STRENGTH ASSESSMENT OF MEMBRANE LNG TANK STRUCTURE BASED ON DIRECT CALCULATION OF STRUCTURAL RESPONSE

Zoran Mravak
Research Department, Bureau Veritas
Neuilly, France

Jérôme de Lauzon
Research Department, Bureau Veritas
Neuilly, France

Yun-Suk Chung
Consulting Department, Bureau Veritas
Busan, Korea

Louis Diebold
Research Department, Bureau Veritas
Neuilly, France

Eric Baudin
Research Department, Bureau Veritas
Neuilly, France

ABSTRACT
Expanding LNG market reinforces the demand for new concepts of LNG transportation. Membrane LNG vessel design widely applied until now, encounters new challenges due to requirement for larger vessel’s capacities and more flexible operation in partially filled conditions.

Present assessment procedures of LNG tank structure usually combine small scale sloshing loads measurement and containment system structural strength assessment, on a comparative base for the reference and target vessels. For the new LNG design, more rational methods become essential in the assessment procedure.

Some improvements in the strength assessment procedure of membrane LNG tank structure is presented in this paper, combining small scale sloshing load measurements with direct FEM calculation of structural response.

The complexity of problem is the consequence of: stochastic nature of impulsive sloshing loads, material used for the cargo containment system at cryogenic temperature and strong hydro-elastic interaction during impacts. Disadvantages of small scale testing and limits of today’s numerical methods require that further in the future certain simplifications and assumptions should remain.

In the paper, method for the design loads selection from the small scale sloshing measurements is described and discussed. The impulse, transferred over the corresponding impacted surface, is the base for the comparison of successive violent sloshing loads. The stochastic nature and statistics of measured loads are discussed. The structural analysis of LNG tank structure under selected design sloshing loads, using on-linear and time-dependant explicit FE calculations, is described.

This paper presents Bureau Veritas recent developments and their applications in the field of sloshing assessment.

1 INTRODUCTION
Today’s global market gas distribution from producers to the end users is subdivided into: local market distribution, using pipe line gas transport; and gas export which can be realized through the pipe lines or overseas transport. About one third of all gas consumption is transported overseas and almost half of the LNG carrier fleet has membrane tanks.

Due to the advantage of gas, comparing with other fossil fuel sources either oil or coal, it is expected that the LNG demand will continue to increase in the future. Growing geographical imbalance between supply and demand will further increase the LNG carrier’s fleet.

The markets demand to cut transportation costs pushes towards design and construction of LNG carriers with significantly larger capacity. To avoid direct influence on vessels construction cost a minimum possible number of tanks is desired. The increasing tanks length and vessels size, as a consequence, could result with violent sloshing loads.

Until now, LNG import terminals have been located onshore along coastlines. To reduce the risk for population today’s market demands show trends towards loading and discharging of gas at the offshore terminals, far from ports and densely populated areas. To discharge the gas offshore, vessels will be moored on-site few days while offloading and the risk for sloshing in partially filled tanks becomes important. To run a continuous offshore discharging operation with minimum of downtime, gas carriers should be capable of operating without tank filling restrictions.

This paper presents Bureau Veritas recent developments and their applications in the field of sloshing assessment.

1 INTRODUCTION
Today’s global market gas distribution from producers to the end users is subdivided into: local market distribution, using pipe line gas transport; and gas export which can be realized through the pipe lines or overseas transport. About one third of all gas consumption is transported overseas and almost half of the LNG carrier fleet has membrane tanks.

Due to the advantage of gas, comparing with other fossil fuel sources either oil or coal, it is expected that the LNG demand will continue to increase in the future. Growing geographical imbalance between supply and demand will further increase the LNG carrier’s fleet.

The markets demand to cut transportation costs pushes towards design and construction of LNG carriers with significantly larger capacity. To avoid direct influence on vessels construction cost a minimum possible number of tanks is desired. The increasing tanks length and vessels size, as a consequence, could result with violent sloshing loads.

Until now, LNG import terminals have been located onshore along coastlines. To reduce the risk for population today’s market demands show trends towards loading and discharging of gas at the offshore terminals, far from ports and densely populated areas. To discharge the gas offshore, vessels will be moored on-site few days while offloading and the risk for sloshing in partially filled tanks becomes important. To run a continuous offshore discharging operation with minimum of downtime, gas carriers should be capable of operating without tank filling restrictions.