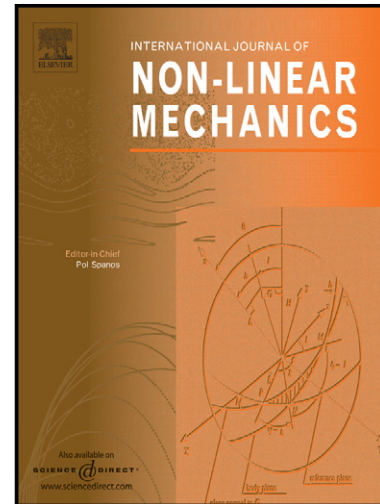


# Author's Accepted Manuscript

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Junhong Ha, Semion Gutman, Sudeok Shon, Seungjae Lee



PII: S0020-7462(13)00158-3  
DOI: <http://dx.doi.org/10.1016/j.ijnonlinmec.2013.08.004>  
Reference: NLM2204

To appear in: *International Journal of Non-Linear Mechanics*

Received date: 5 March 2013  
Revised date: 31 May 2013  
Accepted date: 14 August 2013

Cite this article as: Junhong Ha, Semion Gutman, Sudeok Shon, Seungjae Lee, Stability of shallow arches under constant load, *International Journal of Non-Linear Mechanics*, <http://dx.doi.org/10.1016/j.ijnonlinmec.2013.08.004>

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## STABILITY OF SHALLOW ARCHES UNDER CONSTANT LOAD

JUNHONG HA<sup>1</sup>, SEMION GUTMAN<sup>2</sup>, SUDEOK SHON<sup>3</sup> AND SEUNGJAE LEE<sup>4</sup>

## 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.

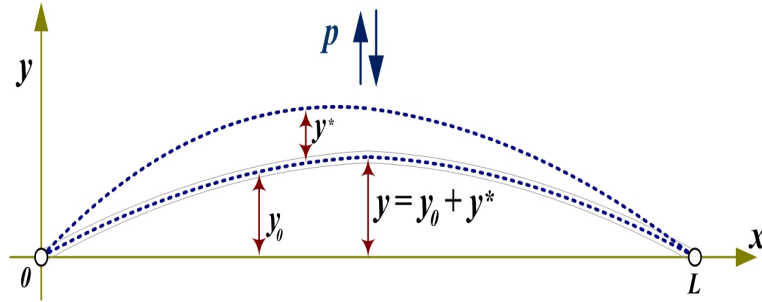


FIGURE 1. Model of a shallow arch

A weak damping model for the arch dynamics is

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

where  $\gamma$  is the air damping constant with a positive value.

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

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

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

$$(1.3) \quad y^*(x, 0) = 0, \quad y_t^*(x, 0) = y_1(x), \quad x \in (0, L),$$

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

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