Influence of the Structural Matrix upon the Thermal-Transfer Factor in the Case of the Composite Boards of Hemp Hurds (II)

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This paper, intended to continue the previous work under the same title, published in the previous number – aims at presenting the experimental results, obtained by laboratory tests, referring to the influence of the massic percentage of the hemp hurds within the composites, as well as to the influence of the participation percentages of the filling materials (cement, lime, sand, plaster etc.), on the thermal-transfer factor. The experimental results place thereby this composite in a position comparable to other construction materials; which emphasizes the importance of this composite, with a view to its being used as construction material, both as boards (for lining) and as blocks (for filling). The analysis of the experimental results shows that this type of composite can be "programmed" and "controlled" in terms of thermal-transfer factor, through the massic participation percentage of the hemp hurds. In this way, one can extend the use of these composites over constructions in areas with variable temperature differences, especially in the cold season. Moreover, by these experimental values, one can devise a methodology for sizing the construction elements, based on thermal-transfer factor to be achieved and, implicitly, on the thermal insulation capacity to be provided by the respective construction.

Keywords: composite, hemp hurds, thermal-transfer factor

The composites made of hemp hurds [1, 2] and mineral binders (cement, lime and sand) are "inspired" by the industrial product existing on the market of the construction materials, called RIGIPS (GYPSUM). Given the thermal characteristics of the lingocellulosic materials, we dare say that, by incorporating the hemp hurds in the mass of ceramic materials (which will be the binder) the thermal-transfer capacity of the new products can be positively influenced.

The theme, approached within a doctoral thesis, consists in the experimental determination of this influence – in terms of value, in comparison with the product on the market and underlies the achievement of new construction products, both with better thermal characteristics and with better mechanical resistances, the hemp hurds behaving as insertions in the volume of the product [3].

The researches conducted by the authors of this paper envisaged to determine recipes with variable massic-participation quotients of the hemp hurds [4] as well as of the materials in the structure of the binder; therefore, resorting to the following:

- the massic-participation percentages of the hemp hurds were 5%, 6%, 7%, 8%, 9%, 10%, 11%, 12%, 13%, 14%, 15%, for the boards (to be used in civil engineering, for lining purposes);
- the massic-participation percentages of the hemp hurds were 20%, 25%, 30% for the blocks (to be used for filling purposes);
- the percentage of 0% hemp hurds – for the achievement of standard products, in relation whereto, the thermal properties were comparatively analyzed, in addition to RIGIPS (GYPSUM);
- the massic-participation percentages of the materials in the structure of the binder (the rest of the composite mass, up to 100%) were:
  - cement 20%, 25%, 30% 35%, 40%;
  - sand 35%, 40%, 45%, 50%, 55%, 60%;
  - lime 20%, 25%, 30%, 35%, 40%.
- the massic-participation percentages of the materials in the structure of the binder (the rest of the composite mass, up to 100% - in the case of plaster) were:
  - plaster 50%, 100%;
  - cement 50%.

The recipes were obtained by combination [5] [6] by modifying the massic-participation percentages of the hemp hurds and of the materials (cement, sand, lime, plaster) which made up the binder in the structure of the composites.

Thermal transfer, through the composites with lignocellulosic matrix, made of hemp hurds

The thermal flow, during the heat transfer from indoors towards outdoors (through the structural elements of the constructions – flat) are determined with the general relation:

$$q_0=\lambda_0*(t_i-t_e)\ /\ \delta \quad [W/m^2] \qquad (1)$$

and the thermal flow across the entire surface, is determined with the relation:

$$Q=q_0*A=\lambda_0*A*(t_i-t_e)\ /\ \delta \quad [W] \qquad (2)$$

where:

q_0 = unitary thermal flow [W / m²];
Q = total thermal flow [W];
t_i = temperature of the indoor environment [°K];
t_e = temperature of the outdoor environment [°K];
λ_0 = the thermal-conductivity coefficient of the panels with homogeneous structure [W/m*K];
δ = thickness of the panels (walls) [m].

When using composites made of hemp hurds, either for lining or for filling the structures, the thermal-conductivity

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coefficient can be analytically defined, based on the value λ_R for Rigips (Gypsum), given that it is a material made of cement, lime and sand, without hamp hurds. In this case, one can write:

$$\lambda_x = c_x * \lambda_R \quad (3)$$

where:

λ_x = is the thermal-conductivity coefficient of the panels within the composite under study, depending on the massic-participation percentage of the hemp hurds;

c_x = is the correction coefficient;

λ_R = is the thermal-conductivity coefficient of the gypsum.

