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Hemp-Straw Composites: Thermal And Hygric Performances

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Abstract

The European ISOBIO project aims to develop new bio-based building insulating materials which contribute to reduce environmental impacts of buildings. The developed materials shall have low embodied energy and low carbon footprint and shall contribute to reduce energy needs of buildings and to ensure high hygrothermal comfort of users. This study investigates the valuation of agro resources as bio-based aggregates and as binding material to produce wholly bio-based composites. The developed composites are made of hemp shiv glued with wheat straw. After a feasibility study which investigates several ways to use wheat straw as a gluing material and several hemp to wheat straw ratio, three hemp-straw composites are selected. Specimens are produced to characterize thermal and hygric properties of developed composites. They show interesting thermal and hygric properties as they have low thermal conductivity (0.071 to 0.076 W/(m.K)) and they are excellent hygric regulators (MBV > 2 W/(m².%RH)).

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Keywords: Bio-based material, Conductivity, Moisture buffer value

1. Introduction

This study is part of the European ISOBIO project which aims to develop new bio-based building insulating materials. The aim is to reduce the embodied energy of materials while also reducing the total energy needs of buildings and allowing high hygrothermal comfort of users. Two kinds of products will be developed within ISOBIO project: insulating panels and bio-based insulating composites to be implemented on-site. The project focuses on the

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valuation of agro resources as bio-based aggregates or as binding material. Five agro resources are considered in ISOBIO project: wheat, rape, hemp, flax and corn cob. They are available as straw, fiber, shiv or dust.

This study investigates the development of bio-based composites to be used to produce insulating panels. This first investigation considers only one kind of bio-based aggregate (hemp shiv) and one kind of agro resource as binding material (wheat straw). The aim is to attest the feasibility of such composites and to qualify their hygrothermal performances, in link with the objectives in term of reduction of energy needs of buildings and in term of hygrothermal comfort of users.

2. Materials and methods

2.1. Developed materials

This study focuses on the valuation of agro resources as bio-based aggregates and as binding material to produce a wholly bio-based composite.

For this first investigation, hemp shiv are used as aggregates and wheat straw is considered as gluing material. Polysaccharide is also used as reference gluing material.

Actually, hemp shiv are commonly used to produce hemp composites with lime based binders or, more recently, with PLA (Polylactic acid) or with starch [1] [2] [3]. The aggregates used to produce the composites are commercial hemp shiv (Chanvribat from LCDA Les Chanvrières de l'Aube – France). Their bulk density is about 100 to 110 kg/m³. Their particle size distribution, measured by sieving, are given fig. 1. The mean width of shiv (W50) is 4 mm for Chanvribat and the width/length ratio is about 4.

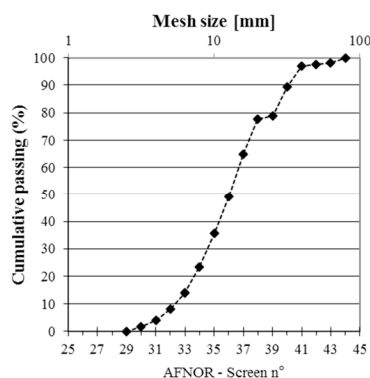


Fig. 1 Particle Size Distribution of Chanvribat hemp shiv

As mentioned in [4], the lignin within the straw and other herbaceous crops acts together with hemicellulose as a perfect natural adhesive for straw and any other cellulosic materials. Thus, wheat straw is expected to be convenient as binding material with hemp shiv. In this study, several ways to use wheat straw as a gluing material are tested, varying the hemp to wheat straw ratio and thermal activation step. Firstly, wheat straw is finely chopped and mixed with hemp shiv. The dry mix is then moistened and processed under pressure and heat. It is shown (fig. 2a) that to ensure good cohesion using the same thermal treatment, a minimum of 15% of wheat straw is required in the dry mix. Then, the selected mix proportioning consists in 80% of hemp shiv and 20% of straw powder.

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