Design and verification of Large Floating Coastal Structures: floating bridges for fjord crossings

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ABSTRACT
LFCS (Design and Verification of Large Floating Coastal Structures) is a research project, funded by the Research Council of Norway, focused on producing recommendations for design of large coastal structures and developing methods and tools for hydroelastic analysis of coastal structures in spatially inhomogeneous environmental conditions and bathymetry.

This paper provides a presentation of the project, and a summary of the related review work on environmental, loads, structural, mooring and physical scaled model tests. Focus is set on floating bridges for fjord crossings. Scaled physical model tests for a floating bridge at SINTEF Ocean's ocean basin (80m x 50m) for March 2020 are in preparation and it is expected that highlights of this activity can also be presented during the presentation at the conference.

KEY WORDS: Large Floating Coastal Structures; Floating Bridges; Fjord crossing, Model Tests; Wave Loads.

INTRODUCTION
Established design and analysis methods for floating structures are based on wave field models that are uniform over the structure. In current design of offshore structures these methods are applied to large rigid bodies as well as systems of interconnected bodies. Considering large floating coastal structures for fjord crossings and near-shore development, every component of environmental loading can vary over the structure; waves can be very different at the two sides of a fjord, wind will be influenced by local topography and current will vary with local bathymetry. The simplest way of dealing with this inhomogeneity is to apply the worst environmental condition to the whole structure. Instinctively this may be taken as conservative. However, in some cases, the uniform load assumption may not be conservative, e.g. in the case of horizontal forces towards the convex side of a curved bridge. The large dimensions (typically 2-4 km for fjord crossing floating bridges) will cause the structure to be quite flexible, and the coupling between the structural deflection and water movement due to waves and current (hydroelasticity) will not be negligible as in the case of traditional rigid bodies, and this interaction may become crucial.

Compared with well-established methods in ocean engineering, the following critical issues are initially identified for the analysis of large floating coastal structures:
- Varying bathymetry and inhomogeneous environmental conditions over the extension of the structure.
- Inhomogeneous environmental loads over the structure.
- Hydroelasticity of large floating coastal structures under inhomogeneous conditions.
- Mooring and station-keeping of large flexible floating structures, modelling of hydroelastic effects in combinations with articulated/elastic interconnections between structural parts.

LFCS (Design and Verification of Large Floating Coastal Structures) is a research project, funded by the Research Council of Norway, focused on producing recommendations for design of large coastal structures and developing methods and tools for hydroelastic analysis of coastal structures in spatially inhomogeneous environmental conditions and bathymetry. The project was established by SINTEF Ocean and NTNU with the support of the Norwegian Research Council, the Norwegian Public Road Administration, Hydro ASA, Multiconsult AS, SWECO AS, and LMG Marin AS. The project started with a kick-off on Nov.30, 2017, with a planned duration to summer of 2021.

In addition to the presentation of the project, this manuscript gives a summary of the work carried out within LFCS relating to the review of gaps and uncertainties on environmental modelling, environmental