At the beginning of the researches, the correction coefficient c_x was not known, as values dependant on the massic percentage of the hemp hurds and its experimental determination was envisaged λ_{EX} by defining the thermal conductivity via measurements and by relating to the gypsum-specific value, which can be defined as follows:

$$c_{EX} = \lambda_{EX} / \lambda_R \quad (4)$$

In this way, the value c_x can be used for defining the total heat flow (respectively the heat losses), with a view to determining the thermal equilibrium, by sizing the heat sources; the relation (2) turning into:

$$Q_x = q_{EX} * A = c_{EX} * \lambda_R * A\ (t_i - t_e) / \delta \ \ [W/m^2] \quad (5)$$

Therefore, we dare say, an important objective of the researches was the determination of the correction coefficient c_{EX} wherewith the heat losses might be defined.

The correction coefficient was determined by experimentally determining the conductivity coefficient λ_{EX}, based on the participation percentages of the hemp hurds, in the constituency of the composite.

Experimental determination of the conductivity coefficient λ_{EX}

The experimental determinations of the thermal-conductivity coefficient, in the case of the composites made of hemp hurds, were made in the laboratories of the Research Institute within *Transilvania* University of Braşov, resorting to a specialized equipment of the type NETZSCH HFM 436/6/1, shown in figure 1.

The testing was made with the method HFM (standardized technique, which falls under ISO 8301), based on the system Peltier, which supposes introducing the test piece between two heated cups, set at different temperatures. The heat flow passing through the test piece is measured with a heat-transfer transducer. The installation can use, for research, test pieces of maximum 600 x 600 x 100mm.

Within the experimental researches, test pieces of 300 x 300mm, of variable thicknesses, were used, for measurements, being inserted in polystyrene boards, as shown in figure 2, both for the lining and for the filling elements.

Temperature differences between the cups were resorted to $\Delta T = t_i - t_e$ [°C] of 10, 15, 20, 25 and 30 °C, where t_i is the temperature of the hot cup (within the space), and t_e is the temperature of the cold cup (outside the space).

The tests conducted for the purpose of determining the thermal-conductivity coefficient λ_{EX} took into consideration the modification in the temperature of the cup that constitutes the external surface, in the range -20°C – (+) 15°C, in steps of 5°C, in order to analyze the possible variation of the thermal-transfer coefficient, based on these parameters T_{EX} and ΔT_X.

The experimental results were obtained (for each test piece) as a diagram similar to those shown in figure 3; the influence of the temperature difference ΔT and of the cup difference, specific to the external surface, on the value and on the variation law of the thermal-conductivity quotient of the composite, with 5, 10 and 15% hemp hurds and 40% cement, 40% sand and 20% lime, as shown in figure 3.

Similarly, determinations were made for the test samples having undergone modifications of the massic-participation percentages for cement, sand, lime or plaster.

The experimental results (in extenso) are shown in table 1.

Table 1 displays the determinations made for RIGIPS (GYPSUM), meant to enable a comparative study. Likewise, a study was conducted on test samples, made with 0% hemp hurds and with the observance of the same participation percentages, for cement, sand and lime.

A quite laborious study was conducted for the composites made of plaster – as binder, the results being

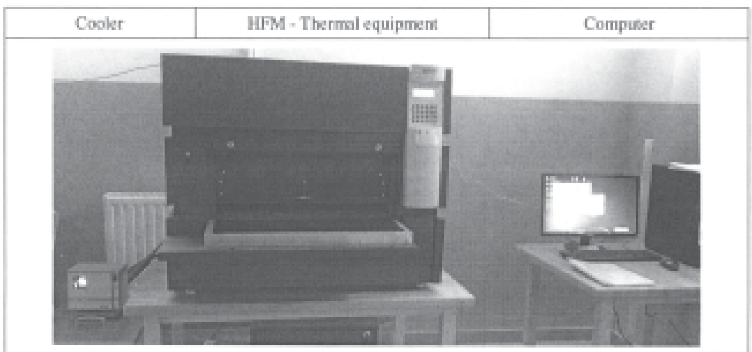
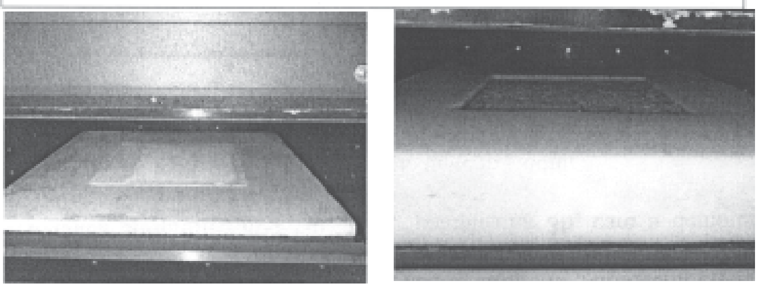


