Hemp-Earth insulation: a novel material for sustainable construction

Anja Kühnis, Guilhem Douillet

University of Bern, Institute of Geology, Baltzerstrasse 1+3, 3012 Bern, Switzerland

Introduction

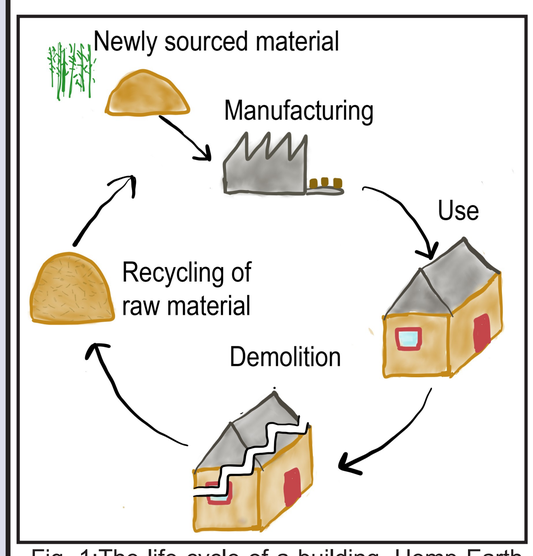

Fig. 1:The life cycle of a building. Hemp-Earth is biodegradable, so it can be recycled as mulch or compost.

The construction sector is responsible for over a third of global energy usage, CO_2 emissions, and waste [1]. Biobased materials like Hemp- Earth are a CO_2 sink[2], compostable and comparable to convenient insulating materials in their insulating ability[3]. Previous research of Hemp–Earth has focused on using Portland cement or lime as additives for stability. This reduces the positive effects on the CO_2 footprint and on biodegradability. Hemp– earth is a non structural load bearing drywall, needing to support its own weight.

Motivation and Related Research Questions

The main motivation of this work is to provide sufficient characterizing data to get hemp– earth approved as a construction material. For this the two main questions to be answered are:

. What effect does the initial water content have on compressive strength?

. Is the relationship of compressive strength and density linear over a large range of densities?

