VIBRATION ANALYSIS OF SINGLE - ANCHOR INFLATABLE DAMS

by

Guruprasad V. Mysore

Thesis submitted to the Faculty of the

Virginia Polytechnic Institute and State University

in partial fulfillment of the requirements for the degree of

Master of Science

in

Aerospace Engineering

APPROVED

Dr. Stergios I. Liapis, Chairman **Dr. Raymond H. Plaut, Co-Chairman**

Dr. Rakesh K. Kapania

June, 1997

Blacksburg, Virginia

VIBRATION ANALYSIS OF SINGLE-ANCHOR INFLATABLE DAMS

by

Guruprasad V. Mysore

(ABSTRACT)

Inflatable dams are flexible, cylindrical structures anchored to a foundation. They are used for a variety of purposes, e.g. diverting water for irrigation or groundwater recharging, impounding water for recreational purposes, and raising the height of existing dams or spillways.

The vibration behavior of such dams is analyzed. Single-anchor inflatable dams with fins are considered. First, a static analysis is performed which yields the equilibrium shapes of the dam, both in the presence and absence of water. Then, a dynamic analysis is undertaken which analyzes the small vibrations of the inflatable dam about the equilibrium configuration, both in the presence of water (hydrostatic water as well as parallel flowing water) and absence of water.

The dam is modeled as an elastic shell. It is assumed to be air-inflated and resting on a rigid foundation. The cross-sectional perimeter, material thickness, modulus of elasticity, and Poisson's ratio are given. The analysis is performed for different values of internal pressure and external water heads.

Initially, the dam is assumed to lie flat. The internal pressure is then increased slowly until it reaches the desired value. Then the external water is applied and the equilibrium configuration is obtained. Small vibrations about this configuration are considered. The water is assumed to be inviscid and incompressible, and potential theory is used. The infinite-frequency limit is assumed on the free surface. A boundary element technique is utilized to determine the behavior of the water, and the finite element program ABAQUS is used to analyze the structural behavior. Both the cases of fluid at rest and flowing parallel to the dam are considered. The vibration frequencies and mode shapes are computed. The effect of the internal pressure of the dam is investigated, and the results are compared to those for the dam in the absence of external water.

Acknowledgments

I would like to thank Dr. Liapis and Dr. Plaut for their advice, patience, and assistance in this research and thesis. I am also thankful to Dr. Kapania for his willingness to join the committee, read the thesis, and make valuable suggestions to improve the content of this thesis. Special thanks go to the members of my research group, particularly Fata Dewi and Jeremy Trowbridge for their constant encouragement and support during the course of this research. I also want to acknowledge financial support from the National Science Foundation under Grant No. CMS-9422248.

Table of Contents

List of Illustrations

List of Tables