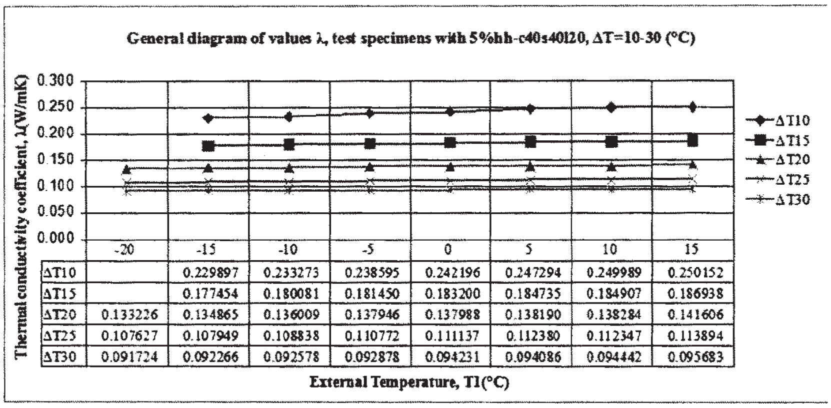
Fig. 1 Equipment NETZSCH HFM (Heat Flow Meter) 436/6/1



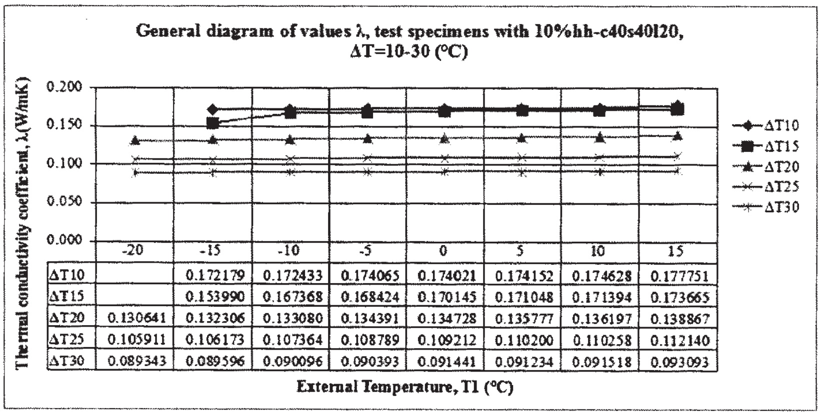
a b

Fig. 2 Fitting of the thin and thick test specimens (blocks) within testing frames (600 x 600mm)

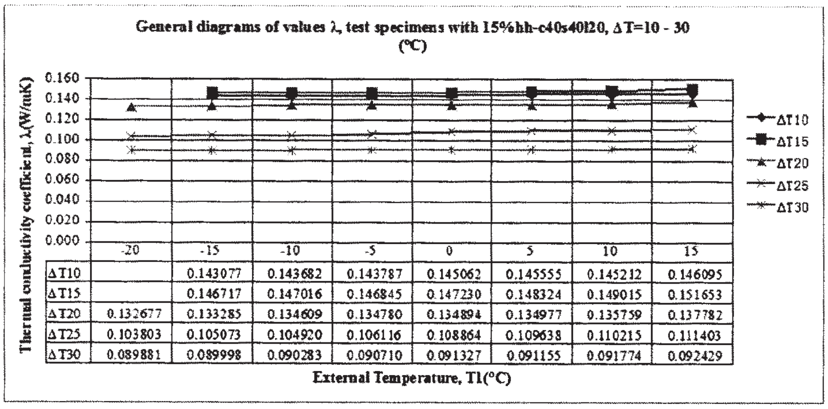
a. Fitting of thin test pieces within polystyrene frame 600 x 600 x 20mm;
b. Fitting of thick pieces (block) within polyurethane frame 600 x 600 x 100mm (deformable in height, at pressing).



	-20	-15	-10	-5	0	5	10	15
ΔT10		0.229897	0.233273	0.238595	0.242196	0.247294	0.249989	0.250152
ΔT15		0.177454	0.180081	0.181450	0.183200	0.184735	0.184907	0.186938
ΔT20	0.133226	0.134865	0.136009	0.137946	0.137988	0.138190	0.138284	0.141606
ΔT25	0.107627	0.107949	0.108838	0.110772	0.111137	0.112380	0.112347	0.113894
ΔT30	0.091724	0.092266	0.092578	0.092878	0.094231	0.094086	0.094442	0.095683



