

The objective of the report is to provide information and recommendations on best practices to verify existing hydraulic structures concerning structural stability fulfilling safety issues as well as sustainability requirements. Reporting practical solutions for several navigation/hydraulic structures by the working group would be welcome.

This could facilitate the acceptance by the verification community and perhaps to aid in education.

The working group should contact other institutions in the design community such as CEN, ASCE, ISO, ICOLD, etc.

6. Working Group membership

Membership proposed to include (background and experience):

- Civil, Structural and Geotechnical Verification/Design engineers, familiar with navigation/hydraulic systems and their operation and maintenance.
- Persons familiar with the verification and/or expert advice for navigation/hydraulic.
- Persons having a close relationship with the Eurocode committees (or similar), other design code development committees or international associations (i.e. ISO, ASCE, ICOLD) would be welcome.

7. Relevance

7.1 Relevance to countries in transition

The proposed guidance can assist countries in transition to maintain existing structures and to reduce climate change.

7.2 Climate Change

This proposed guidance will support the reduction of greenhouse gases, save gray energy and reduce exploitation of natural materials. Conservation of existing structures or parts of them is the biggest lever for climate protection.

7.3 UN Sustainable Development Goals

This proposed guidance is intended to directly contribute to the following SDG's:

- Goal 9: Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation,
- Goal 11: Make cities and human settlements inclusive, safe, resilient, and sustainable,
- Goal 13: Take urgent action to combat climate change and its impact.

8. References

- PIANC (2015): WG 140: Semi probabilistic design concept for hydraulic structures. PIANC.
- PIANC (2023): WG 199 Health Monitoring of Ports and IW structures. PIANC
- USACE (2020): ER 1110-2-8161 – Structural design and evaluation of civil works building. USACE.
- AASHTO (2012): „AASHTO LRFD bridge design specifications ", LRFDUS-6, American Society of State Highway and Transportation Officials.
- BAW-TbW (2016): „Bewertung der Tragfähigkeit bestehender, massiver Wasserbauwerke (TbW)". Bundesanstalt für Wasserbau.
- BAW-TbVS (2018): „Bewertung der Tragfähigkeit bestehender Verschlüsse im Stahlwasserbau (TbVS)". Bundesanstalt für Wasserbau.
- DIN 19702 (2013): "Massivbauwerke im Wasserbau – Tragfähigkeit, Gebrauchstauglichkeit und Dauerhaftigkeit". DIN.
- CEN (2002): EN 1990 - "Eurocode (0) – Basis of structural design"; including A1 (2005) and AC (2010). CEN.
- CEN/TS 17440 (2020): "Assessment and retrofitting of existing structures". CEN.
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