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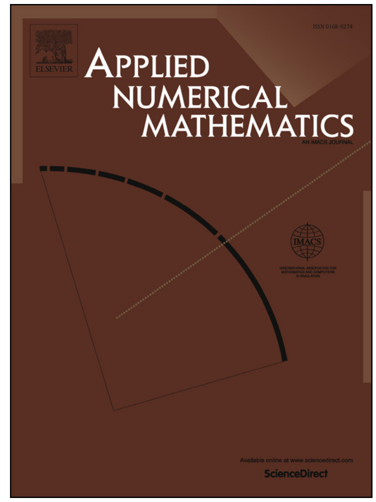


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# Comparisons of methods for solving static deflections of a thin annular plate

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**Abstract**

A highly accurate method for obtaining static deflections of a thin annular plate is helpful to effectively design the complicated structures with these plates. There have been numerous methods to achieve such a target. However, there is no direct technical literature for comparing these methods comprehensively. Therefore, the current study aims at performing comparison of three methods, optimization method (OM), finite element method (FEM), and harmonic differential quadrature (HDQ) method. Combining an instance, the comparisons give us insight into high accuracy and consistency of each other, showing high accuracy of the methods in this field. Compared with the results of FEM, the maximum error, less than 1%, demonstrates that the accuracy of the OM is high enough. Combining the small errors, the excellent stability of those brings a reliable method in this field. The maximum error and fluctuation drawn from the HDQ are evidently larger than those of the OM, and it is difficult to obtain results with higher accuracy based on the HDQ. Finally, the work described here suggests that the OM can be utilized to deal with such a complex problem in view of engineering and theory, and the HDQ method is more suitable to study the method for solving very complex partial differential systems of high order.

**Key words**: Thin annular plate, Deflection, FEM, OM, HDQ

## Introduction

The thin annular plates which are known as the primary elements of complicated structures have been widespread in different fields of applications including, but not limited to, hydraulic machinery, automobile shock absorber, precision instrument, valves and so on[**1**, **2**]. Effective design of these devices greatly depends on an accurate solution of the deflection of a plate. Therefore, scholars have utilized their best knowledge to solve static deflections of plate structures. Their methods are mainly used to deal with the large deflection equation, Von Karman equation presenting bending deflections [**3**, **4**]. The following is a brief summary of the relevant methods.

Owing to the nonlinear, high order and coupling characteristics of the governing equations, it is extremely difficult to obtain analytical solutions for the more complex boundary conditions. Numerical methods are therefore usually utilized to solve the problem, such as finite difference and differential transformation method[**5**], Fourier series[**6**], power series method[**7**], finite difference relaxation methods[**8**], finite element and boundary element method[**1**,**9-11**], locally transversal linearization method[**12**], modified multiple scale method[**13**], Chien WZ's perturbation method