Construction and Building Materials 123 (2016) 8–14

Contents lists available at ScienceDirect

Construction and Building Materials

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

Load characteristics based on loading conditions of large soft body used for impact resistance testing of lightweight wall

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HIGHLIGHTS

- A large soft body is used for impact resistance testing of a lightweight wall.
- The load characteristics vary with the loading conditions.
- Maximum load acting on the test wall increases linearly with the potential energy.
- Further, the maximum load is different for different filler types.
- The length of the rope used for hanging the body should be greater than 2.5 m.

ARTICLE INFO

Article history:
Received 6 April 2016
Received in revised form 10 June 2016
Accepted 22 June 2016

Keywords:
Lightweight wall
Impact resistance test
Large soft body
Filler types
Rope length

ABSTRACT

The load characteristics of a large soft body used for the impact resistance testing of a lightweight wall varied with the loading conditions. It was found that the maximum load acting on the test wall increased linearly with the potential energy. Further, the maximum load was different for different filler types. It was also found that the length of the rope used for hanging the large soft body should be greater than 2.5 m in order to ensure the reliability of the test results. Finally, the axis of the hanging body did not have any effect on the load characteristics.

1. Introduction

Non-load-bearing lightweight walls have numerous advantages. For instance, they decrease the building weight, increase the degree of freedom of the spatial layout, and allow for simple construction. However, since they involve relatively light and fragile members in contrast to load-bearing walls, the proof strength for ensuring its structural safety must be secured [1–5]. In particular, since the lightweight walls installed within buildings are the construction elements that are mainly encountered in everyday life, their impact resistance against various types of impacts, both artificial and physical, should be high [6–9]. To test the impact resistance of a construction member such as a lightweight wall, one of two types of bodies, namely, a small hard body such as a steel ball or a large soft body such as a sandbag, can be used [10–18]. However, few studies have examined the extent to which these impacting bodies actually simulate the loads, the validity of the test conditions, the correlations between the bodies used, and the different test methods. For this reason, when one is designing and fabricating a lightweight wall that is to satisfy a set of requirements or when a business decision has to be made regarding the development of new building materials or methods, this lack of common performance indicators can be a significant inconvenience [19–21].

The purpose of this study is to experimentally investigate the effects of the characteristics of the load applied to a lightweight wall under different loading conditions, including for different types of filler and different rope lengths. This was done by using a large and soft body with a mass of 50 kg, which is most commonly used for the impact resistance testing of wall

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http://dx.doi.org/10.1016/j.conbuildmat.2016.06.118
0950-0618/

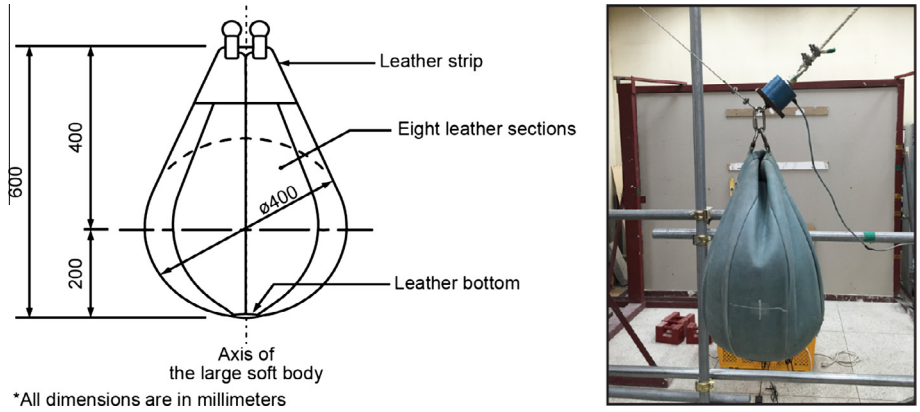

Fig. 1. Large soft body (50 kg spheroconical bag).

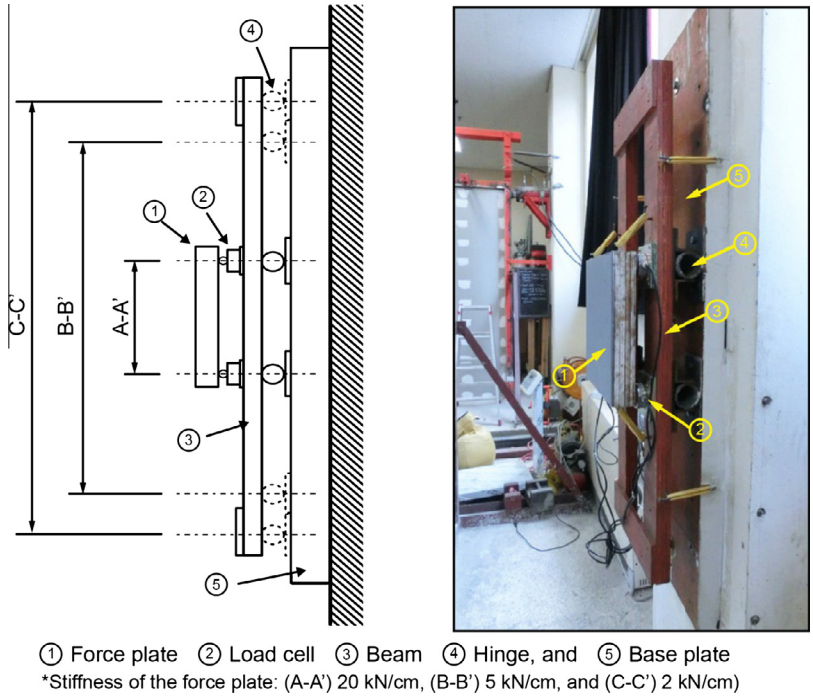

Fig. 2. Apparatus for measuring the impact load.

components, in order to ensure the accuracy of the test results, which are still to be investigated further to determine the loading conditions.

2. Materials and methods

2.1. Large soft body

The large soft body used in this study was a spheroconical leather bag (mass of 50 kg, diameter of 400 mm),[1] namely, a body similar to the one defined in the BS 5234-2[2] and KS F 2613[3] standards. The rope used for hanging the body was a wire rope (diameter of 6.5 mm). For fixing the large soft body, an electromagnet was used. An outline of the large soft body is shown in Fig. 1.

[1] ISO 7892 (Vertical building elements – Impact resistance tests – Impact bodies and general test procedures), NT BUILD 493 (Wall components – Resistance to impact from a soft body), JIS A 6512 canvas bag is used at movable partitions.

[2] BS 5234-2 (Partitions (including matching linings). Specification for performance requirements for strength and robustness including methods of test).

[3] KS F 2613 (Performance test methods of non-bearing lightweight wall for building construction).

Table 1
Experimental plan.

Factors	Levels
Types of filler	Glass beads (ø3) Glass beads (ø10) Sand (1690 kg/m^3)
Rope length (m)	1.0, 1.5, 2.0, 2.5, 3.0
Axis of the large soft body	Vertical incline
Drop height (m)	0.1, 0.2, 0.3, 0.6, 1.0

2.2. Force plate

Fig. 2 shows the specifications of the force plate designed and manufactured to analyse the characteristics of the various loads corresponding to the large soft body. An EDS-400A compact recorder (KYOWA, Japan) was used to collect and analyse the signals from four load cells (rated capacity of 5 kN) installed beneath the force plate. The sampling frequency was set to 1000 Hz. The stiffness of the force plate could be adjusted to three levels at different three stages (A-A': 20 kN/cm, B-B': 5 kN/cm, and C-C': 2 kN/cm). During this study, the stiffness of the force plate was set to 20 kN/cm.