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Technical Note

Evaluation of the acoustic performance of a modular construction system: Case study

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ABSTRACT

The aim of this technical note is to characterize the value of acoustic treatments applied to sustainable buildings. The technique is not common in Brazilian construction, but the market needs construction techniques like the ones that will be showed here. At the end of the article, a comparison between masonry with concrete blocks and the industrialized system (built in steel framing) is presented. The simplified method of measuring acoustics was chosen, to be as close as possible to the regular engineering method. The tested buildings have been classified accordingly. This project made use of the Brazilian law and some European laws.

1. Introduction

According to the World Health Organization [27], in recent years, the effects of noise pollution on human health have been accumulating. Important epidemiological studies have found that cardiovascular diseases, which are consistently associated with exposure to noise, are developing due to exposure to environmental noise.

The WHO's report showed the available evidences regarding risk estimation for the burden of cardiovascular disease attributable to environmental noise. The related evidences were based on the known exposure–response relationship of some European citizens.

Acoustics is the scientific study of sound, which is the pressure fluctuation or disturbance sensed by the human ear or measured by a microphone at a point in space. In contrast, noise is regarded as "unwanted" sound. Building acoustics refers particularly to the acoustics issues in buildings, such as room acoustics [16].

People are exposed daily to noise inside their own homes and from neighboring houses. The noises in residential buildings are numerous, including floor impact sounds, airborne sounds like music or voices, and drainage noises from neighboring units, as well as traffic noises from outside. In addition, ventilation systems and home appliances like refrigerators emit constant noises [14].

Nowadays building materials are expected to perform several functions and to be sustainable. For example, materials are supposed to satisfy structural, thermal and acoustical demands. The acoustics demands include both sound absorption and sound insulation. The requirement for a gain of time and money during the construction is becoming more important with the growing interest in sustainable building, which aims to reduce greenhouse gas emission [6].

One way to minimize the influence of noise pollution in the population is through the sound insulation of occupational and residential units, using construction techniques with performance levels appropriate for the purpose of each environment.

Throughout the planet, the construction industry is dedicated to the pursuit and implementation of strategies to modernize the sector, where the construction rationing plays a key role. In this sense, the most notable trends are related to the use of full systems or partially prefabricated ones, able to maximize the potential of embedded rationing in construction processes.

The optimization of the construction system is increasing, due to the need to reduce costs and minimize waste. Sealing walls with Oriented Strand Board, cement boards, cement-bonded particleboard and plasterboard are in the class of products which assist the industrialization of construction. They can be used in the execution of walls, floors, and roofs.

The sealing materials mentioned above are part of the walls which will be analyzed in this technical note. The Oriented Strand Board (OSB), is a reconstituted wood based panel composed of oriented wood strands bonded by hot-pressing by using thermosetting adhesive resins [5,23].

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Cement-bonded wood particleboard (CBWP) is made of strands, particles or fibers of wood mixed with portland cement and small amounts of additives manufactured into panels, bricks, tiles and other products used by the construction industry in applications such as wall, roof sheating and tiles, floor, fences, and sound barriers. Wood is the aggregate and the reinforcing agent, cement is the binder, water is the reactant, and the additives are the catalyst [18]. Cetris [4] brings the weighted sound reduction index (R_w) for a 16 mm-thick CBWP panel, which is about 32 dB, and Viroc [26], brings the R_w value about 35 dB, for the same thickness.

The fiber reinforced cement boards are composed by a mixture of Portland cement, cellulose or synthetic fibers and aggregates. However, there are some fundamental differences in the boards, according to the construction market. The main on is that there are two groups: with fibers dispersed in the matrix; and with fiberglass meshes on both surfaces. A non-asbestos fiber-cement product composed of Portland cement, cellulose fiber and refined san with 6 mm-thick is in a Sound Transmission Class about 30 dB [24].

Gypsum plasterboard consists of a gypsum core sandwiched between two layers of paper [15]. Building systems based on cold-formed steel profiles, gypsum plasterboard and mineral wool is gaining ground in many countries. It started in the US and the inspiration came from timber-framed buildings [25]. Nowadays, another construction cultures, as the Brazilian, are improving themselves through the Drywall market.

