



Study on Analysis of Thick Plate and Multi-layer Slab with Various Mixed Boundary Conditions

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Summary

In this paper, new analytical technique to express partially fixed boundary condition was developed by the method which arranged dummy girders neighbourhood simply supported side. Moreover, the technique to combine with point matching method is proposed, which makes the use to arbitrary range of side possible. Applications to ordinary thin plate theory and hybrid method based on thick plate theory were shown. It was clearly found that several results calculated by this technique coincide finely with previous studies for difficult problems with partially clamped portions. Besides, three-dimensional behaviours about displacement and stress subjected to local loading can be obtained for multi-layer slab with same condition mentioned above. Furthermore, this technique was extended to the thick board problem with the so-called boundary condition of a hybrid model on which the conditions of freedom, simple support, and fixation are intermingled on one support neighbourhood.

Keywords: mixed boundary condition, dummy girder, thick plate theory

1. Introduction

In design of deck slabs of highway bridge, bending moment is calculated according to current highway bridge specifications and section specifications are determined by the calculated values. In this specification, support conditions for the boundary edges of simple slabs, cantilever slabs and continuous slabs are limited to be uniform [1]. However, since rotational deformation of a support girder is restrained in the neighborhood of vertical stiffener of a plate girder bridge, it leads to a complicated situation that rotational condition varies depending on locations even in the same girder. Further, the structure in which the overhanging length of a prestressed concrete box-girder bridge is lengthened and the bridge is supported with struts, which has been adopted to highways recently. These deck has simple support, partially-fixed support and irregular support conditions at the same time, in the view from the deck slab side. Section modulus for deck slab design having such a mixed boundary is determined based on values obtained from an experiment and numerical results obtained by the finite element method.

On the other hand, since pavement is laid in a deck slab of a highway bridge, it is necessary to make approach from a three-dimensional point of view in order to determine stress and displacement that act on the deck slab and pavement precisely. For example, when the unity with the deck slab waterproofing membrane for life lengthening of the deck slab and adhesion problem such as detachment are considered, the evaluation by the analysis of a multistory structure system is generally required. Furthermore, consideration of many layers is necessary in analyses concerning repairs such as the top surface overlay method, steel plate adhesion method and carbon fiber seat adhesion method that are applied to steel-concrete composite deck slabs and fatigued deck slabs. In the top surface overlay method, which has often been applied to express highways in particular, detachment has become obvious and therefore verification of sliding phenomena that occur on the contact interface of a reinforcing overlay material and the existing deck slab is an urgent important issue [2]. Pursuit of such study items will provides information that can be useful for durability improvement of the existing deck slabs.

It is considered that the number of multi-layer system deck slabs supported in irregular boundary conditions will increase with diversification of deck slab structures as mentioned above. Generally,