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Warsaw, 8.06.2026

### **ABSTRACT OF THE DISSERTATION**

„Influence of Compaction Level and Mixture Composition on the Physical and Mechanical Properties of Hemp–Lime Composite ”

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This doctoral thesis concerns hemp-lime composite, a building material combining hemp shives with a lime binder, characterised by a low carbon footprint and favourable hygrothermal properties. In the context of growing requirements for decarbonisation of the construction sector and the increasing importance of embodied carbon in building materials, organic-mineral composites represent a promising alternative to conventional construction materials. Despite the growing popularity of this technology, the lack of systematic research on the influence of material and technological variables, combined with the absence of unified testing methods, hinders the predictability of composite properties and limits its wider application in construction practice.

The thesis pursues two main objectives. The first involves a systematic assessment of the influence of four variables on the physical and mechanical properties of the composite: three mix composition variables, namely the binder-to-shiv ratio (B/S), the water-to-binder ratio (W/B), and hemp shiv particle size, as well as the compaction degree (CD) as a technological variable. The second objective is the proposal of a new criterion for determining compressive strength, tailored to the specific mechanical behaviour of the composite.

The research programme comprises seven scientific publications, within which over 300 specimens were tested in total, covering thermal conductivity, compressive strength, water vapour permeability and specific heat measurements. It was demonstrated that the B/S ratio is the dominant variable governing thermal conductivity and compressive strength, acting primarily through bulk density. Compaction degree exerts a significant, non-linear influence on composite properties, with the largest gains observed at the transition from CD = 150% to CD = 170%. The W/B ratio showed marginal influence at B/S = 1:1, while hemp shiv particle size had a limited effect on thermal conductivity. Bulk density serves as a reliable intermediate descriptor linking technological variables to composite properties ( $R^2 = 0.94$  for  $\lambda$  and  $R^2 = 0.68$  for compressive strength). The proposed criterion based on 1% permanent strain yields reliable results for mixes with B/S  $\geq 2:1$ .

The findings of this thesis contribute to the standardisation of testing methods for hemp-lime composites, in particular through the proposal of a new compressive strength criterion, the development of an objective method for determining compaction degree, and the verification of image analysis for hemp shiv characterisation. The results provide a basis for developing design guidelines for the wider application of this material in sustainable construction.

  
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