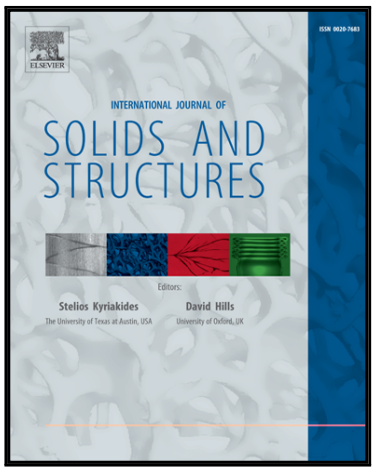

Large Deflections of an Elastic Rod in Contact with a Flat Wall

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Large Deflections of an Elastic Rod in Contact with a Flat Wall

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Abstract

This paper presents an analytical solution of two types of contact between an elastic rod and a flat frictionless rigid wall. The first problem deals with large deflections of a rod with one end clamped and the other end pushing towards the clamped end by the wall. The second problem deals with the deflections of a rod that is pushed between fixed wedges. The solutions of both problems are given in terms of Jacobi elliptic functions. The solutions are illustrated using several examples, including deformed rod shapes and load-deflection paths.

Key words. Elasticity, Large deflections, Elastica, Contact problems

1 Introduction

In this paper, we discuss the large deformation of an isotropic and homogeneous Bernoulli–Euler rod (Antman 2005) in contact with an inclined frictionless rigid wall(s). We consider two cases (Fig 1.). In the first case, one end of the rod is clamped and the other end pushes towards the clamped end by the wall. In the second case, the free rod is pushed between fixed walls (wedges). We emphasize that the second problem is different from the problem of squeezing the free rod between movable walls, that is, it is a special case of the first problem. However, if the walls are frictionless, then squeezing of the rod between walls is not possible since there is no applied vertical force that will prevent the rod from sliding up the walls. In both problems, there may be a point and a line contact between the rod and the wall. Therefore, the first problem differs from the classical cantilever problem, and the second differs from the well-known three-point bending problem (Frisch-Fay 1962). For possible