

## UTILIZATION OF HEMP AS A FILLER OF CEMENT-BONDED PARTICLEBOARDS



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### Summary

Cement bonded particleboards are composed from wooden material, cement, water and hydration admixtures. To satisfy customers and new ecological trends in building industry wood particles can be replaced with relative new progressive alternative fast renewable material – hemp. Despite the fact that there were initial doubts about interactions between hemp and cement matrix, for now it seems hemp has no influence on cement matrix behavior and also high properties of final hemp based cement bonded particleboards make from this aggregate great substitution for wood particles.

**Keywords:** Cement bonded particleboards, alternative material, hemp, filler substitution

### 1 Introduction

The cement-bonded particleboards can be applied in system buildings of all kind, they are ideal for dry method of construction, for buildings in demanding climatic conditions and in areas, where the other advantageous properties of this building material can be used. The boards are composed from wooden material, cement, water and hydration admixtures.

The major component, which forms filler in cement bonded wood composites is wood. Wooden particles are gained from timbers, which mean that it is necessary to produce them first. Application of varied alternative fillers may partly or even fully exclude this part of production. This will achieve lower costs and at the same time it contributes to - by smaller consumption of wooden particles - to decrease logging; wood is also renewable raw material, but with lower growth rate.

One of alternatives that might meet price and technological requirements is substitution of wooden particles by hemp. Hemp (***Cannabis sativa***) can be used as a full or partial substitute for wood particles.

## 1.1 Hemp (*Cannabis sativa*)

**Cannabis sativa**, also known as hemp has become notorious during recent years as an illicit source of narcotic drugs. In fact, the species is versatile and have the wide variety of possible uses. Its seeds, stalks, flowers and oils can be used in wide range of industry, like agriculture, automotive industry, cosmetics, building industry, furniture, paper, textile, food, recycling, etc.

It is an excellent alternative to wooden material for building materials; moreover, in some aspects its qualities even surpass the wood characteristics. Clear and evident benefits it is possible to behold in fast renewability; withal in comparison with other similar organic materials attain interesting mechanical qualities, usable in building materials.

## 2 Hemp based cement-bonded particleboards

### 2.1 Interaction between cement matrix and hemp aggregate

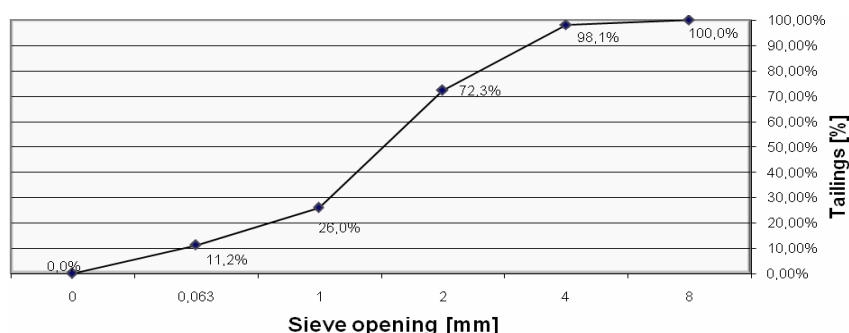
For the first time producer delivered grounded raw hemp (**Fig. 2**). Hemp in this condition couldn't be used, for further application to modified particleboards it had to be processed and sifted to separate fractions of hemp. In the cooperation with CIDEM Hranice, a. s., division CETRIS we obtain processed and sifted hemp particles with maximum size 4 mm. **Fig. 2** and **3** shows treated and sifted hemp particles and its sieve analysis.



**Fig. 1** Wood particles used in cement bonded particleboards

**Fig. 2** Grounded non-treated hemp

**Fig. 3** Grounded and treated hemp particles



**Fig. 4** Sieve analysis of treated hemp particles.

For hemp utilization as a filler to cement bonded particleboards is very important interaction with bonding component which is cement in this case. The hemp may not impact hydration of cement components which secures compactness of this composite. There is no unified method to prescribe hemp usability as a filler to cement bonded boards. There was made own method in this purpose.