	-20	-15	-10	-5	0	5	10	15
ΔT10		0.172179	0.172433	0.174065	0.174021	0.174152	0.174628	0.177751
ΔT15		0.153990	0.167368	0.168424	0.170145	0.171048	0.171394	0.173665
ΔT20	0.130641	0.132306	0.133080	0.134391	0.134728	0.135777	0.136197	0.138867
ΔT25	0.105911	0.106173	0.107364	0.108789	0.109212	0.110200	0.110258	0.112140
ΔT30	0.089343	0.089596	0.090096	0.090393	0.091441	0.091234	0.091518	0.093093



	-20	-15	-10	-5	0	5	10	15
ΔT10		0.143077	0.143682	0.143787	0.145062	0.145555	0.145212	0.146095
ΔT15		0.146717	0.147016	0.146845	0.147230	0.148324	0.149015	0.151653
ΔT20	0.132677	0.133285	0.134609	0.134780	0.134894	0.134977	0.135759	0.137782
ΔT25	0.103803	0.105073	0.104920	0.106116	0.108864	0.109638	0.110215	0.111403
ΔT30	0.089881	0.089998	0.090283	0.090710	0.091327	0.091155	0.091774	0.092429

Fig. 3. General diagrams of values λ, test specimens with 5%hh, 10%hh, 15%hh-c40s40l20, ΔT=10 - 30 (°C)

shown in table 2 and table 3, for participation quotients 50% cement and 50% plaster, respectively 100% plaster.

For the test pieces usable as filling materials, the obtained results are shown in table 4.

With the experimentally obtained data, the correction coefficient was determined, based on λ_{EX} and λ_R. The results are shown in table 5.

The data shown in table 5 are specific to the massic participation of the ceramic materials, of 40% cement, 40% sand and 20% lime.

Conclusions.

The analysis of the results obtained by laboratory testing the composites with lignocellulosic basic matrix, made of hemp hurds; and the comparative study conducted in parallel with the GYPSUM; as well as the control samples, with 0% hemp hurds, led to the following conclusions:

-the tests were made on the cutting-edge equipment of the Research Laboratory within *Transilvania* University of Braşov;

-the tests were made on test pieces based on recipes having envisaged the modification of the massic percentages of the hemp hurds, as well as of the materials in the structure of the mineral binder (cement, sand, lime);

-the tests were made in parallel with test samples of Rigips (Gypsum) obtained from Rigips (Gypsum) boards, acquired on the market, as well as with test samples with 0% participation of hemp hurds – made within the laboratory;

The obtained results have shown that:

-the values of the thermal-conductivity coefficient are lower in the case of the test samples obtained from composites with hemp hurds, than in the case of RIGIPS (GYPSUM) or of the test sample;

-the values of the conductivity coefficient are lower, with the rise of the temperature difference ΔT (between the two cups) respectively outdoors and indoors the construction;

-the values of the conductivity coefficient have relatively low oscillations, based on the temperature of the exterior cup;

-the values of the conductivity coefficient drop, once with the rise in the massic percentage of hemp hurds, both in the case of the binder made of cement, lime and sand; and in the case of the binder made of plaster.

In this way, one can say that the shift to the current technological lies for manufacturing RIGIPS (GYPSUM), of the composites with hemp hurds and mineral binders might bring significant advantages:

-enhancement of a residual product – hemp hurds;

-achievement of industrial products (construction materials) with better properties, in terms of thermal

Table 1
COMPARATIVE SITUATION OF THE DATA OBTAINED WHEN DETERMINING λ, BASED ON % OF HEMP HURDS IN THE CERAMIC RECIPE c40s40l20 AND RIGIPS

