Case Studies in Construction Materials 3 (2015) 48–55

Contents lists available at ScienceDirect

Case Studies in Construction Materials

journal homepage: www.elsevier.com/locate/cscm

Short communication

Application of flexi-wall in noise barriers renewal

B. Daee, M.H. El Naggar*

Department of Civil and Environmental Engineering, The University of Western Ontario, London, ON N6A 5B9, Canada

ARTICLE INFO

Article history:
Received 25 March 2015
Received in revised form 20 June 2015
Accepted 22 June 2015
Available online 27 June 2015

Keywords:
Noise barrier
Polyurethane Foam
Poly-block
Polyurea
Accelerated construction

ABSTRACT

This paper presents an experimental study on structural performance of an innovative noise barrier consisting of poly-block, light polyurethane foam (LPF) and polyurea. This wall system (flexi-wall) is intended to be employed as a vertical extension to existing noise barriers (sound walls) in an accelerated construction method. To aid in the wall design, several mechanical tests were conducted on LPF specimens and two full-scale walls were then fabricated employing the same LPF material. The full-scale walls were subjected to lateral loading in order to establish their lateral resistance. A cyclic fatigue test was also performed on a full-scale flexi-wall in order to evaluate the performance of the wall under a repetitive loading condition. The results of the experiments indicated the suitability of flexi-wall in accelerated construction and confirmed that the structural performance of the wall system under lateral loading is satisfactory for the sound wall application. The experimental results were discussed and a preliminary design procedure for application of flexi-wall in sound wall applications was also developed.

1. Introduction

Noise barriers or sound walls are usually constructed along the roadways to mitigate the airborne noise emanating from vehicles. Most of the provinces across Canada have established a “noise barrier retrofit program”, which mainly involves the extension and renewal of the existing sound walls in urban environments, to mitigate noise pollution and minimize its impacts on public health. According to the published policy of ministries of transportation of several provinces (e.g., Ontario, Alberta and British Columbia), accelerated and cost-efficient construction techniques, which do not alter the structural system and foundation of the existing walls, are desired. The program also focuses on the sound walls built in the last few decades which are not high enough and are required to be vertically extended by 1–2 m to influentially absorb and reflect the vehicles noise.

An innovative sound wall system was developed in the University of Western Ontario, and was examined to serve as a vertical extension to the existing sound walls. The wall system (denoted as flexi-wall) consists of stay-in-place poly-blocks as formwork, light polyurethane foam (LPF) reinforced with steel rebars as structural cores and polyurea as a coating of the wall surfaces (Fig. 1). Poly-blocks are interlocking light-weight blocks which are stacked up layer by layer and act as formwork for the LPF cores. The poly-block is $20 \times 20 \times 80\,cm^3$ and includes four cylindrical voids with 14 cm diameter. It is made of molded low-density polyurethane and weighs approximately 1 kg. The poly-blocks are fire-resistant blocks and have an excellent capability to absorb, mitigate and reflect a wide range of noises with unmatched frequency of reflective noise.

* Corresponding author. Fax: +1 519 661 3808.
E-mail addresses: bdaee@uwo.ca (B. Daee), melnagga@uwo.ca (M.H. El Naggar).

http://dx.doi.org/10.1016/j.cscm.2015.06.003

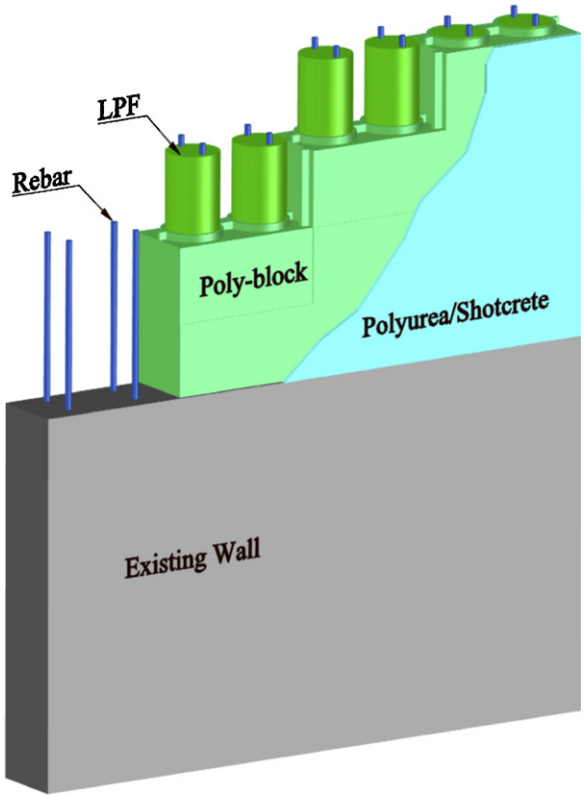

Fig. 1. Extending an existing sound wall using flexi-wall.

Polyurea coating is an abrasion-resistant finishing layer, which is sprayed on the surfaces of the wall and sets within 2–3 min. This layer also enhances the surface resistance of poly-blocks against stone impact, weathering, fire development, chemicals and penetration. LPF is an expanding liquid mixture which is injected into the poly-block voids and cures within 10 min. Steel rebars are epoxied into holes drilled in the existing sound wall to connect the wall extension to its base.

In comparison with conventional masonry walls, a flexi-wall is more noise-absorbing and can be built significantly faster. The construction of flexi-walls along roadways is also less obstructive since there is no need for construction vehicles and mobile cranes, which usually block or constrict the roads during roadside construction. This accelerated technique also

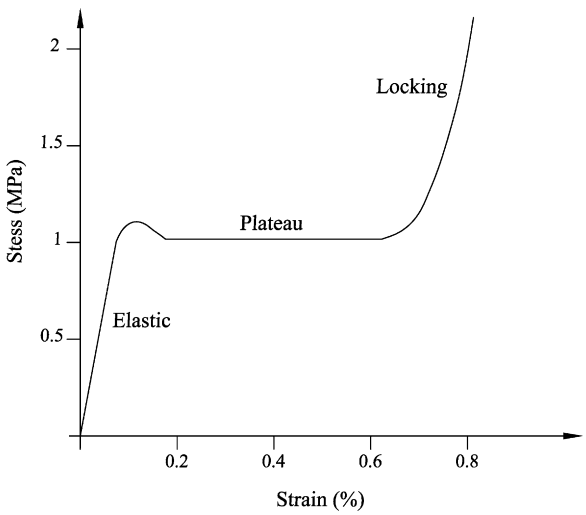

Fig. 2. Typical compressive behavior of LPF.