Available online at www.sciencedirect.com

ScienceDirect

Procedia IUTAM 25 (2017) 131–140

Procedia IUTAM

www.elsevier.com/locate/procedia

IUTAM Symposium on Storm Surge Modelling and Forecasting

Study on the design of excessive typhoon and its induced storm surge

Yuwen Li [a], Lu Li [a], Xiaotao Du [a,*], Hua Liu [b]

[a]*Shanghai Water Engineering Design & Research Institute Co.Ltd., 200061, Shanghai, China*
[b]*MOE Key Laboratory of Hydrodynamics, Shanghai Jiao Tong University,200240, Shanghai, China*

Abstract

Excessive typhoon design is an interesting topic in coastal engineering. To design an excessive typhoon, the most popular method is typhoon path translation, but it may cause unreasonable results sometimes. In this paper, a correction method is introduced by using statistical air pressure map and wind speed map. Longquangang area along the north bank of Hangzhou Bay is taken as the research area here. The designed typhoon path is translated from Typhoon Khanun (2005). After typhoon strength correction and time translation, the result of wind speed and typhoon-induced storm surge seems more reasonable and can be used in coastal engineering, such as dike design and dike risk assessment.

Selection and peer-review under responsibility of IUTAM Symposium on Storm Surge Modelling and Forecasting.

Keywords: typhoon; storm surge; coastal engineering

1. Introduction

Shanghai is a city located between Changjiang Estuary and Hangshou Bay area as shown in Fig. 1. Sea dikes along the Changjiang Estuary, including Chongming Islands, and North coast of Hangzhou Bay are the first defence line to prevent the city from storm surge hazard. According to the data from 1956 to 2014, tropical cyclone is one kind of weather phenomenon that can impact the coastline of Shanghai severely. Shanghai city is influenced by typhoon 1.6 times every year on average, and the highest frequency is 4 times a year. During the typhoon impact time, especially during the spring tide, the storm surge is obvious. The record of historical high water level has been

*Corresponding author. Tel.: +86-21-32558093; fax: +86-21-32558100.
E-mail address: duxiaotao@sina.com.cn

2210-9838
Selection and peer-review under responsibility of IUTAM Symposium on Storm Surge Modelling and Forecasting.
10.1016/j.piutam.2017.09.020

broken several times. It is a great menace to the city's safety and people's life.

Fig. 1. Location of Shanghai and research area.

In recent years, extreme weather phenomena appear frequently, and the sea level rising, caused by global warming, makes the first defence line face a grim situation. During the typhoon "Khanun" in September 2005 which was numbered 0515, the coastal structures of Zhelin and Huadian sea dikes were broken by storm surge and typhoon induced waves.

Nowadays, the processes of typhoon can be numerically simulated by some developed models, such as Takahashi typhoon model[1], Holland wind model[2] and the SLOSH wind model[3], but sometimes we have to answer the question if there is the possibility of an excessive typhoon that can impact Shanghai city and how big it will be. To answer this question, we need to design a typhoon first, but unfortunately, it is a hard work to do. Some studies use the way of translating a historic typhoon to a certain place as the designed typhoon path, and use its original pressure and wind speed[4,5]. The result of this method is that the created typhoon may cause a huge storm surge to research area that may be unreasonable, sometimes unacceptable.

Duan et al.[6] indicates that the lowest centre pressure of typhoon at the northwest Pacific Ocean is related to the latitude where it's located. We follow this idea and conduct some study on the excessive typhoon design, and then give some reasonable results of storm surge from designed typhoon.

2. Basic models

A storm surge model includes two parts, typhoon model, which consists of pressure field and wind field, and hydraulic model. The storm surge model will be briefly introduced below.

2.1. Typhoon model

Max wind radius is an important parameter for typhoon wind field. There is no theoretical equation to calculate the max wind radius, but there are complicated empirical equations that are suitable for different typhoons. Following Willoughby and Rahn[7], the equation is used here:

$$R = 51.6\exp(-0.0223V + 0.0281\varphi) \tag{1}$$