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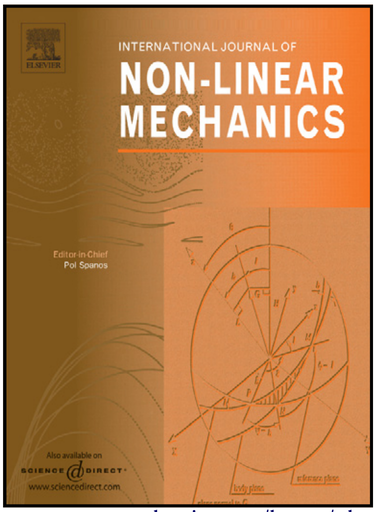

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STABILITY OF SHALLOW ARCHES UNDER CONSTANT LOAD

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1. Introduction

Design of large span roof structures requires an analysis of static and dynamic behavior of shallow arches under various loads. There are several mathematical models for such arches. A review of contemporary models is provided in [10].

Let a shallow arch be positioned over the interval $[0, L]$ with $L = \pi$. Suppose that it is subjected to a load $p = p(x, t)$, under which it takes the shape $y = y(x, t)$ for $x \in [0, L]$, $t > 0$. Let $y_0 = y_0(x)$ be its initial load–free shape. Then $y^* = y(x, t) - y_0(x)$ represents the deflection of the arch shape at (x, t) from y_0 over the interval $[0, L]$, as shown in Figure 1.

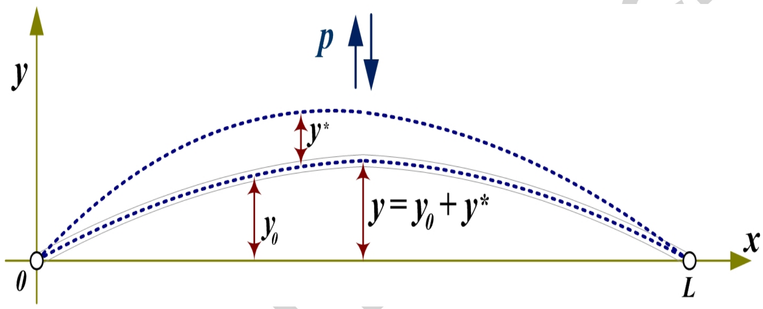

Figure 1. Model of a shallow arch

A weak damping model for the arch dynamics is

$$\frac{\partial^2 y^*}{\partial t^2} + \frac{\partial^4 y^*}{\partial x^4} - \left[\frac{1}{2L}\int_0^L \left\{ \left(\frac{\partial y^*}{\partial x}\right)^2 + 2\frac{\partial y_0}{\partial x}\frac{\partial y^*}{\partial x} \right\} dx \right] \left(\frac{\partial^2 y_0}{\partial x^2} + \frac{\partial^2 y^*}{\partial x^2}\right) + \gamma \frac{\partial y^*}{\partial t} = p, \tag{1.1}$$

where γ is the air damping constant with a positive value.

In this paper we consider the hinged ends boundary conditions, that is,

$$y^*(0, t) = y^*(L, t) = y^*_{xx}(0, t) = y^*_{xx}(L, t) = 0, \quad t \geq 0. \tag{1.2}$$

The load–free shape y_0 is also assumed to satisfy (1.2). The initial conditions are given by

$$y^*(x, 0) = 0, \quad y^*_t(x, 0) = y_1(x), \quad x \in (0, L), \tag{1.3}$$

where y_1 will be assumed to be equal to zero for the stability analysis.

Equation (1.1) is written in a dimensionless form. It is obtained from the original physical form, which can be found in [12, 13, 14], after a change of variables. This equation has attracted a lot of interest in mathematics and engineering, and many