Buried pipeline response to ice gouging on a clay seabed large scale tests and finite element analysis

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Abstract
An ice gouge on the seafloor transmits loads to a buried pipeline via the soil, even if the burial depth is greater than the gouge depth. To validate finite element models that capture this, tests have been carried out at as large a scale as practical, using rigid indenters as ice keels. This papers covers tests performed in clay including a buried steel pipe, finite element (FE) modelling thereof, using a fully coupled model based on an Eulerian representation of the soil, and a Lagrangian representation of the keel and the pipe. For the FE model, undrained conditions are assumed, and the total stress response of the clay determined using a time-invariant elastoplastic material based on the Von Mises yield surface with isotropic strain hardening, and the stress-strain curve obtained from unconfined compression (UC) tests. Despite the simplicity of the soil modelling, the FE results for strains in a buried steel pipe are in agreement with the values from the test. Subgouge deformations away from the pipe from the FE analysis are small, but those from the test even smaller. This paper provides further details of the tests, the FE analysis and the comparison of results for gouge depth, pulling force, subgouge deformations and pipe response.