ABSTRACT

The execution strategy of LNG terminal projects has been moving to modularization during the last two decades. Normally the fabrication yard and terminal jobsite are at different locations, sometimes even at two different continents. Therefore, modules’ ocean transportation subsequently becomes a critical step in the whole LNG terminal construction process. A modularized supporting structure could contribute as much as 30–50% of the total weight of the module, which makes module transportation acceleration criteria vital for the entire module design. This paper presents a comparative study of module acceleration during ocean transportation between rule-based and voyage-specific methods, and proposes an empirical method based on 20 actual voyages data to bridge the gap between these two methods. The proposed method reduces the conservatism in rule-based method, and thus improve structural design efficiency during early design stages of an LNG terminal project.

KEY WORDS: LNG Module; Modularization; Ocean Transportation; Acceleration

INTRODUCTION

The execution strategy of LNG (Liquified Natural Gas) terminal projects has been moving to modularization and offsite fabrication during the last two decades. LNG module ocean transportation subsequently becomes a critical step when the module fabrication yards and jobsites are located at different continents. Therefore, accelerations induced during ocean transportation will have significant impact on module design and structural integrity management. The module supporting structure is typically much heavier than a corresponding site-erected, stick-built supporting structure. A modularized supporting structure could contribute as much as 30–50% of the total weight of the module, which makes module transportation acceleration criteria vital for the entire module design process.

Current acceleration criteria for module design are either derived from industry recognized rules and codes, such as DNVGL, named as Rule-Based Acceleration; or from motion analysis of vessel and route specific data, named Voyage-Specific Acceleration.

In the early design stages of Pre-FEED and FEED (Front End Engineering Design), due to the lack of detailed information about the module fabrication yard, route, transportation vessel, metocean data, exposure time, etc., rule-based accelerations are typically calculated and provided for module structural design and module material take-off (MTO) estimation.

Once the transportation logistics are finalized at project EPC (Engineering Procurement and Construction) phase, a vessel-route specific motion analysis can be conducted to obtain the voyage-specific accelerations, which show rule-based acceleration is conservative in most cases, particularly in transverse and vertical directions. Conservative acceleration will lead to conservative structural design of the module, support structure, grillage, and sea fastening, and thus increase material and cost.

It is difficult to develop an efficient module design approach considering sea transportation loads when the transportation vessel, route, and environmental conditions are not well defined in the early engineering phases. But the historical project acceleration database will bridge the gap between rule-based and voyage-specific accelerations, give a reasonable interpretation and predict a more realistic acceleration criteria for module structure design.

Based on the real-time measured data, Sun (2014) provided a detailed module acceleration comparison between numerical prediction and field observations, and it was found that voyage-specific accelerations from motion analysis match well with the real-time measurements. This verifies that the voyage-specific acceleration criteria are reliable and can