-20°C	Rigips	0%p	5%p	6%p	7%p	8%p	9%p	10%p	11%p	12%p	13%p	14%p	15%p
ΔT10	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
ΔT15	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
ΔT20	0.130	0.138	0.133	0.139	0.133	0.130	0.130	0.131	0.130	0.128	0.130	0.129	0.133
ΔT25	0.106	0.113	0.108	0.116	0.109	0.107	0.099	0.106	0.105	0.106	0.105	0.106	0.104
ΔT30	0.089	0.093	0.092	0.096	0.094	0.093	0.086	0.089	0.091	0.093	0.092	0.088	0.090
-15°C	Rigips	0%p	5%p	6%p	7%p	8%p	9%p	10%p	11%p	12%p	13%p	14%p	15%p
ΔT10	0.224	0.265	0.230	0.232	0.202	0.218	0.219	0.172	0.168	0.148	0.150	0.155	0.143
ΔT15	0.172	0.175	0.177	0.174	0.175	0.180	0.173	0.154	0.167	0.150	0.152	0.158	0.147
ΔT20	0.130	0.138	0.135	0.140	0.133	0.131	0.131	0.132	0.131	0.129	0.131	0.130	0.133
ΔT25	0.106	0.114	0.108	0.115	0.109	0.108	0.100	0.106	0.106	0.107	0.105	0.107	0.105
ΔT30	0.089	0.094	0.092	0.096	0.094	0.094	0.087	0.090	0.092	0.093	0.092	0.088	0.090
-10°C	Rigips	0%p	5%p	6%p	7%p	8%p	9%p	10%p	11%p	12%p	13%p	14%p	15%p
ΔT10	0.225	0.266	0.233	0.232	0.204	0.219	0.220	0.172	0.167	0.150	0.150	0.158	0.144
ΔT15	0.173	0.176	0.180	0.175	0.176	0.186	0.175	0.167	0.171	0.151	0.153	0.158	0.147
ΔT20	0.131	0.138	0.136	0.141	0.135	0.132	0.132	0.133	0.132	0.130	0.133	0.131	0.135
ΔT25	0.106	0.114	0.109	0.115	0.110	0.108	0.100	0.107	0.106	0.108	0.106	0.107	0.105
ΔT30	0.089	0.094	0.093	0.097	0.094	0.094	0.088	0.090	0.092	0.095	0.092	0.087	0.090
-5°C	Rigips	0%p	5%p	6%p	7%p	8%p	9%p	10%p	11%p	12%p	13%p	14%p	15%p
ΔT10	0.226	0.266	0.239	0.233	0.205	0.219	0.222	0.174	0.168	0.150	0.152	0.158	0.144
ΔT15	0.175	0.179	0.181	0.177	0.178	0.187	0.176	0.168	0.172	0.152	0.154	0.160	0.147
ΔT20	0.131	0.138	0.138	0.141	0.135	0.132	0.132	0.134	0.132	0.131	0.134	0.132	0.135
ΔT25	0.107	0.113	0.111	0.115	0.110	0.108	0.101	0.109	0.108	0.108	0.107	0.109	0.106
ΔT30	0.090	0.094	0.093	0.097	0.094	0.092	0.086	0.090	0.091	0.093	0.093	0.088	0.091
0°C	Rigips	0%p	5%p	6%p	7%p	8%p	9%p	10%p	11%p	12%p	13%p	14%p	15%p
ΔT10	0.226	0.269	0.242	0.234	0.205	0.220	0.223	0.174	0.170	0.151	0.152	0.159	0.145
ΔT15	0.176	0.180	0.183	0.179	0.178	0.188	0.177	0.170	0.170	0.151	0.154	0.160	0.147
ΔT20	0.132	0.138	0.138	0.141	0.135	0.135	0.134	0.135	0.135	0.132	0.134	0.133	0.135
ΔT25	0.107	0.114	0.111	0.116	0.111	0.112	0.105	0.109	0.111	0.109	0.110	0.112	0.109
ΔT30	0.090	0.095	0.094	0.097	0.094	0.094	0.088	0.091	0.093	0.095	0.092	0.088	0.091
5°C	Rigips	0%p	5%p	6%p	7%p	8%p	9%p	10%p	11%p	12%p	13%p	14%p	15%p
ΔT10	0.229	0.273	0.247	0.238	0.206	0.219	0.224	0.174	0.173	0.150	0.155	0.160	0.146
ΔT15	0.177	0.182	0.185	0.180	0.181	0.188	0.178	0.171	0.172	0.151	0.156	0.159	0.148
ΔT20	0.131	0.138	0.138	0.142	0.136	0.136	0.135	0.136	0.136	0.134	0.137	0.135	0.135
ΔT25	0.107	0.114	0.112	0.116	0.112	0.113	0.106	0.110	0.112	0.109	0.112	0.112	0.110
ΔT30	0.090	0.095	0.094	0.097	0.094	0.095	0.089	0.091	0.094	0.096	0.093	0.088	0.091
10°C	Rigips	0%p	5%p	6%p	7%p	8%p	9%p	10%p	11%p	12%p	13%p	14%p	15%p
ΔT10	0.234	0.273	0.250	0.239	0.206	0.220	0.225	0.175	0.174	0.150	0.155	0.159	0.145
ΔT15	0.179	0.181	0.185	0.180	0.180	0.189	0.180	0.171	0.174	0.153	0.156	0.160	0.149
ΔT20	0.132	0.138	0.138	0.143	0.136	0.137	0.137	0.136	0.138	0.135	0.138	0.136	0.136
ΔT25	0.108	0.114	0.112	0.117	0.112	0.113	0.105	0.110	0.111	0.109	0.112	0.113	0.110
ΔT30	0.091	0.095	0.094	0.098	0.094	0.095	0.089	0.092	0.094	0.095	0.093	0.089	0.092
15°C	Rigips	0%p	5%p	6%p	7%p	8%p	9%p	10%p	11%p	12%p	13%p	14%p	15%p
ΔT10	0.239	0.272	0.250	0.239	0.205	0.220	0.226	0.178	0.174	0.151	0.156	0.159	0.146
ΔT15	0.181	0.184	0.187	0.184	0.182	0.191	0.181	0.174	0.177	0.156	0.160	0.160	0.152
ΔT20	0.131	0.141	0.142	0.145	0.138	0.138	0.137	0.139	0.138	0.136	0.138	0.136	0.138
ΔT25	0.109	0.115	0.114	0.118	0.113	0.114	0.106	0.112	0.113	0.111	0.113	0.113	0.111
ΔT30	0.091	0.096	0.096	0.098	0.095	0.096	0.089	0.093	0.094	0.096	0.094	0.089	0.092

