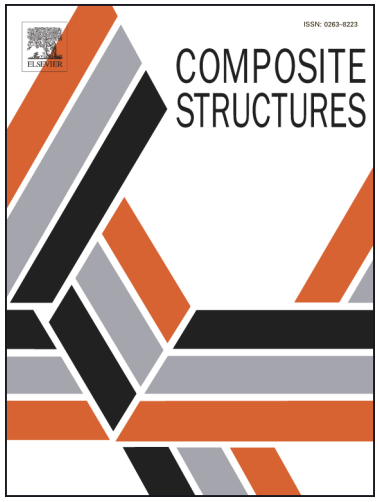

Analytical method to investigate nonlinear dynamic responses of sandwich plates with FGM faces resting on elastic foundation considering blast loads

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PII: S0263-8223(17)30247-7
DOI: http://dx.doi.org/10.1016/j.compstruct.2017.03.087
Reference: COST 8408

To appear in: *Composite Structures*

Received Date: 24 January 2017
Revised Date: 14 March 2017
Accepted Date: 25 March 2017

Please cite this article as: Mohammadzadeh, B., Noh, H.C., Analytical method to investigate nonlinear dynamic responses of sandwich plates with FGM faces resting on elastic foundation considering blast loads, *Composite Structures* (2017), doi: http://dx.doi.org/10.1016/j.compstruct.2017.03.087

Analytical method to investigate nonlinear dynamic responses of sandwich plates with FGM faces resting on elastic foundation considering blast loads

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Abstract

An analytical approach is presented to investigate nonlinear dynamic responses of sandwich plates. To obtain governing differential equations of motion, the higher order shear deformation theory is employed together with Hamilton's principle. The Navier's solution and Runge-Kutta method using available mathematical package software MAPLE 14 are used to solve the governing equations. This method can consider any required number of layers through the sandwich plate thickness. To evaluate the method validity a sandwich plate with FGM face sheets and the FRC core resting on an elastic foundation is subjected to the blast load due to the burst of 5kg charge. The maximum plane-normal displacement is obtained by the analytical method and numerical approach. Comparison between results shows good agreement. Thereafter, time histories obtained from both analytical and numerical approaches are compared. The interlaminar stresses are obtained through the sandwich plate thickness. The results show that neither material failure nor delamination occurs.

Keywords: Blast Load, Sandwich Plate, Functionally graded materials, Fiber-reinforced concrete, Dynamics, Interlaminar stresses.

1. Introduction

Sandwich structures have been widely used in industrial applications. Several studies paid considerable attention to the behavior of structures in the case of applying blast or impact loads. Explosive charges can target different kinds of structures, so it gains importance to be studied. An explosion can be defined as a very fast chemical reaction involving a solid, dust or gas, during which a rapid release of hot gases and energy takes place [1]. The blast wave pressure distribution, pressure-time history, can be stated as a function of time as Eq. (1) represents [2]:

$$P(t) = P_{s0^+}\left(1 - \frac{t}{t_{0^+}}\right)\exp\left(\frac{-b(t-t_a)}{t_{0^+}}\right), \quad (1)$$

where P_{s0^+} is incident pressure (Maximum pressure of blast wave), 't' time, t_{0^+} positive phase duration, t_a blast wave arrival time and b is dimensionless wave decay coefficient. Sandwich structures are increasingly being applied to various types of industries and sectors such as aerospace, marine and automobile engineering, because of their superior characteristics and structural performance with light weight [3]. Functionally graded materials (FGM) has recently attracted attentions because of their considerable advantages over conventional materials [4]. The most common FGMs are a composition of metal and ceramic.