

Estimation of Seismic Forces and Analysis of Quay Wall in KACC Marina in The Eastern Zone of KSA

M. A. Hasan¹ and Ayman M. Mostafa²

¹Dept. of Civil Eng., Shoubra Faculty of Engineering, Banha University, Shoubra, Cairo.

²Dept. of Irrig. & Hydr., Faculty of Engineering, Cairo University, Orman, Giza, Egypt

ABSTRACT

A study has been conducted to estimate the appropriate value of the seismic forces applicable for the stability analysis of berths in the Eastern zone of KSA. Since KSA does not have a specialty code for the design of coastal structures, relevant international coastal codes have been called in the design of concrete gravity-type quay walls and the Saudi Building Code (SBC 301). The Japanese standards for the design of port facilities (2009) as well as the Coastal Engineering Manual, British Standards (BSI) and Uniform Building Code (UBC) have been called. It has been found that horizontal forces in the range of 1~4% of the structure weight are developed on the quay walls depending on the soil type and degree of occupation / possible hazards. Both ordinary and extra-ordinary cases of loading have been considered. The use of the Japanese code produces stable and economic sections; however, the BSI produces more conservative design of the quay walls. It has been concluded that the case of seismic forces is not the critical case of loading in the Eastern zone of KSA and the BSI requires about 15% of the concrete volume more than the sections computed by the Japanese code.

KEY WORDS: Coastal structures; seismic forces; stability, cases of loading; KSA codes.

INTRODUCTION

King Abdallah Civic Center (KACC) is one of the most significant and iconic projects currently been sponsored by the government of the Kingdom of Saudi Arabia in the Eastern zone. KACC is located in Al-Shati bay along the Arab Gulf coast of Al-Dammam city. The project comprises a marina serving motor yachts and sailing boats. The hydraulic design was prepared by DHI (Danish Hydraulic Institute) and the structural design by CEC of Egypt in a consortium led by Zuhair Fayeze and Partners (ZFP) of KSA. The marina has a navigation water depth of 6.5m below Mean Sea Level (MSL) and concrete quay walls. It has long been well-known over the past decades that the eastern zone in the Kingdom of Saudi Arabia (KSA) is safe against earthquakes due to their low magnitude and minor frequency of occurrence. However, it has recently been a growing interest by the government of KSA to

consider seismic forces in the design of building and non-building structures, e.g., berths and coastal structures. Since KSA does not have a specialty code for the design of coastal structures, relevant international coastal codes have been adopted in the design of concrete gravity-type quay walls considering ordinary and extra-ordinary cases of loading. The applicable codes considered are the SBC 301, Japanese standards for the design of port facilities (2009) as well as the Coastal Engineering Manual, British Standards (BSI) and Uniform Building Code (UBC). The latter codes vary in their factors of safety especially when BSI is compared with the Japanese code. The municipality of Dammam requested the most conservative code for safe design of the marina. Investigations have been made for estimating the appropriate seismic forces for consideration in the design of quay walls as well as the effect of using various codes. It has been found that the eastern zone has been classified as seismic code zero as per the official seismic zone map published by the Ministry of municipalities and village affairs in KSA and Saudi Geological Survey (SGS) Authority. This still implies that seismic forces in the eastern zone of KSA have minor impact on the design forces of coastal structures. Recently, SGS recommends the use code 1 or 2 for the Eastern zone of KSA. On the other hand, KSA building code 2007 excludes coastal and water structures from its scope for estimating the seismic forces. Thus, a clear estimate of seismic forces is needed for consideration in the design of berths in the eastern zone of KSA.

PROJECT AREA

The project area has been selected by the Municipality of the Eastern Region in Al-Shati bay along the Arabian Gulf on the East coast of the Kingdom of Saudi Arabia (see Figures 1a and 1b). The bay extends from south to North and has an average width of about 1.5 Km while its length is about 3 Kilometers. The nature of soil on the seabed as per the soil investigations conducted on-site is coarse sand and the shore is protected by revetment along most of the bay.

The tidal constituents for the project area have been estimated based on Admiralty Tide Tables, and the tidal height differences were estimated. The estimated tidal levels in the project area are shown in Table 1. The Highest and Lowest Astronomical Tides (HAT and LAT) are +1.30m and -1.28m, respectively. The Mean High Water Level (MHWL) is +1.01 and the Mean Low Water Level (MLWL) is -0.69m. On the other hand, the average tidal range is 1.70m. Figure 2 shows the predicted tidal variation at Dammam in Sept., 2008.