Leach was made from wood particles and then from hemp for experiments. For comparison was used common water from water-supply system. The leach was got so that we left to infuse wood or hemp particles in water in ratio 1:10 weight parts. The leaches had been left in laboratory environment for 24 hours. Then we removed from the leach any solids by filtration through the filter paper. So we got net leaches from both, wood and hemp particles.

The experiment itself was executed with comparative method. We tested and compared the initial and final setting times and final strengths of spot samples. We compared three standard samples 40×40×160 mm from each test mixture. Each mixture was made according to standard (ČSN EN 196-1), with different mixing water (leaches). Results are written in **Tab. 2**.

**Tab. 1** One day hemp and wood leach and their comparison

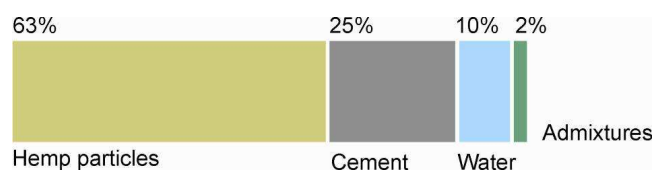
Parameter	Unit	Mix water requirements, ČSN EN 1008	Leach	
			Wood	Hemp
CHSK Cr	mg/l	-	897	2640
Sulphates SO <sub>4</sub> <sup>2-</sup>	mg/l	Max. = 2000	75	159
Humic substances	mg/l	Qualitative setting, brightly yellow	9.93	50.5
Reducing sugars	mg/l	Max. 100	<50	<50

**Tab. 2** Tested parameters

Sample	Bulk density [kg/m <sup>3</sup> ]	Final strength	
		R <sub>oh</sub> [N/mm <sup>2</sup> ]	R <sub>fl</sub> [N/mm <sup>2</sup> ]
Wood particles leach	2050	8.0	43.0
Hemp leach	2030	7.8	42.5
Common water	2070	7.9	43.2

In the cooperation with CIDEM Hranice, a. s., division CETRIS were mixed and pressed full cement bonded particleboards with treated hemp as a filler. The slabs were conditioned as well as common cement bonded particleboards in drier and then sawed up to testing samples. On these samples were in the labs determined their physical and mechanical properties (**Tab. 3**).

Hemp based cement bonded particleboards which were made are from treated hemp particles, cement, water and hydration admixtures. Fine fraction lay on both sides of coarse fraction of slab mixture. This is the reason of fine surface of final products.



**Fig. 5** Composition by volume

**Tab. 3** Hemp based cement bonded board strength characteristics and their comparison

Parameter	Unit	Hemp based cement bonded particleboards	Average values of CETRIS particleboards	ČSN EN 634-2
Bulk density	kg/m <sup>3</sup>	1,285	1,350	min. 1,000
Tensile strength	N/mm <sup>2</sup>	11.9	11.5	min. 9
Mod. of elasticity	N/mm <sup>2</sup>	7,330	6800	min. 4,500

### 3 Conclusions

From results of executed experiments follows that substances contained in hemp did not have noticeably affected bonding interactions between hemp and bonding material - cement. The leach from hemp showed higher value of parameters (**Tab. 1**), but they do not even reached determined limits. From this point of view tested hemp leach complies with the values determined by norm. First of all it concerns with presence of substances that can cause decrease of material durability by their aggressive actions in cement matrix (e.g. sulphates) or substances that retard cement hydration, so by this way they may have bad influence on cement matrix formation (organic compounds, e.g. carbohydrates, phosphates, etc.). All three samples, mixture from hemp or wood particles leach or common water, were correctly and smoothly hardened (**Tab. 2**). Physical and mechanical properties of cement bonded particleboards with hemp as a filler (**Tab. 3**) shows very high values comparable with properties of common cement bonded particleboards. For now it seems that hemp has no influence on cement matrix behavior and also with high properties of final hemp based cement bonded particleboards they can be used as a full substitution for cement bonded particleboards. Potential harmful changes might have a harmful influence on hemp based cement bonded particleboards durability. Therefore another part of our testing is focused on hemp filler behavior in cement matrix and potential changes observed in time.

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