AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
STRUCTURAL ENGINEERING DEPARTMENT

STRENGTHENING OF PONTOONS OF RIBBON TYPE FLOATING BRIDGES

BY

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A thesis
Submitted in partial fulfillment for
The requirements of the degree of doctor of philosophy
In Civil engineering (structural)

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STATEMENT

This dissertation is submitted to Ain Shams University for the degree of Doctor of Philosophy in Civil Engineering (Structural).

The work included in this thesis was carried out by the author in the Department of structural engineering, Faculty of engineer, Ain Shams University.

No part of this thesis has been submitted for a degree or qualification at other university or institution.

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Title of thesis

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ABSTRACT

The objective of this research work is to study the different techniques for strengthening the internal structure of pontoons of the "ribbon-type" floating bridges with an emphasis on increasing the "load – carrying" capacity of existing floating bridges.

The research presented here is directed into two main approaches, the first approach is concerned with the strengthening of existing bridge pontoons through addition of structural elements, to increase their moment-carrying capacity. The newly designed

pontoon bridges are analyzed in detail to determine their dynamic behavior under the effect of moving vehicles, with careful consideration of the additional weights imposed by the strengthening system applied to the pontoons. The second approach is mainly directed towards developing partial fixation between pontoons through modification of the pontoon connections, without any changes to the internal pontoon configuration.

An extension is made to the analytical model already developed in previous research, for the determination of the dynamic response of floating bridges interactively with the moving vehicles. A new nonlinear element is proposed for the simulation of the newly proposed pontoon connections. A mathematical model is proposed to idealize the reaction of the underlying fluid, incorporating the proposed nonlinear element. A software package is developed using Microsoft Excel in connection with Visual Basic for the implementation of the mathematical model.

An extensive parametric study is conducted for the determination of the effect of the main factors affecting the behavior of the strengthened pontoon bridges, including pontoon weight, fixation type, degree of partial fixation, and vehicle loads. The analysis results were used to develop conclusions and recommendations related to the practical strengthening of existing pontoon bridges. The effect of various strengthening strategies on the overall bridge load-carrying capacity are discussed in detail.

Key words: Floating bridges - single pontoon analysis – torsional moment - eccentric loads – fluid-structure interaction – dynamic analysis

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Chapter (1)
INTRODUCTION

1.1 Introduction

Bridges are constructed to cross obstacles. The obstacles may be water, infrastructures or elevation difference. A floating bridge can be used doubtlessly to cross a water obstacle when it is impossible to construct a conventional bridge. The construction difficulties of the conventional bridges involve the several factors such as a high water depth, a seabed soil weakness, an occurrence of sever earthquake etc.

The human necessity to cross the obstacles was existed since the times. Although of using many type of structures for this purpose such as the conventional bridges, floating bridges, tunnels and tubes, civil engineers still face many difficulties to find the suitable alternatives to cross the unusual obstacles. All the mentioned conventional structures have design and construction limitations which make them inappropriate for all situations. In spite of the broad variations in the types of those structures, there is still lack to cover all cases. . The technical restrictions are not the only factors influencing the choice of a floating bridge; the economical factor plays also an important role. A floating bridge is a cost-effective solution when the cost of conventional bridge construction is too high. The bridge foundations are the most costly structural element.