Available online at www.sciencedirect.com

ScienceDirect

Procedia Engineering 172 (2017) 634 – 639

Procedia Engineering

www.elsevier.com/locate/procedia

Modern Building Materials, Structures and Techniques, MBMST 2016

Experimental and numerical analysis of an aluminum cantilevered beam with polymer adhesive

Natalia Lasowicz[a]*, Robert Jankowski[a]

[a]*Faculty of Civil and Environmental Engineering, Gdańsk University of Technology, ul. Narutowicza 11/12, 80-233 Gdańsk, Poland*

Abstract

In this paper, experimental and numerical investigation on a composite cantilevered aluminum beam has been conducted. The subject of the study consists of two plain aluminum elements bonded with polymer adhesive of different thickness. It has been proven in the previous study that this kind of material has high damping properties. During an experimental investigation, value of damping ratios have been obtained. The aim of a numerical analysis was to determine dynamic parameters, such as modes of free vibration and corresponding natural frequencies. The results obtained from the analysis have been compared with the values estimated for plain cantilevered beam. The results of the study clearly show that bonding two stiff elements with the analyzed polymer adhesive leads to the significant increase in overall damping properties.

Peer-review under responsibility of the organizing committee of MBMST 2016

*Keywords:*polymer adhesive; dynamic load; damping ratio.

1. Introduction

Dynamic loads are the most dangerous and unpredictable type of loads acting on civil engineering structures. Wind actions, earthquakes (see, for example, [1-4]) or crowd load can be mentioned as the most common ones. Structures that are regularly subjected to dynamic actions start to vibrate [5]. That type of response of the structure may have catastrophic effects. A large number of accidents, involving structures subjected to dynamic loads, have been observed in the past. The collapse of Tacoma Narrows Bridge in 1940 during high wind is one of the example

* Corresponding author. Tel.: +48583471174; fax: +48583472044.
Email address: natmajew@pg.gda.pl

Peer-review under responsibility of the organizing committee of MBMST 2016
doi:10.1016/j.proeng.2017.02.074

of destructive effects. Hundreds of thousands of people lost their lives during the earthquake that have place in 2010 in Haiti. Also crowd load has significant influence on structural behavior [6-8]. It has been proven in previous studies that mass of the people significantly decreases values of natural frequency of the structure [9, 10]. In 1992 in Corsica, the collapse of temporary grandstand killed hundreds of spectators during sport game. It is obligatory to consider the presence of dynamic loads at the design stage [11,12]. To avoid such situations, it is necessary to provide adequate stiffness to the structure. In the case of temporary steel grandstands, the application of additional diagonal members may result in reduction of structural vibrations. Nowadays, economic and esthetic aspects are often found to be very important at the design stage, that is why much more slender and quite light structural member are used to erect such structures. These kind of elements are more easily excitable to vibrations [13].

In this paper, an idea of using polymer adhesive in reduction of structural vibrations has been considered. Six different models have been analyzed during experimental and numerical study. One of them describes plain aluminum cantilevered beam, while the rest consider composite aluminum beams with polymer adhesive of different thickness inside. The polymer mass considered in the study is a specially designed flexible two-component grout, which has high damping properties what has been proven in the previous studies [14]. The aim of the study is to determine dynamic parameters, such as modes of free vibrations and corresponding natural frequencies and damping ratios of a composite aluminum cantilevered beam with polymer adhesive inside.

2. Experimental study

The first stage of the investigation has been devoted to an experimental study. Dynamic parameters, such as modes of free vibrations, corresponding natural frequencies and damping ratios have been determined. Six different models of aluminum beams have been considered during an experimental study. One of them describes plain cantilevered beam (**Model 1**), while the rest of them consider composite beams with polymer adhesive of different thickness inside (0.5 mm - **Model 2**, 1.2 mm - **Model 3**, 1.75 mm - **Model 4**, 3.1 mm - **Model 5**, 5 mm - **Model 6**).

Models assumed in the study consist of the same aluminum cantilevered beams of total dimensions: 9x30x1250 mm. A scheme of the beam bonded with polymer mass is presented in Fig. 1.

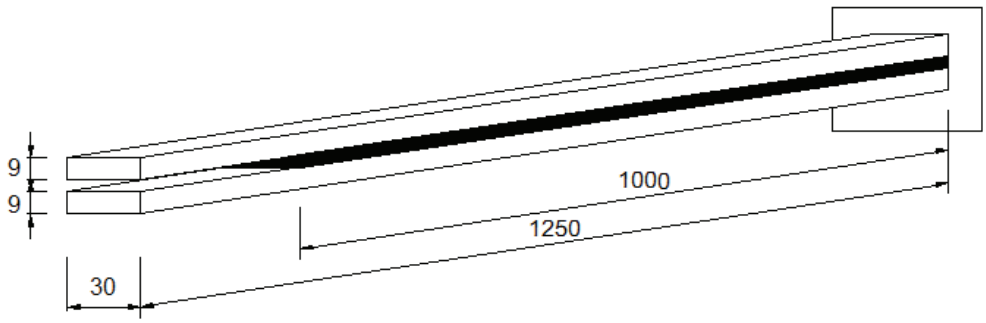

Fig. 1. A scheme of composite beam consisting of two aluminum cantilevered beams bonded with polymer mass.

All models have been induced to vibrations by applying an initial drift at the end of the beam. The behavior of the beams has been observed and recorded by two accelerometers installed on the metal side at the end of each beam. The total time of each measurement was equal to 12.5 seconds. A large number of acceleration time histories have been obtained. Based on them, natural frequencies for all six models have been calculated. Six representative acceleration time histories estimated for each model are presented in Fig. 2. It can be seen from Fig. 2. that the application of polymer mass increases the value of the natural frequency.