The researches of Glé et al. [6]; Berardi and Iannace [3]; Oldham et al. [19] and Asdrubali et al. [2], bring the acoustics properties of materials made with vegetable particles, natural fibers, biomass materials and reed, respectively. These studies can represent a sustainable and low cost alternative to common building materials in acoustics properties context.

This study aims to evaluate the acoustic performance of a modular and industrialized building system through the simplified field method, indicated by ISO (International Standard) 10052:2004 [12], with some modifications that elevate the accuracy, staying

Fig. 1. The buildings.

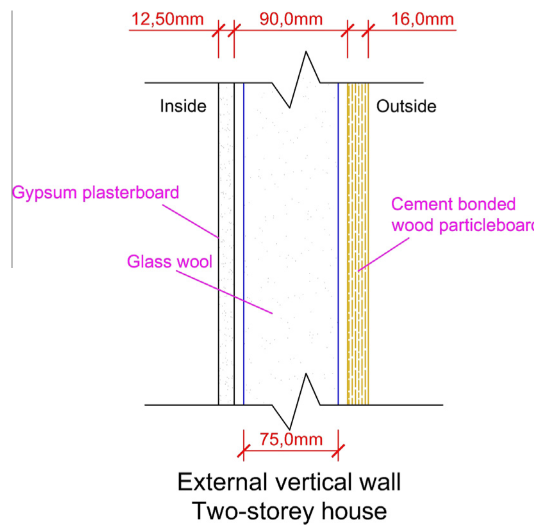

Fig. 3. External vertical wall of the two-storey house.

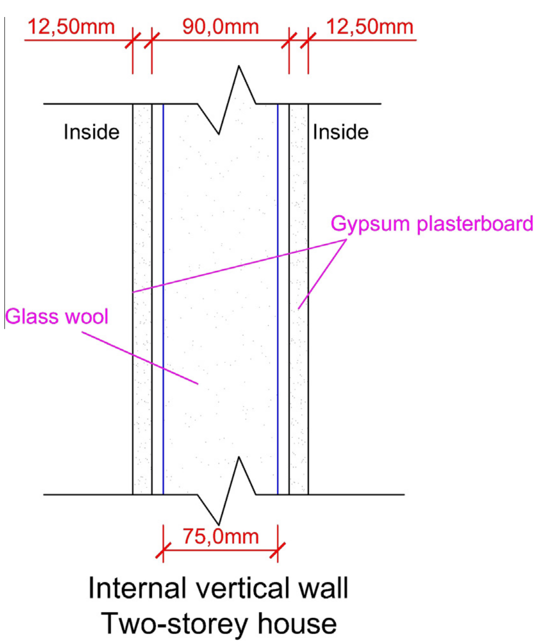

Fig. 2. Internal vertical wall of the two-storey house.

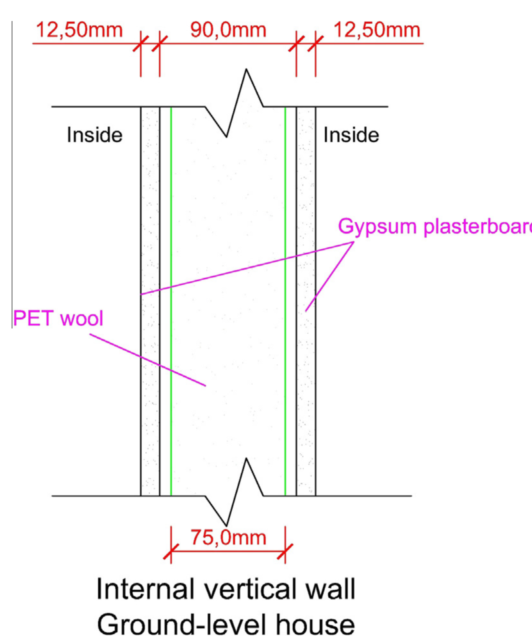

Fig. 4. Internal vertical wall of the ground level house.