UNIVERSITI TEKNOLOGI MARA CAWANGAN KUALA TERENGGANU

MEC299

SIMULATION OF A FLOW OVER A UNDERWATER PILLAR OF DIFFERENT SURFACE ROUGHNESS USING COMPUTATIONAL APPROACH

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ABSTRACT

Pillars are the medium which act as an integral part of the load path between the superstructure and the foundation. Pillar are designed to resist the vertical loads, as well as the horizontal loads from the bridge superstructure. Surface roughness influences fluid flow in networks which has been studied for well over a century. However, there are no recent experiment that had been done to simulate the flow over an underwater pillar using different surface roughness through computational simulation. The main objective of this project is to investigate the relation between the velocity and the submerge pillar roughness. To meet the objectives of this research, detailed experimental studies on three-dimensional flow structures and different surface roughness around three-column bridge pillars are carried out in a software called Ansys and Solidwork. Previous investigations indicate that surface roughness around bridge pillars is the reason of turbulence water flow. Hence, it is true that using different surface roughness on pillar can determine the type of water flow that go through.

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CHAPTER 1 INTRODUCTION

1.1 Background of Study

A bridge is a man-made structure built to avoid physical obstacles without closing the way underneath such as a body of water, valley, or road. It is constructed for the purpose of providing passage over the obstacle. The first bridges made by humans were probably spans of cut wooden logs or planks and eventually stones, using a simple support and crossbeam arrangement. The Romans built arch bridges and aqueducts. The Romans also used cement, which reduced the variation of strength found in natural stone. Designs of bridges vary depending on the function of the bridge, the nature of the terrain where the bridge is constructed and anchored, the material used to make it, and the funds available to build it.(Balasubramanian, 2017) .With the construction of offshore structures and underwater projects, increasing requirements are put forward for underwater pillar(Yan et al., 2022)

Pillars are the medium which act as an integral part of the load path between the superstructure and the foundation. Pillar are designed to resist the vertical loads, as well as the horizontal loads from the bridge superstructure. These the horizontal loads are not resisted by the abutments. The configuration of the fixed and expansion bearings, the bearing types and the relative stiffness of all of the pillars are determined by the magnitude of the superstructure loads applied to each pillar. To estimate the horizontal loads applied at each pillar must consider the entire system of pillars and abutments and not just an individual pillar. The pillars shall also resist wind loads, ice loads, water pressures and vehicle impact, the loads applied directly to them. Design of Bridges by considering staged construction, whether new or rehabilitation, is to satisfy the requirements of LRFD for each construction stage and by utilizing the same load factors, resistance factors, load combinations, etc. as required for the final configuration.(Goswami, n.d.)

1.2 Problem Statements

Over the last 30 years, a lot of bridges were damaged by the flood. Damage of these bridges can all be attributed to or partially attributed to destabilization of the bridge pillar. Generally, a great majority of bridges are built across rivers, and routinely the water flow force on the pillar is calculated using the methods specified in the design codes(Wang et al., 2015).Generally, a great majority of bridges are built across rivers, and routinely the water flow force on the pillar is calculated using the methods specified in the design codes. When the rainstorm comes, the pillar is not submerged in water in the downstream side at the moment of the flood impacting the pillar, and the water flow force on the pillar at the very moment cannot be determined using the methods provided by the design codes, since the methods only apply to the case of flood flowing around the pillar(Wang et al., 2015). Flow factors relies upon careful measurement of the continuous surfaces to determine the effect of distributed roughness. (Leighton et al., 2014) .

Surface roughness (texture) influences fluid flow in networks which has been studied for well over a century. The exact effect roughness has on fluid flow has not been completely understood, but a working estimate has been offered by a variety of authors over time. The work of Colebrook, Nikuradse, and Moody has provided practitioners with a method to include at least a first order estimate of roughness effects, but their work has been limited to relative roughness (roughness height to diameter) values of 5% or less.(Taylor et al., 2005a) It is therefore necessary to investigate the effects of surface roughness around bridge pillars and develop a practical method to predict the maximum water flow.(Shrestha, 2015) It is necessary to investigate whether the impact effect and the fluid-structure coupling effect can be neglected.(Wang et al., 2015)

However, there are no recent experiment that had been done to simulate the flow over an underwater pillar using different surface roughness through computational simulation.

1.3 Objectives

The main objectives of this project are:

1. To investigate the relation between the velocity and the submerge pillar roughness

2. To analyse the water flow pattern in submerge pillar region