



An Analytical Estimation of the Strength of River Dikes Concrete Revetments Subjected to Ice Loads in Condition of Existence of Nonzero Shear Force

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Abstract

Reinforced concrete continuous coverings are partly used as a fine revetment in river dikes. In icy regions, there is the possibility of freezing the water surfaces. If this condition happens, even once during the design period of a revetment, it will have severe destructive effects on it. Therefore, the strength control of revetments under the ice loads caused by frozen water surface would be useful in sub-zero conditions. The most critical condition would be forming a frozen layer on water surface then lowering the water level under this frozen layer that may cause the frozen layer floated. So far, analytical studying of the revetment strength under ice loads considering above situation has been carried out so less. This method would be applicable in rivers capable of freezing in which concrete lining dikes is designed and applied. In this paper, an analytical method is proposed to determine the concrete revetment strength under the condition of existence of nonzero shear force.

Keywords: Frigid region rivers, Dikes, Concrete revetment, Analytical solution, Shear force

1. INTRODUCTION

Dikes (the embankments made for controlling floods) is the oldest, and have long been one of the most important methods of flood control. According to the literature review conducted about analytical solution of concrete revetments of river dikes against ice loads, the following investigations can be mentioned as an introduction to understanding the different reactions of the ice against different loads, the use of concrete in marine projects and also the study of dike revetments under different loads including wave and ice loads.

Pilarczyk and Hendriksma, by referring that the use of concrete in the Netherlands to strengthen the protection of marine structures dates back to the early twentieth century, examined the concrete revetments of dikes along the beach [1]. Gadd and Leidersdorf examined the performance of concrete revetments constructed of concrete plates attached together faced to the impacts of wave and ice [2]. Fish developed a model of yield and creep combination for isotropic ice, in a considered state of pluriaxial tension [3]. Choi investigated the mechanical failure considering different characteristics and mechanisms of deformation, by making a physical ice model [4]. Leclair et al. applied a broad-spectrum constitutive modeling technique to saline ice [5]. Morse and Hicks investigated the effects of forming ice in rivers in Canada and other North American countries between years 1999 to 2003 [6]. Song et al. studied crystallized ice creep mechanism [7]. Liu et al. created a series of finite element models simulating the cracking progress of ice sheets due to a concentrated load on a circular floating ice sheet [8].

Since analytical solutions of resistance against ice loads has not been done till now, in this paper, an analytical solution is proposed to study the factors affecting the strength of concrete revetments of dikes. The application of this analytical method would be in the rivers subject to freezing conditions in which the dikes with concrete revetments have been designed and implemented.

2. THE ANALYTICAL MODEL

2.1. DESIGN LOADS DUE TO GLACIAL ON REVETMENTS

The type and severity of an ice layer covering dikes can depend on local conditions, including characteristics of the climate, the hydrological regime and climate conditions and the topography of the coastline. Generally,