CHAPTER I

INTRODUCTION

<u>Background</u>

In recent years , the boundary element methods (BEM) have been so well developed that they are considered to be a powerful alternative to a " domain-type " method of solution such as finite elements and finite differences. It was first formulated in terms of influence functions and since then several formulation have been developed . The method of approach may be categorized into the following :

1. Direct Formulations : Where the unknown functions appearing in the integral equations are the actual physical variables of the problem.

2. Semi-Direct Formulations : Wherein the integral equations can be developed in terms of functions analogous to stress functions of the actual problem.

3. Indirect Formulations : Which express the integral equations in term of a unit singular solution of the original differential equation distributed at a specific density over the boundary of the region of interest.

All of these methods employ the principle of superposition and therefore will find application to either completely linear ones.

The essence of boundary element method is the transformation of the governing differential equations in to an equivalent set of integral equations on the boundary and hence the dimensions of the problem considered are reduced by one : i.e.,the analysis of two-dimensional problems generate only one-dimensional boundary integral equations and three-dimensional problems are reduced to surface integral equations only.

By the results of its advantages , BEM. has been applied in several field of problems such as fluid mechanic , elasticity , plate, and so on. Some of the first group of authors who applied boundary element method to the problem of bending of plate are Jaswon and Maiti [1] who formulated the problems in term of singular integral equations and solved them numerically around the boundary for uniformly loaded rectangular plates either clamped or simply supported edges. Altiero and Sikarskie [2] presented the formulation only for clamped plates of arbitrary plan form and discussed about singularites involving higher derivatives of the deflection which caused numerical difficulties in the integral equations. Wu and Altiero [3] extended the formulation to include plates of arbitrary boundary conditions and applied to rectangular plates with mixed boundary conditions. Morris Stern [4] employed the direct formulation in term of a pair of singular integral equations involving displacement,normal slope,moment and shear on the boundary. These equations are then coupled with prescribed boundary conditions involving the same variables furnishing , thereby , a convenient basis for numerical solution . Masataka Tanaka [5] presented the formulation for small and large displacements of thin elastic plates of arbitrary boundary conditions by direct boundary element method.

An entirely different formulation from the above mentioned papers uses the reciprocal theorem of Maxwell-Betti based on energy considerations and its author , Tottenham [6] formulated the problem without concerning complicated mathematical formulation.

Skew plates or oblique parallelogram plates are found frequently in modern construction and widely used as floors in building , bridges , ship halls , etc. The deflection and stress resultants of a skew plate are calculated by several methods such as analytical method , energy method , finite differences method , finite elements method , and so on. The method that has never been applied to those skew plate problem is THE BOUNDARY ELEMENT METHOD .

Scope of Study

The object of this present study is to apply the direct method of boundary element method to the bending problem of thin isotropic elastic skew plates subjected to uniformly distributed loads with arbitrary boundary conditions. However , only numerical solutions for four cases of boundary conditions are attempted ,namely ;

1) All Edges are Simply-Supported.

2) All Edges are Clamped .

3) Two Opposite Edges Simply-Supported and the Other Two Edges Clamped.

4) Two Opposite Edges Simply-Supported and the Other Two Edges Free.

The numerical results of deflections , bending moments and Kirchhoff's shear forces of five skew plate angles (45°, 60°, 75°, 80°, 85°) and three aspect ratios (1.0 , 1.5 , 2.0) with pratical accuracy are collected in the tables . The computer program developed in " fortran 77 " languages is also included for any skew plate angles and aspect ratio.

In order to show the correction and accuracy , some of these results are compared to the exact solution , the acceptable finite elements program " SAP*4 " and the results of other investigator.