Use of technical hemp for concrete - Hempcrete

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Abstract. We live at the time of trying to reduce the carbon footprint, which also involves the production of building insulation. Today's trend is the construction of passive houses with the best insulation and reduced heating costs. By reducing the incineration of non-renewable sources for heating, we will reduce the carbon footprint, but by increasing the classical building thermal insulation, whether based on plastics or minerals. A suitable option is natural materials. This article deals with the use of technical hemp in concrete. Hemp is a historically widely used plant, but its decline has occurred due to its similarity to the THC variety, so this plant is now more known for its narcotic effects. For use in construction, industry, etc., the Cannabis Sativa L. variety, so-called Technical Hemp with negligible THC content, is used. Today, the use of technical cannabis is rediscovered. By adding technical hemp to the concrete, we improve the thermal properties of the concrete to the detriment of strength properties. The article describes different properties of the hemp concrete compared to the conventional concrete. In the building construction industry, it is known for the use in the cannabis insulation, hemp concrete, hemp oils and varnishes, Honeycomb plaster, ropes and strands. The best known are the cannabis insulation in the form of mats and hemp ropes, but there is also a widespread use of cannabis, which is discussed in this article. By measuring, the compressive strengths of the cannulated concrete were 1.13 MPa, which is comparable to that of the lightweight concrete and foam concrete. From this finding, that hemp concrete can be used as a filler material, nickels as a carrier material. This concrete can be used as a binder, both hydraulic lime and cement. However, when using cement, it is necessary to mineralize the shaker, which is a laborious and long-lasting activity.

1. Introduction

Hemp is a historically widely used plant, but its decline has occurred due to its similarity to the THC variety, so this plant is now more known for its narcotic effects. For use in construction, industry, etc., the Cannabis Sativa L. variety, so-called Technical Hemp (Figure 1) with negligible THC content, is used. Today, the use of technical cannabis is rediscovered. [1]

In building construction industry is known for use in cannabis insulation, hemp concrete, hemp oils and varnishes, Honeycomb plaster, ropes and strands. [1] The best known are cannabis insulation in the form of mats and hemp ropes, but there is also a widespread use of cannabis, which is this article.

Most Hempcrete manufacturers use hydraulic lime as a binder. Then with cannabis as a filler, there is no problem with the fact that hemp hurds is an organic substance, because it is mineralized by mixing it with hydraulic lime, which makes it an inorganic filler. However, if cement is used as a binder, there is a problem because the hemp hurds would prolong the time of hydration, which would result in a lot of undesirable circumstances. For this reason, it is necessary to first mineralize hemp hurds.
2. Formation sample

In the production of patterns, we proceeded according to the recipes K. Mikulica [2], who has already tried to use cement for the production of hemp concrete rather than hydraulic lime. The composition of the cannabis mineralization formulation is shown in Table 1.

Table 1. Composition of a recipe for the preparation of mineralized hemp hurds [2]

| Component          | Quantity per 1 m³ |
|--------------------|-------------------|
| Hemp hurds         | 100 Kg            |
| Hydrated lime      | 110 Kg            |
| Water              | 565 Kg            |

Mineralization of hemp hurds (Figure 2) took place for 7 days and then a mixture was prepared according to Table 2. The author of the table [2] used only 80 g of water per 1 m³ of concrete due to the volume of water used for hemp hurds mineralization. In our research, we had to give more water, namely 167 Kg per 1 m³ of concrete, because all the water dried out during the mineralization process. We chose the water factor of 0.44.

Table 2. Composition of Hemperete Recipe [2]

| Component                       | Quantity per 1 m³ |
|---------------------------------|-------------------|
| Cement (CEM II/N-M 32,5 R)      | 380 kg            |
| Mineralized hemp hurds          | 775 kg            |
| Water                           | 80 kg (167 kg)    |

Unfortunately, even 7 days of the process of mineralization of hemp hurds was not enough, and during the hydration process, there was an increase in time compared to conventional concrete.
In this way, 6 samples of hempcrete were created (Figure 3). For comparison, what causes cement shingles in cement, another 6 samples of cement composite were made. The cement slurry was composed of the same cement with the same water coefficient 0.44.

3. Subject & method of research
Measurement of all values started on hardened concrete, i.e. after 28 days. Samples of hempcrete and cement composite were measured at one time to maintain the same conditions. The measurement results are shown in Table 3. In addition to the measured values, values for hempcrete based on hydraulic lime according to manufacturers are also given here. [3] [4]
Table 3. Comparison of properties

|                             | Hempcrete based on hydraulic lime | Hemprcete based on cement | Cement Composite |
|-----------------------------|-----------------------------------|---------------------------|------------------|
| Volumetric mass density (Kg/m³) | 330 ± 10                          | 722                       | 1584             |
| Porosity (%)                | 71,1 ± 0,5                        | 55,77                     | 33,98            |
| Water absorption (%)        | -                                 | 77,03                     | 20,63            |
| Compressive strength (MPa)  | -                                 | 1,13                      | 33,05            |
| Flexural strength (MPa) (figure 4) | -                              | 0,36                      | 8,98             |

Figure 4. A sample of Hemprcete after a flexural strength test

4. Results and discussions
Hemprcete is used for both floors, walls and roofs on plaster, ie the entire envelope of the building. However, in the case of walls, it is not used as a supporting part, but only as a filling part. In particular, the supporting framework is provided by wooden beams, among which the hemp concrete is sprayed or vented. Similarly, cannabis is applied to floors and roofs. In the case of hemprcete, where the binder is cement, an increase in strength is expected over hemprcete with hydraulic lime.

For a comparison of strengths, Table 4 show where the compressive strengths of selected materials are shown. The strength of the measured strength of hemprcete is approaching the foam concrete. This concrete cannot be referred to as a carrier.
Table 4. Comparison of compressive strengths of selected elements for perimeter walls

| Element                        | Strength (MPa) |
|--------------------------------|---------------|
| Hempcrete (our samples)        | 1.13          |
| Ceramic perforated blocks      | 5-15          |
| Clay red bricks                | 15-20         |
| Concrete cavity blocks         | 3-4           |
| Foam concrete                  | 0.5 – 1.5     |
| Porous concrete                | 2-5           |
| Leichtbeton                    | 2             |

5. Conclusions

The work has demonstrated the use of hemp hurds as a filler in lightweight concrete, and the fact that hempcrete can be used both on hydraulic lime and on cement basis. However, when using cement, it is necessary to mineralize the shaker, which is a laborious and long-lasting activity.

The strength of such concrete approaches the strength of the lightweight concrete, the closest to the foam concrete. Consequently, these concretes cannot be used as a carrier concrete, but only as filler. Even though the cement can be used as a binder for hempcrete, it seems that the hydraulic lime is more suitable.

References

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