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Effects of Sloshing Loads on Fatigue Strength of Independent Type B LNG Tank

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The objective of the present study is to investigate the load effects due to sloshing impact on the fatigue assessment of an independent type B LNG tank. The selection of the cargo containment system type for an FLNG (Floating LNG) is mainly related to the sloshing problem. FLNG are considered to be operating at an intermediate loading condition prone to sloshing inside the containment system. One of the most popular LNG containment systems for the FLNG is an independent prismatic tank categorized as IMO (International Maritime Organization) type B tank, in which the ship hull supports the LNG tanks. It is recognized that the independent type B tank is free from possible liquid sloshing inside the tank from the standpoint of its strength due to its stiffened panel structure. However, from the standpoint of fatigue assessment of the cargo tank, it needs careful verification. In the present study, the sloshing impact pressures on the internal structures of an independent type B tank are predicted based on scaled sloshing model tests using a 2D rectangular tank with internal structures. Finally, a fatigue assessment based on the sloshing model results is carried out to quantify the effects of sloshing loads on the fatigue strength of an independent type B tank.

INTRODUCTION

The increased demands for natural gas make the exploitation of stranded offshore gas fields attractive. The locations of many stranded gas fields are in deep water and isolated from onshore infrastructures or other pipelines (Zhao et al., 2011). In recent years the FLNG (Floating LNG production, storage and offloading concept) business has rapidly grown and is now at the forefront of offshore industry focus. The LNG FPSO (the original name for FLNG) concepts shown in Fig. 1 have a number of advantages over conventional LNG supply chains. The main advantages come about when the FLNG is used in a deep water field or in remote locations. In these locations, laying a pipeline is generally not cost effective. In short-life gas fields, the FLNG can move the production facility to a new location once the existing field is depleted (Kerbers and Hartnell, 2009).

The motion of the liquid with a free surface contained in any moving vehicle or structure can become so large that it results in resonant excitation. This problem is known as sloshing. Liquid sloshing in a partially filled cargo tank has caused severe damage to ship structures (SSC, 1990; Gavory and Seze, 2009). General strategy for the development of FLNG design is related to total project cost and technical feasibility. The proposed technical solutions must be proven to be reliable and safe in practice. This requires a number of solutions to structure design, chemical process and hydrodynamics, including hull strength, topside process, mooring system, riser system, selection of the containment system and so on.

Selection of the cargo containment system type and the number of cargo tanks in FLNG has been of particular interest for several decades in the offshore LNG industry. It is thoroughly related to the sloshing issue due to the demand for partial filling operation. The LNG containment system must be capable of withstanding the damage that can occur when the vessel's motions cause sloshing in partly filled tanks (Zhao et al., 2011; Zalar et al., 2006; Kerbers and Hartnell, 2009).

Feasible solutions lie in wait for all these concerns. Both IHI's SPB-type containment system and the 2-row membrane tank configuration proposed by DSME appear capable of reducing and withstanding the impacts due to liquid sloshing (Ryu et al., 2009; Kerbers and Hartnell, 2009). Fig. 2 shows a schematic view of

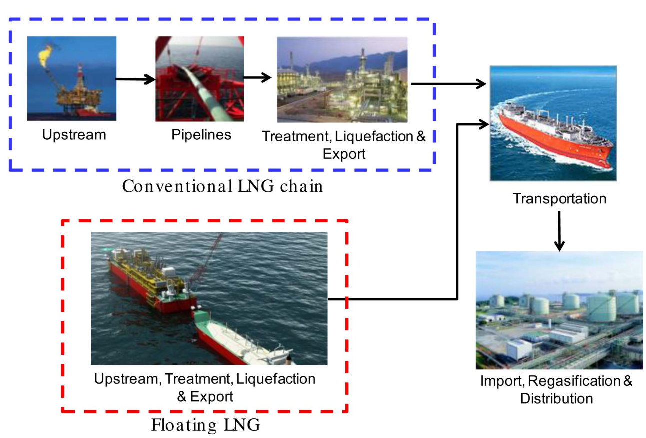

Fig. 1 Concept of Floating LNG and LNG supply chain (Song, 2012)

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