PIANC WG 151
InCom

Terms of Reference

Impacts of seismic loads and vessel impact on lock gates

Objective of the Working Group

The main objective of the WG is to define a general methodology for the analysis and design of lock gates and approach structures considering seismic loads and vessel impact.

Background

In 2010, current practice for the design of lock gates and approach structures is a relatively standard activity for a suitably experienced engineering company if the design requirements and the load cases are clearly specified.

Relevant, robust, reliable and effective software is available to assess the strength (stress, deformation, buckling, damage limitations etc) of lock gates and approach structures even if exceptional load cases must be considered.

Gates share many common design aspects with large bridges, and the design of such bridges to provide the required seismic resistance is a relatively normal design issue. Similarly, in the car industry, it is normal practice to perform numerical simulations of crash tests on new models of cars even before they are built and tested as prototypes. These simple examples show that the numerical tools to study the effects of seismic loads and vessel impacts on lock gate structures are available.

So what are the design issues to be considered in determining the effects of seismic loads or vessel impact on gate structures and approach works? In general terms, these are:

For seismic loads:
- what is the appropriate source and return period for design spectra?
- when should response spectra be used and when should time histories be used?
- is there amplification in the substructure?
- is there soil/structure interaction?
- what is the added hydrodynamic mass and how is it distributed?
- what are the effects of the pressure waves induced in the water column by the vertical accelerations of the lock bed?
- how are responses in different directions and modes combined?

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- what operational levels of damage can be accommodated?
- how should the analysis be carried out?
- how can the design be implemented to deliver the required robustness and ductility levels?

For vessel impact,
- what is the mass and hull form of the vessel?
- what should be the design speed(s) to consider for impact ?
- what shape(s) of the impacting vessel cause the most severe damage?
- what is the effect of added hydrodynamic mass?
- what level of damage can be accepted ?
- up to which level of impact/damage should the gate or approach structutecontinue to be operated ?
- how should the analysis be carried out, and how can such analysis be verified against real events?
- how can the design be implemented to deliver the required robustness and ductility levels?

Obviously there are probabilistic issues within these problems. The probability of a minor impact on a gate or approach structure on a regular basis which causes no significant degradation of capability or performance is relatively high for most lock gates or structures, but the general probability of having a major impact which causes substantial damage and its potential ramifications is much more complex to assess.

Final Product and Matters to be investigated

The report will first compile design examples of lock gates and sapproach structures that have been designed considering seismic loads, vessel impact or both of them.

The review will concern:
- the design requirements that have been considered (eg ground acceleration spectra for the seismic loads and vessel definition, size and speed for the vessel impacts),
- the analytical and design methods (empirical, analytical and numerical) used to implement such design requirements within the design and calculation procedure current best practice
- the requirements of the regulatory or approval authorities, and
- empirical evidence of performance in practice

Based on the existing situation and current practice, the members of the WG will undertake a survey of the various organizations currently facing such issues, such as VNF/CETMEF with Seine Nord Europe, ACP for Panama, BAW, Rijkwaterstaat, British Waterways, UK Ministry of Defence, and the US Corps of Engineers. If possible, a general methodology will be established. If this is not possible, the various approaches will be discussed and compared.

Based on the collected data, the WG will perform some benchmarking and statistical analysis, which will be used to propose general recommendations for the analysis and design of lock gates considering seismic loads and ship impact.

Countries in Transition

This WG does not have a specific issue concerning Countries in Transition as vesselimpact on lock gates and approach structures is a general concern for all the countries in the world.

For seismic loads, the WG is especially relevant for the countries located in seismically active areas such as those on the Pacific Rim, eg Panama and Japan, the Mediterranean basin and to a lesser degree the East Coast of the USA.

However, it should be noted that high integrity facilities in countries not traditionally thought of as seismically active may require significant substantiation against the risk of seismic events occurring over long time periods, such as once in 10,000 years.

Expected WG Members

The WG needs to have three types of members:

- Public authorities such as VNF/CETMEF, ACP Panama, BAW, Rijkswaterstaat, British Waterways, UK Ministry of Defence, US Corps of Engineers, etc.
- Structural Engineers of Engineering companies/Design Companies, which have the experience and practice of such structural analysis (seismic and impact) in other field of activities (as TNO in Holland; SBE, BEG, Technum, in Belgium, Halcrow in UK, Germanischer Lloyd, etc)
  and

Scientists (Universities) who have particular seismic and impact engineering skills and can also perform the benchmarking and the statistical assessment.
A representative of MarCom should be invited to join the Working Group