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Please fill in your abstract title.	Stress and Structural Analysis of Inner Pipe of Cryogenic Flexible Hose

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Abstract

Three-dimensional finite element analysis (FEA) model is established, stress and structural of cryogenic metal corrugated pipe that used for transmission system for liquefied natural gas (LNG) is analyzed. FEA models of the fully assembled hose and selective individual components were generated to assess their structural response to different loading scenarios, resulting stress concentrations and layer interactions. A sensitivity study of the corrugation profile of the corrugated pipe was performed to minimize stress concentrations and allowable bending radius.
Finite element (FE) analyses of the inner pipe of cryogenic flexible hose used for transmission system for liquefied natural gas (LNG) under axial, bending, and internal pressure loading were carried out to evaluate global load-deformation and local stress responses.

To ensure sound structural performance and integrity of the flexible hose during offloading operations, a Failure Mode and Effects Criticality Analysis (FMECA) was performed. 3D finite element models of the fully assembled hose and selective individual components were generated to assess their structural response to different loading scenarios, resulting stress concentrations and layer interactions. A sensitivity study of the corrugation profile of the corrugated pipe was performed to minimize stress concentrations and allowable bending radius.

Advanced finite element analysis can be used to analyze all layers of a complex structure as a cryogenic flexible hose, identify layer interactions, stress concentrations, material yielding and limit states instead of relying on simplistic empirical design approaches or superposition schemes. Finite element modeling of inner pipe of cryogenic flexible hose was performed under tension, compression, bending and internal pressure. Unless modeling of local buckling under compression is sought, models with axi-symmetric corrugations, as opposed to 3D models including the helical corrugation, are sufficient. Finite element simulations that incorporated the proposed material model were conducted for tension, compression, bending, and internal pressure cases. The simulation results were in very good agreement with the full-scale global response test data. However, fatigue life predictions using the local stresses and the plain material S-N curve, did not match with the results obtained from full scale fatigue tests. It is believed that spatial variation in strain hardening/residual stresses left in the inner pipe of cryogenic flexible hose after corrugation forming, and biaxial local stresses during pipe deformation that are not accounted for in the fatigue calculations may have contributed to the discrepancy.

The results show that the structural parameters have a significant influence on the mechanical properties of the cryogenic metal corrugated pipe. The rules found from the sensitivity analysis provide useful references for the structural design and manufacturing process of the cryogenic flexible hose.

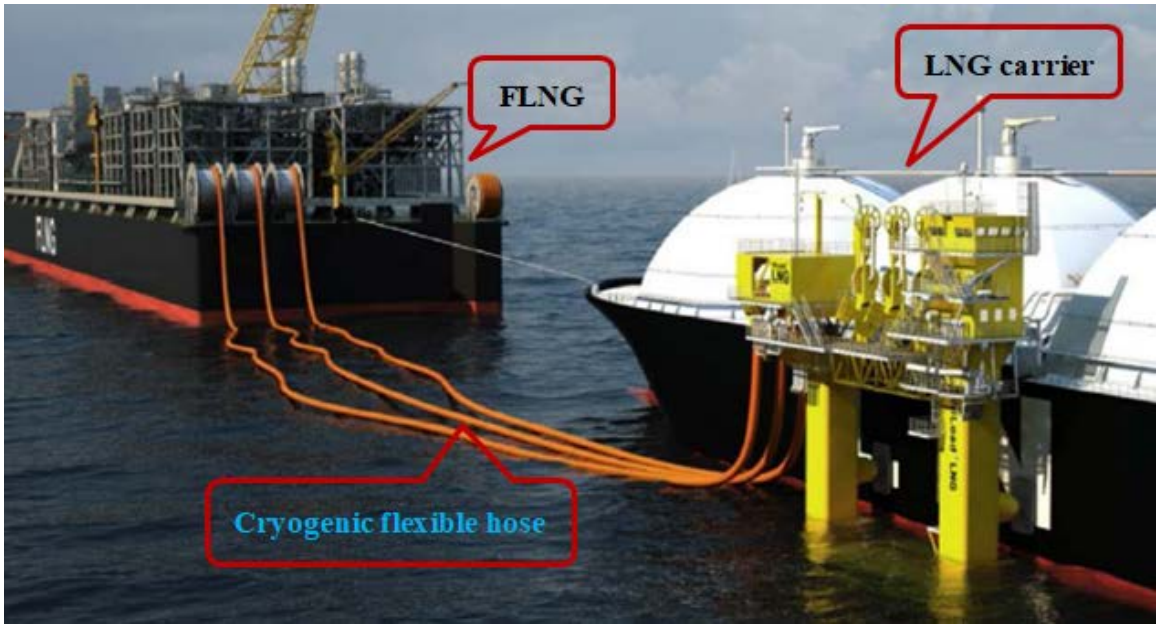

Fig. 1 Cryogenic flexible hose system operation scheme design

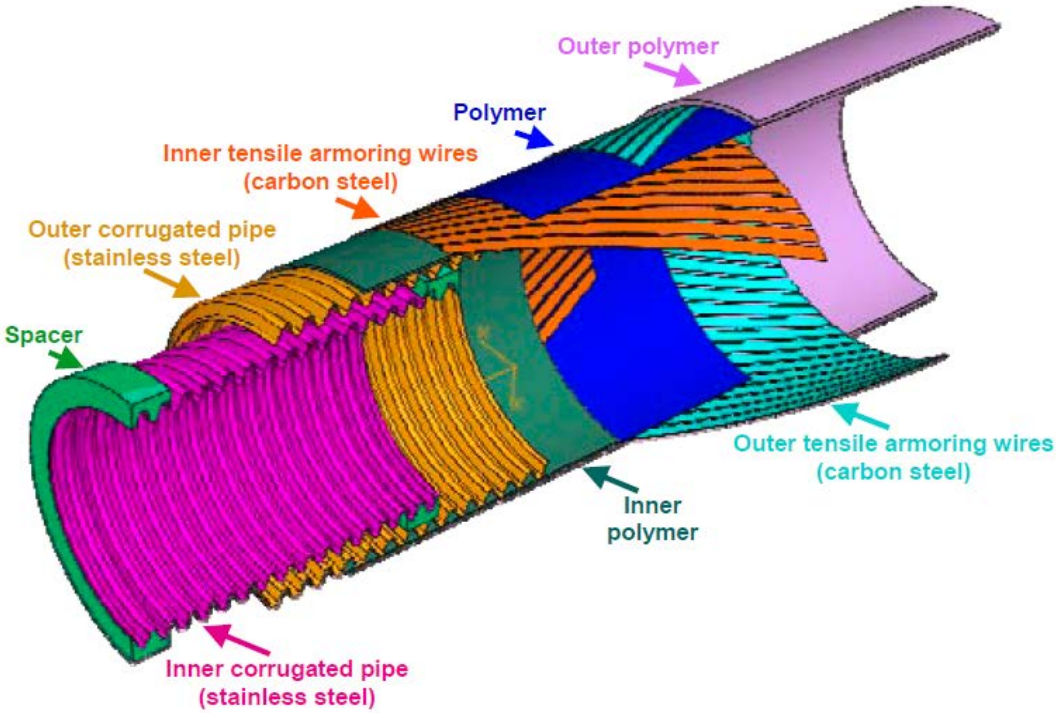

Fig. 2 Cryogenic flexible hose layer construction