Methods

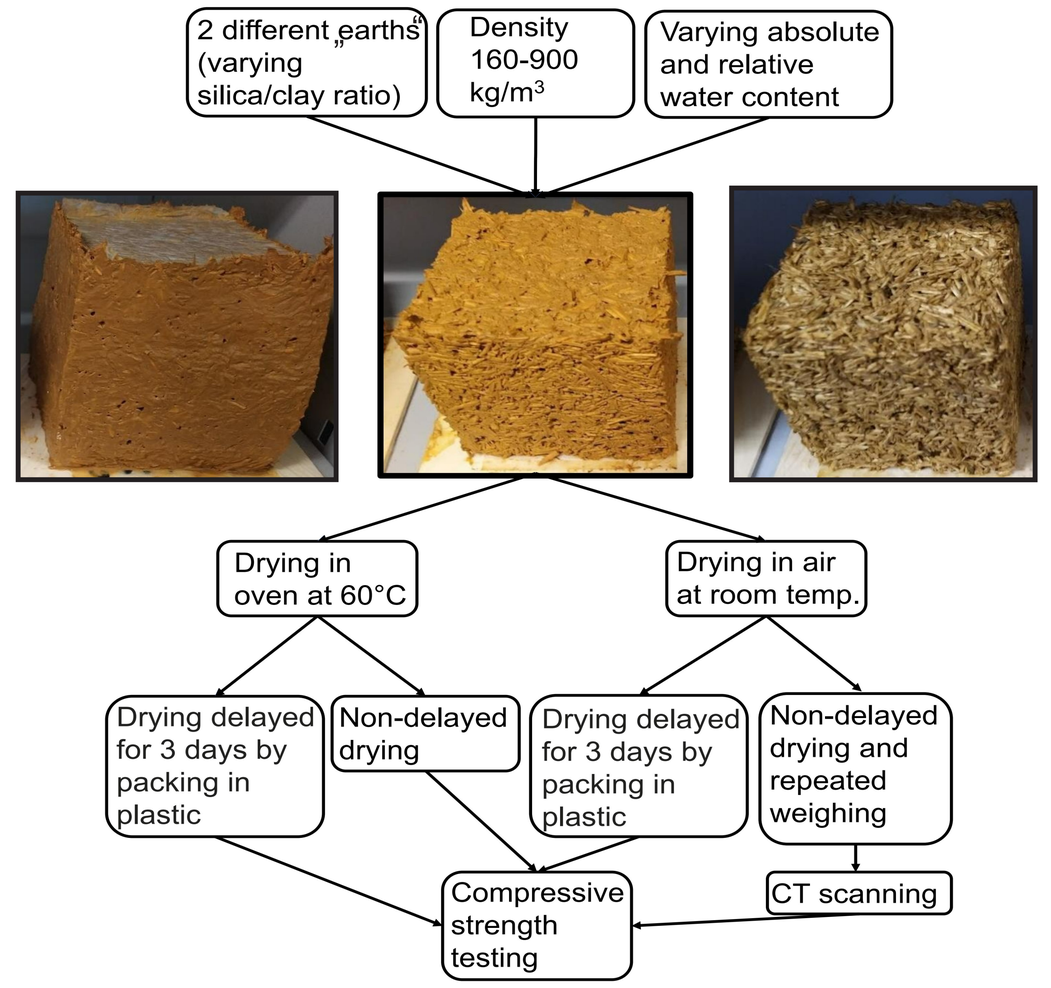

Fig. 2:Flow chart for the methods used in this work. Absolute water content: total water used in the mixture, relative water content: distribution of water between „earth“ and hemp, density is proportional to hemp-„earth“ ratio.

Results

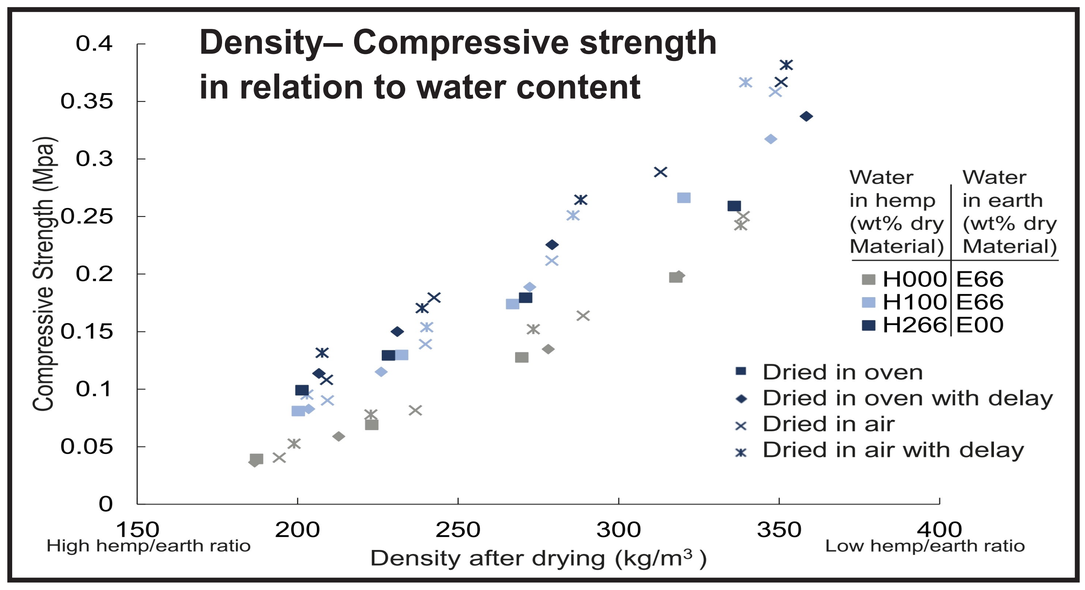

Fig. 3: Density– compressive strength in dependence of absolute and relative water content in „earth“ and hemp.

. At equal absolute water content (water in hemp + water in earth) the distribution of water between hemp and earth has no significant effect on compressive strength.

. Drying conditions have no effect in samples with low absolute water content.

