



Henderson Colloquium 2024

'The Intricate World of Moving Bridges'



Summary & Outcome



Monday July 1st to Wednesday July 3rd 2024
Christ's College, University of Cambridge



Introduction

Since 1975 the British Group of IABSE have held a two-day colloquium in Cambridge every summer for about 25 invited participants. The purpose of the event is to exchange views on a structural engineering theme of topical importance. Each participant is invited to make a short presentation to trigger constructive discussions in the relaxed surroundings of Christ's College. The theme of the 2024 colloquium is "**The Intricate World of Moving Bridges**". The event was an enriching exploration of the challenges and innovations inherent in the design, construction, and maintenance of moveable bridges.

Colloquium Aims

The primary aim of the colloquium is to cultivate interdisciplinary discussions on the multifaceted aspects of moveable bridges, emphasizing their dynamic intersection of structural, mechanical, and electrical engineering.

Based on the discussion had at the colloquium, this short report outlines the areas for further research around moving bridges and identifies common areas for necessary development.



Conclusion Session

The conclusion session highlighted the gaps in our understanding of movable bridges that were discussed during the colloquium and listed below.

- Absence of a clear procurement system and design standards related to movable bridges.
 - o Harmonization of standards - Do we need an international harmonization of standards?
- Potential areas which need additional research to help the understanding of movable bridge behaviour.
 - o Differential Thermal Gradients
 - o Movable Bridges Construction specifications

Procurement & Design Standards of Movable bridges

Additional work is required on the procurement system that leads the design of movable bridges. Clients need to be educated on the complexity of the movable bridges. They need to understand the costs involved in the design and construction of movable bridges (different from fixed bridges). Costs related to the maintenance of movable structures that generally are more onerous than fixed bridges. They need the right skills/people for the design and construction of these complicated structures (Structural and MEICA designers/contractors are equally import for the success of a movable bridge).

Movable bridges have been designed in the UK using AASHTO, Dutch codes and BS EN related to the general design for cranes. Currently, there is not a harmonized standard which the designer can use as reference.

The same applies to contractors. Some of the fabrication specification such as to EN 1090-2 and ISO 19901-5 do not provide tolerances for movable bridges.

Based on the above considerations, clients need to have the right procurement process in place to ensure a better way to procure the design of movable bridge, designers need to have guidance for the structural and MEICA design and execution and contractors need a movable bridge construction specification.

The above message and the knowledge shared at the colloquium needs to be externally shared with the engineering community and clients.

It could be shared through the IABSE task group which could focus on the production of a **Best Practice Document**: Consideration for procurement of movable bridge.

This document would educate clients and it can be used as guidelines for contractor, architects and engineers.

The Best Practice Document can potentially include the followings:

- Procurement of movable bridge. It should have a section to educate the client on the procurement of movable bridge as described previously. Type of different contracts should also be discussed.
- Mechanical design guidance. Include the difference between hydraulics and electrical.



- Structural design guidance. Clarify the design criteria for the new bridges. Includes load combination and thermal loads. The loads should also take in account for future temperature and sea levels changing due to the climate change effect.
- Reference table with the type of bridges and width of channel across the world.
- Movable bridges taking in account tram/train. This is related to the potential transition to Net-Zero. Fewer cars replaced by more electric public transportation.
- Maintenance. Improve the maintenance and replacement of mechanical equipment. Design the bridge and MEICA for potential upgrades. Consider the access to the mechanical equipment and the frequencies of the maintenance and inspection of these elements.
- Machinery life and CE marking.
- Competences in independent checks
- The future of shipping. Considering the size and how the channel will be used in future.
- Standards for references in the guidelines. This would help to close the gap on the harmonization of standards related to the design of movable bridges. The guidance should list the current available standards that should be used for the structural and MEICA design of movable bridges.
- Embodied carbon calculation for movable bridges. This should help to choose the most appropriate type of bridge reducing the embodied carbon. It should also include the embodied carbon of the mechanical equipment.
- Lessons Learnt – Expose our mistakes/errors and how we have learnt from it.

The guidance document should also include the feedback from the following parties:

- Dutch Authority, Port of London Authority (PLA), Canal and River Trust, and similar client authorities.
- Consider the input from people using the channel.
- Include the bridge operators' feedback.

The knowledge of movable bridge could also be shared online through a website.

This conclusion session and some of the most significant presentation will be shared at the IABSE talk on October 15th 2024.

Potential areas of research

Thermal gradients for Bridges

Movable bridges are highly sensitive to temperature. The mechanical and structural design is impacted by the longitudinal and transversal thermal gradient (mainly for new light steel bridges). Current standards do not cover the thermal case adequately for these bridges and there is space for further research to fill the gap.

Some topics that emerged at the colloquium and they can be part of this research group are:

- Develop design analysis using monitored air temperature. (it might be the case that site specific air temperature can generate larger movements than the thermal gradient load combination stated in the Eurocode)
- Using light colours on bridges can help reduce temperature movements.
- The effects of temperature on ropes/cables at the top of the towers of vertical lifting bridges. The design should consider that the high temperature can damage the lubricant



reducing the life expectation of the cables. The temperature can also extend some cables more than others generating tilting/twisting of the deck.

Movable Bridges Construction Specification

It was noted that the USA authorities are developing a new movable bridge construction specification, assisted by consultants Hardesty & Hanover. It was suggested that the learning from this is shared internationally via a new IABSE task group.

Abstracts

Additional information to the notes below can be found in the Henderson Colloquium 2024 Abstracts attached at the end of this report.