KANSAS DEPARTMENT OF TRANSPORTATION

FINITE ELEMENT MODELING APPROACH AND PERFORMANCE EVALUATION OF FIBER REINFORCED POLYMER SANDWICH BRIDGE PANELS*

***Available Electronic Only**

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RESEARCH

Introduction

In the United States, about 27% of the bridges are classified as structurally deficient or functionally obsolete. Bridge owners are continually investigating methods to effectively retrofit existing bridges, or to economically replace them with new ones. Modern composite materials for structural applications, at one time only in the domain of aerospace engineering, are increasingly making their way into civil engineering applications.

Project Objective

This study aims at developing finite element modeling techniques for sandwich structures.

Project Description

Parametric studies were carried out with the objective of developing equivalent elastic properties, which would be useful parameters in design. A distinction was made between in-plane and out-of-plane behavior, and properties were derived accordingly. The performance of the sandwich, such as the interface stress between the flange and wearing surface could then be evaluated. Therefore, through finite element modeling, optimization can be achieved in order to minimize the interface stress. The contribution of stiffness of the wearing surface to structural performance, a factor which is not usually accounted for in typical design procedures, is also examined. An effort is also made to analyze the temperature effects on the structure's performance. A conceptual approach aimed at studying the thermal performance of the panel due to both uniform and gradient temperature variations is presented.

Project Results

The analysis of the sandwich panel for out-of-plane behavior (bending) was also performed. The entire complicated panel can be reduced to an equivalent solid orthotropic plate whose flexural and shear properties can be calculated from the equations formulated in this work. This approach comes handy when dealing with bridge decks whose behavior is governed by bending and perhaps shear response.

The conceptual thermal analysis performed in this work compared the same panel under two different boundary conditions – simple and continuous support. The finite element study showed that under uniform temperature change all stresses at the interface were consistently higher for the case of the continuously supported panel.

Report Information

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