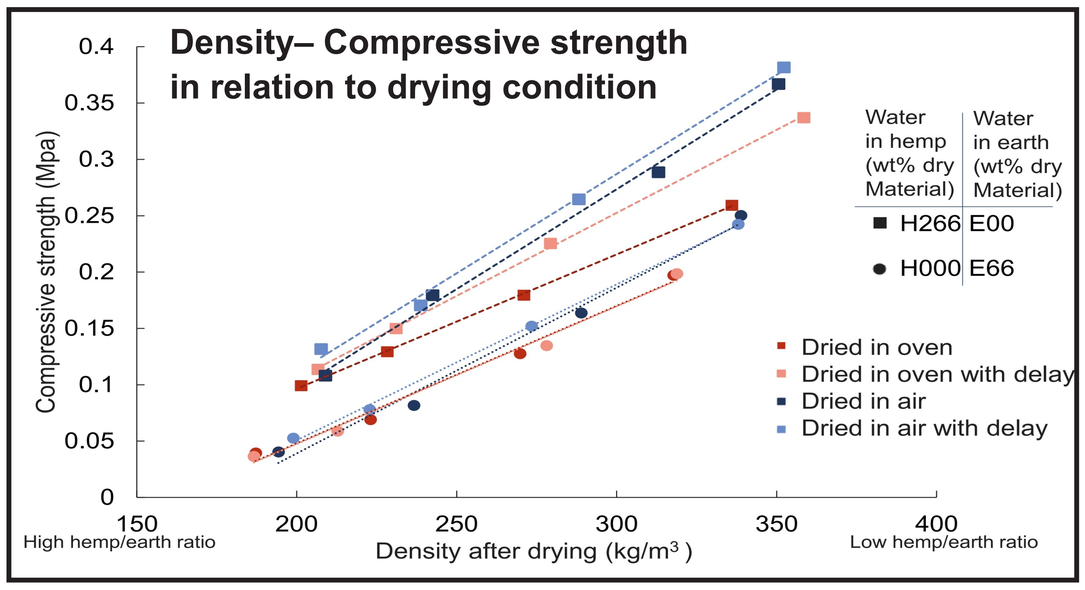

Fig. 4: Density– compressive strength in dependence of drying conditions

. Drying conditions have no significant effect on compressive strength in blocks with low absolute water content.

. At high absolute water content drying in air with delay creates the strongest blocks while drying in oven without delay creates the weakest blocks.

. Other results:

  . Blocks made of earth with more clay dry slower than those made with less clay and denser blocks take longer to dry than lighter blocks.

  . The material appears homogeneous in CT scans.

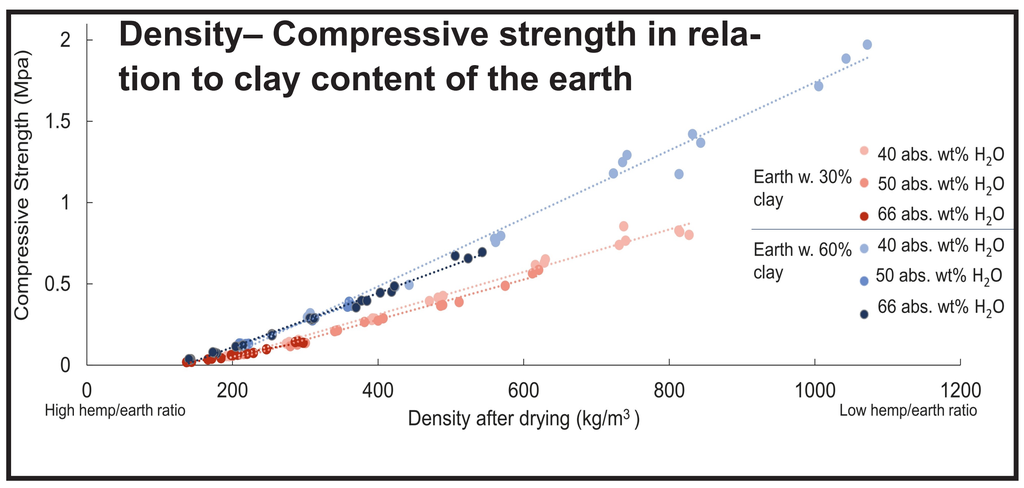

Fig. 5: Density– compressive strength in dependence of clay content of the „earth“.

. Density– Compressive strength relationship is linear over the measured density range and blocks made with „earth“ with a higher clay content have higher compressive strength than those with less clay.

Preliminary Conclusions:

Using „earth“ with a high clay content, drying the blocks slowly (storing in plastic for 3 days and then drying in air) and using a lot of water in the initial mixutre (high absolute water content) are factors that create blocks with high compressive strength. The data from this project about compressive strength as a function of density supports the linear trends found in other works, but in a larger density range. The results about accelerated and delayed drying need further investigation to find out a possible structural cause, for example dry cracks in the „earth“. Overall these results add to the existing work in supporting hemp– earth as an alternative to current conventional insulating materials in building construction.

References:

[1]: Trachte, S. (2012). Matériau, Matière d'Architecture Soutenable Choix responsable des matériaux de construction, pour une conception globale de l'architecture soutenable.

[2]: Shea, A., Lawrence, M., & Walker, P. (2012). Hygrothermal performance of an experimental hemp–lime building. Construction and Building Materials, 36, 270–275. https://doi.org/10.1016/J.CONBUILDMAT.2012.04.123

[3]: Mazhoud, B., Collet, F., Pretot, S., & Lanos, C. (2017). Development and hygric and thermal characterization of hemp-clay composite. Https://Doi.Org/10.1080/19648189.2017.1327894, 22(12), 1511–1521. https://doi.org/10.1080/19648189.2017.1327894

Contact:
anja.kuehnis@students.unibe.ch
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UNIVERSITÄT BERN