Table 2
COMPARATIVE SITUATION OF THE DATA OBTAINED WHEN DETERMINING λ, BASED ON % OF HEMP HURDS IN THE CERAMIC RECIPE c50p50 AND RIGIPS

-20°C	Rigips	0%p	5%p	10%p	20%p
ΔT10	0.000	0.000	0.000	0.000	0.000
ΔT15	0.000	0.000	0.000	0.000	0.000
ΔT20	0.130	0.137	0.130	0.126	0.118
ΔT25	0.106	0.112	0.105	0.110	0.104
ΔT30	0.089	0.092	0.103	0.094	0.088
-15°C	**Rigips**	**0%p**	**5%p**	**10%p**	**20%p**
ΔT10	0.224	0.226	0.120	0.134	0.117
ΔT15	0.172	0.174	0.173	0.136	0.118
ΔT20	0.130	0.137	0.131	0.128	0.118
ΔT25	0.106	0.112	0.105	0.110	0.104
ΔT30	0.089	0.092	0.103	0.094	0.088
-10°C	**Rigips**	**0%p**	**5%p**	**10%p**	**20%p**
ΔT10	0.225	0.227	0.124	0.135	0.118
ΔT15	0.173	0.175	0.174	0.135	0.119
ΔT20	0.131	0.137	0.132	0.129	0.119
ΔT25	0.106	0.113	0.106	0.111	0.105
ΔT30	0.089	0.093	0.104	0.095	0.088
-5°C	**Rigips**	**0%p**	**5%p**	**10%p**	**20%p**
ΔT10	0.226	0.228	0.125	0.135	0.119
ΔT15	0.175	0.178	0.176	0.136	0.119
ΔT20	0.131	0.137	0,134	0,133	0.120
ΔT25	0.107	0.113	0,107	0,112	0,106
ΔT30	0.090	0.093	0.104	0,095	0,088
0°C	**Rigips**	**0%p**	**5%p**	**10%p**	**20%p**
ΔT10	0.226	0.228	0,124	0.136	0.119
ΔT15	0.176	0.179	0,178	0,137	0,119
ΔT20	0.132	0.137	0.134	0.137	0,119
ΔT25	0.107	0.113	0.108	0.114	0,107
ΔT30	0.090	0.093	0,104	0,096	0,090
5°C	**Rigips**	**0%p**	**5%p**	**10%p**	**20%p**
ΔT10	0.229	0.229	0.126	0.135	0,120
ΔT15	0.177	0.181	0.180	0.139	0,120
ΔT20	0.131	0.137	0.134	0.135	0.119
ΔT25	0.107	0.113	0.110	0.115	0.108
ΔT30	0.090	0.093	0.104	0.096	0.090
10°C	**Rigips**	**0%p**	**5%p**	**10%p**	**20%p**
ΔT10	0.234	0.232	0.126	0.136	0.120
ΔT15	0.179	0.181	0.180	0.143	0.120
ΔT20	0.132	0.137	0.135	0.134	0.119
ΔT25	0.108	0.113	0.110	0.114	0.108
ΔT30	0.091	0.094	0.106	0.097	0.090
15°C	**Rigips**	**0%p**	**5%p**	**10%p**	**20%p**
ΔT10	0.239	0.233	0.126	0.136	0.119
ΔT15	0.181	0.184	0.182	0.145	0.121
ΔT20	0.131	0.140	0.138	0.136	0.121
ΔT25	0.109	0.114	0.110	0.116	0.110
ΔT30	0.091	0.095	0.104	0.098	0.091

Table 3
COMPARATIVE SITUATION OF THE DATA OBTAINED WHEN DETERMINING λ, BASED ON % OF HEMP HURDS IN THE CERAMIC RECIPE p100 AND RIGIPS

