Contact-induced folding of inhomogeneous arches

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Abstract

We study the contact mechanics between a hemispherical arch with the inhomogeneity distribution of bending stiffness and a rigid plane. We first introduce the elastica model with the inhomogeneity distribution of bending stiffness depending the arc-length. Since the elastica involves geometrical nonlinearity and a contact problem involves unknown moving contact boundary, the problem yields a nonlinear free boundary value problem. To solve the problem numerically, we transform the free boundary value problem to the fixed boundary value problem by making a change of variables and then we use a continuation scheme with a relaxation method. We examine how the inhomogeneity distributions of bending stiffness affect the load-displacement responses and the critical loads for the buckling or the localized failure.

Keywords: Buckling, Elastica, Arches, Contact Mechanics, Inhomogeneity, Variable Stiffness