SANDWICH PANELS CONSTITUTED OF FIBROCEMENT FACES AND COMPOSITE CORE BASED ON RESIDUES AND VEGETAL POLYURETHANE RESIN: PRODUCTION VIABILITY EVALUATION

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OBJECTIVES

The main objective of this work is to evaluate the **production viability of sandwich panels constituted by fibrocement faces and composite core based on residues and vegetal polyurethane resin** (Figure 01).

Figure 01 - Sandwich beams for Flexural tests.

BACKGROUND AND JUSTIFICATION

Buildings - enormous resource-consumers (about 40 per cent of energy, water, materials);
Brazil - the lack of organization in the building construction sector, at all levels, results in:

- **Low productivity;**
- **Great waste of materials and labor;**
- **Debris generation.**

Abundant generation of many types of residues and by-products:

- **Wood chips** – there is data that in Brazil 50% of the wood is transformed into wood sawdust, chips, pieces etc.
- **Leather shavings** – the Brazilian leather shaving generation is in the range of 66,3 to 88,4 thousand tons/year, 23,8% in São Paulo State.
- **Scrap tires, tire pieces** – in Brazil 180 million discarded tires are disposed off at landfill sites, more than 35 millions are discarded per year and 2 to 3 billions are stored in open areas.

SUSTAINABILITY ISSUES

The proposed panel employment allows the following environmental benefits:

Figure 02 - Discarded tires.

- **Lower building energy consumption** provided by the insulating behavior of the panel;
- **Uses of a natural and renewable Polyurethane resin (Figure 02);**
- **Reduction of some types of residues;**
- **Advantages related to the industrialized construction process**, which permits raw-material and labour rationalization, besides debris and waste reduction;
- **Production of the core composites by the use of a low energy demand technique**.

METHODOLOGY

Tests with the core composites and the fibrocement were conducted to characterize some physical and mechanical properties.
The composites are constituted by residues (wood chips, leather shavings tanned with chrome and tire pieces), which were agglomerated by polyurethane resin of Castor Oil (*Ricinus communis*).
Fourteen Fibrocement compositions were proposed and tested.

PRELIMINARY RESULTS

Table 01 - Composite core leaching and solubilization results.

LEATHER SHAVINGS LEACHING AND SOLUBILIZATION RESULTS CHROME CONCENTRATION AND BRAZILIAN STANDARD LIMITS		
Sample	**Test**	
	Leaching	**Solubilization**
As received	44,20	274,00
Latex treated	39,70	57,40
Highest density	6,59	12,21
Medium density	2,37	18,05
Lowest density	3,30	16,45
Highest density PU coated	0,00	0,00
Medium density PU coated	0,00	0,00
Lowest density PU coated	0,00	0,00
Standard NBR 10004 max	5,00	-
Standard NBR 10005 - max	-	0,05

Figure 03 - Composite core materials. Leather shavings PU coated, leather shavings, wood chips, rubber.

The composites thermal properties results demonstrate efficient insulating performance, required characteristic to constitute sandwich panels core, as well as they presented resistant capacity (Figures 04 and 05).
The leaching and solubilization tests showed that there is no satisfactory chrome stabilization in the leather shavings composites, demanding further investigations (Table 01).
Overall, the study results suggest that the composites application as a core material holds high potential and warrants further attention (Figure 03).

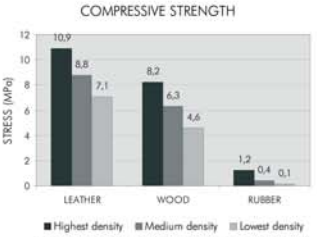

Figure 04 - Composite core compressive strength.

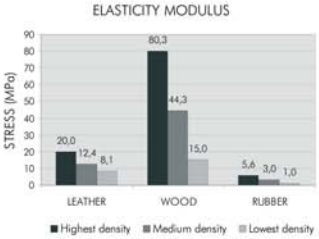

Figure 05 - Composite core elasticity modulus.

Table 02 - Fibrocement main properties.

FIBROCEMENT MAIN PROPERTIES			
Compressive Strength (MPa)			32,94
MOE (Gpa)			15,90
MOR (MPa)			7,40
Tensile Strength by Diametrical Compression (MPa)			3,09
Toughness Indexes I^5 I^{10} I^{20}	3,40	5,73	10,50
Residual Strength Factor $R_{5,10}$ $R_{10,20}$		33,80	18,40

According to the fibrocement appraised results, a composition was chosen with enough resistant capacity and tenacity to constitute the panel faces, supporting the research conclusion by the sandwich beams tests (Table 02).

COORDINATES

São Carlos (Figure 07) is located in the central area of the São Paulo State, 228 km distant of the capital (São Paulo), in the southeast area of Brazil (Figure 06).
Latitude 22°01'10"S - Longitude 47°53'38"W
Climate predominantly tropical, with average temperatures varying between the maxim of 26,9°C

Figure 06 – São Paulo State in Brazil.

Figure 07 – São Carlos in São Paulo State.

NEXT STEPS

Facing Bending Stress, Core Shear Stress, Sandwich Beam Deflection, Flexural Stiffness, Core Shear Modulus and Impact Resistance tests are been conducted with the sandwich components.

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