-20°C	Rigips	0%p	5%p	10%p	20%	30%
ΔT10	0.000	0.000	0.000	0.000	0.000	0.000
ΔT15	0.000	0.000	0.000	0.000	0.000	0.000
ΔT20	0.130	0.135	0.132	0.128	0.102	0.081
ΔT25	0.106	0.111	0.105	0.104	0.101	0.082
ΔT30	0.089	0.091	0.107	0.088	0.094	0.083
-15°C	**Rigips**	**0%p**	**5%p**	**10%p**	**20%**	**30%**
ΔT10	0.224	0.249	0.231	0.142	0.099	0.081
ΔT15	0.172	0.172	0.176	0.154	0.099	0.082
ΔT20	0.130	0.135	0.133	0.130	0.105	0.081
ΔT25	0.106	0.111	0.105	0.104	0.101	0.082
ΔT30	0.089	0.091	0.107	0.088	0.094	0.082
-10°C	**Rigips**	**0%p**	**5%p**	**10%p**	**20%**	**30%p**
ΔT10	0.225	0.250	0.237	0.147	0.100	0.081
ΔT15	0.173	0.173	0.176	0.154	0.105	0.081
ΔT20	0.131	0.135	0.134	0.131	0.105	0.082
ΔT25	0.106	0.111	0.106	0.106	0.103	0.082
ΔT30	0.089	0.092	0.108	0.089	0.095	0.083
-5°C	**Rigips**	**0%p**	**5%p**	**10%p**	**20%**	**30%p**
ΔT10	0.226	0.250	0.236	0.151	0.101	0.082
ΔT15	0.175	0.176	0.179	0.155	0.106	0.082
ΔT20	0.131	0.135	0.136	0.133	0.105	0.083
ΔT25	0.107	0.112	0.108	0.107	0.105	0.083
ΔT30	0.090	0.092	0.108	0.089	0.095	0.084
0°C	**Rigips**	**0%p**	**5%p**	**10%p**	**20%**	**30%**
ΔT10	0.226	0.251	0.238	0.160	0.103	0.083
ΔT15	0.176	0.176	0.180	0.158	0.107	0.082
ΔT20	0.132	0.135	0.136	0.133	0.106	0.082
ΔT25	0.107	0.112	0.108	0.107	0.105	0.084
ΔT30	0.090	0.092	0.109	0.090	0.096	0.084
5°C	**Rigips**	**0%p**	**5%p**	**10%p**	**20%**	**30%**
ΔT10	0.229	0.252	0.238	0.155	0.104	0.083
ΔT15	0.177	0.178	0.182	0.159	0.107	0.083
ΔT20	0.131	0.135	0.136	0.133	0.106	0.083
ΔT25	0.107	0.111	0.110	0.108	0.105	0.085
ΔT30	0.090	0.092	0.110	0.090	0.096	0.084
10°C	**Rigips**	**0%p**	**5%p**	**10%p**	**20%**	**30%**
ΔT10	0.234	0.254	0.238	0.161	0.103	0.083
ΔT15	0.179	0.178	0.182	0.159	0.110	0.084
ΔT20	0.132	0.137	0.137	0.134	0.106	0.085
ΔT25	0.108	0.112	0.109	0.109	0.106	0.085
ΔT30	0.091	0.093	0.110	0.091	0.097	0.085
15°C	**Rigips**	**0%p**	**5%p**	**10%p**	**20%**	**30%**
ΔT10	0.239	0.258	0.238	0.161	0.103	0.084
ΔT15	0.181	0.180	0.184	0.160	0.111	0.085
ΔT20	0.131	0.139	0.140	0.137	0.110	0.086
ΔT25	0.109	0.113	0.112	0.110	0.108	0.087
ΔT30	0.091	0.094	0.111	0.091	0.096	0.086

insulation; and implicitly, in terms of heat losses – with implications on the diminution of the energetic consumptions, with a view to heating the constructions;

-achievement of ecological products;

-achievement of products with better mechanical properties (resistance to bending, resistance to shock, resistance to screw pulling) due to the “fittings” made by incorporating the hemp hurds;

-achievement of lighter products, with better characteristics, in terms of phonic insulation.

The authors aim, for the future, at presenting the physico-mechanical characteristics of the products obtained from hemp hurds, as well as their capacity of phonic attenuation; these updates placing the results in the area of interest of the construction-material economy.

-20°C	block 20%hh - c40s40120	block 25%hh - c40s40120	block 30%hh - c25s55120	block 30%hh - c30s50120	block 30%hh - c35s45120
ΔT10	0.000	0.000	0.000	0.000	0.000
ΔT15	0.000	0.000	0.000	0.000	0.000
ΔT20	0.119	0.101	0.082	0.080	0,.080
ΔT25	0.116	0.104	0.083	0.079	0.,079
ΔT30	0.118	0.107	0.084	0.082	0.087
-15°C	block 20%hh - c40s40120	block 25%hh - c40s40120	block 30%hh - c25s55120	block 30%hh - c30s50120	block 30%hh - c35s45120
ΔT10	0.118	0.103	0.083	0.076	0.081
ΔT15	0.118	0.093	0.078	0.081	0.080
ΔT20	0.120	0.106	0.084	0.081	0.082
ΔT25	0.117	0.105	0.084	0.079	0.081
ΔT30	0.120	0.109	0.088	0.084	0.087
-10°C	block 20%hh - c40s40120	block 25%hh - c40s40120	block 30%hh - c25s55120	block 30%hh - c30s50120	block 30%hh - c35s45120
ΔT10	0.118	0.107	0.085	0.082	0.082
ΔT15	0.119	0.107	0.085	0.082	0.083
ΔT20	0.121	0.107	0.084	0.082	0.082
ΔT25	0.119	0.105	0.085	0.080	0.081
ΔT30	0.119	0.111	0.089	0.084	0.088
-5°C	block 20%hh - c40s40120	block 25%hh - c40s40120	block 30%hh - c25s55120	block 30%hh - c30s50120	block 30%hh - c35s45120
ΔT10	0.120	0.108	0.086	0.083	0.084
ΔT15	0.120	0.107	0.085	0.082	0.085
ΔT20	0.121	0.109	0.085	0.082	0.082
ΔT25	0.122	0.110	0.087	0.083	0.084
ΔT30	0.122	0.111	0.090	0.085	0.088
0°C	block 20%hh - c40s40120	block 25%hh - c40s40120	block 30%hh - c25s55120	block 30%hh - c30s50120	block 30%hh - c35s45120
ΔT10	0.120	0.110	0.094	0.083	0.085
ΔT15	0.121	0.109	0.087	0.085	0.085
ΔT20	0.122	0.109	0.087	0.087	0.084
ΔT25	0.125	0.109	0.090	0.087	0.085
ΔT30	0.124	0.112	0.092	0.090	0.089
5°C	block 20%hh - c40s40120	block 25%hh - c40s40120	block 30%hh - c25s55120	block 30%hh - c30s50120	block 30%hh - c35s45120
ΔT10	0.121	0.112	0.098	0.087	0.086
ΔT15	0.124	0.111	0.090	0.087	0.087
ΔT20	0.124	0.114	0.089	0.088	0.087
ΔT25	0.126	0.117	0.093	0.090	0.089
ΔT30	0.127	0.116	0.093	0.091	0.090
10°C	block 20%hh - c40s40120	block 25%hh - c40s40120	block 30%hh - c25s55120	block 30%hh - c30s50120	block 30%hh - c35s45120
ΔT10	0.124	0.116	0.098	0.090	0.088
ΔT15	0.126	0.113	0.092	0.089	0.089
ΔT20	0.126	0.120	0.092	0.090	0.089
ΔT25	0.129	0.121	0.094	0.092	0.090
ΔT30	0.129	0.119	0.096	0.093	0.093
15°C	block 20%hh - c40s40120	block 25%hh - c40s40120	block 30%hh - c25s55120	block 30%hh - c30s50120	block 30%hh - c35s45120
ΔT10	0.127	0.124	0.098	0.093	0.090
ΔT15	0.130	0.123	0.095	0.093	0.091
ΔT20	0.130	0.120	0.096	0.093	0.093
ΔT25	0.132	0.125	0.098	0.095	0.093
ΔT30	0.132	0.122	0.099	0.097	0.096

Table 4
COMPARATIVE SITUATION OF THE VALUES λ TESTED FOR THE TEST PIECES BLOCK, WITH 20, 25 AND 30% OF HEMP HURDS

Table 5
RATIO BETWEEN % OF HEMP HURDS INCORPORATED IN THE CERAMIC MASS AND GYPSUM (INHOMOGENEOUS ALVEOLAR STRUCTURE/ HOMOGENEOUS STRUCTURE)

$C_{5\%}$	$C_{6\%}$	$C_{7\%}$	$C_{8\%}$	$C_{9\%}$	$C_{10\%}$
0.5349	0.5313	0.5277	0.5241	0.5205	0.5169
$C_{11\%}$	$C_{12\%}$	$C_{13\%}$	$C_{14\%}$	$C_{15\%}$	
0.5133	0.5097	0.5060	0.5024	0.4988	

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Manuscript received: 16.04.2014