

# PHYSICAL AND MECHANICAL PROPERTIES ASSESSMENT OF LIGNOCELLULOSIC RICE STRAW-BASED RIGID POLYURETHANE FOAM FOR STRUCTURAL SANDWICH PANEL CORES

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## ABSTRACT

This study is conducted to determine the physical properties such as density and thermal conductivity, and the mechanical properties such as compressive strength, shear strength and tensile strength of the novel lignocellulosic rice straw-based rigid polyurethane foam. Results show that the lignocellulosic rice straw-based rigid polyurethane in this study meet the requirements indicated in ASTM E 1730-02 and can be used as structural sandwich panel core materials.

## METHODOLOGY

### Foaming Formulation

Ingredients	Concentration, php <sup>a</sup>	
	LRS PU foams	Control PU foams
<b>B-side materials</b>		
VORANOL <sup>®</sup> 490 (Petroleum-based polyol)	85	100
Rice straw-based polyol	15	0
Polycat <sup>®</sup> 8 (gelling catalyst)	0.5	0.5
INV <sup>®</sup> 690 (surfactant)	1.5	1.5
Distilled water (blowing agent)	1.0	1.0
<b>A-side materials</b>		
Isocyanate index <sup>b</sup> of PAPI <sup>®</sup> 27	110	110

**Table 1.** Formulations for lignocellulosic rice straw-based rigid (lrs) PU foams and control PU foams

### Foam Characterization

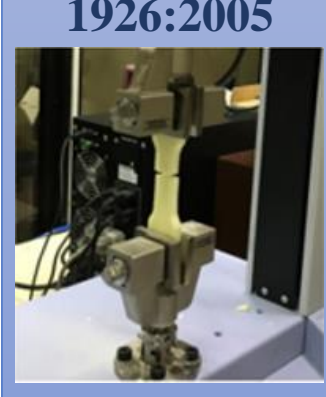
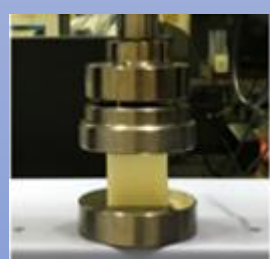
Density Test  
ASTM D 1622-08

Compressive  
Strength  
ASTM D 1621

Shear Strength  
ASTM C 273 &  
ISO 1922

Tensile  
Strength  
ISO  
1926:2005

Thermal  
Conductivity  
ASTM C 518-15



Requirement Procedure	Type 1	Type 2	Type 3
Density, kg/m <sup>3</sup> , max	41.6	55.7	72.0
Thermal conductivity, W/mK, max	0.036	0.037	0.037
Compressive strength, kPa, min	172.4	275.8	448.2
Shear strength, kPa, min	172.4	241.2	275.8
Tensile strength, kPa, min	206.8	344.7	517.1

**Table 2.** Standard Specification for Rigid Foam for Use in Structural Sandwich Panel Cores based on ASTM E 1730-02

## CONCLUSION

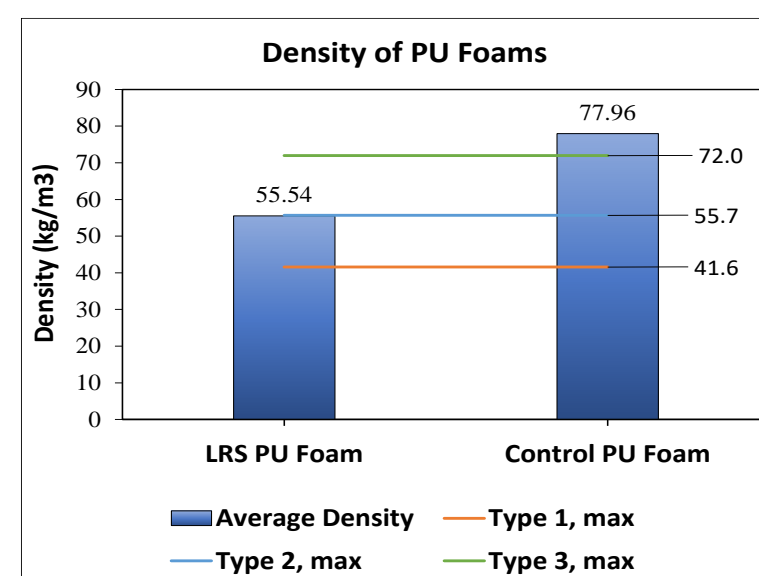
The results of the study clearly show that the physical and mechanical properties of the lignocellulosic rice straw-based rigid polyurethane foam passed the specifications for structural sandwich panel core listed in ASTM E 1730-02 and classified as Type 2 structural sandwich panel core.

## INTRODUCTION

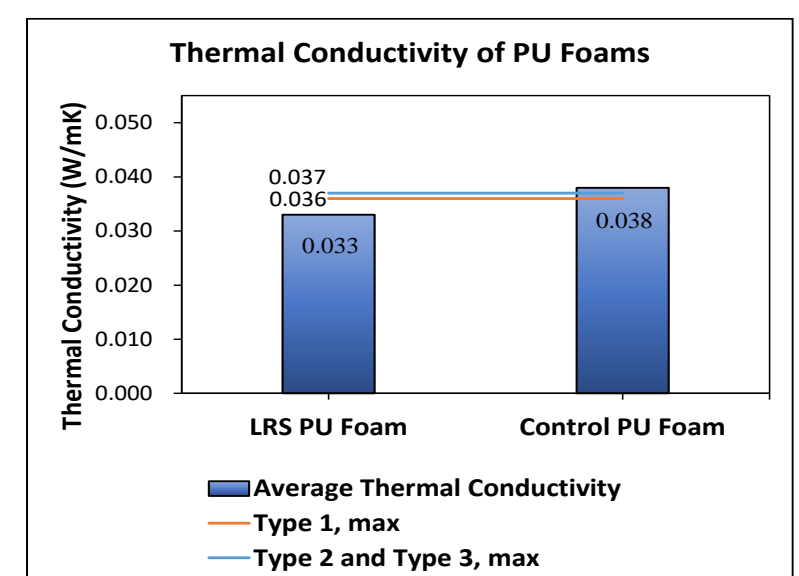
In designing a structural component such as a sandwich wall panel, it is necessary to study the behavior of the rigid polyurethane foam. This investigation was made to determine the properties of the lignocellulosic rice straw-based rigid polyurethane foam such as its density, thermal conductivity, compressive strength, shear strength and tensile strength based on American Standard Testing Method (ASTM) and to assess if the properties meet the requirements for structural sandwich panel cores as specified in ASTM E 1730-02. The results were compared to the properties of petroleum-based rigid polyurethane foams.

## RESULTS AND DISCUSSIONS

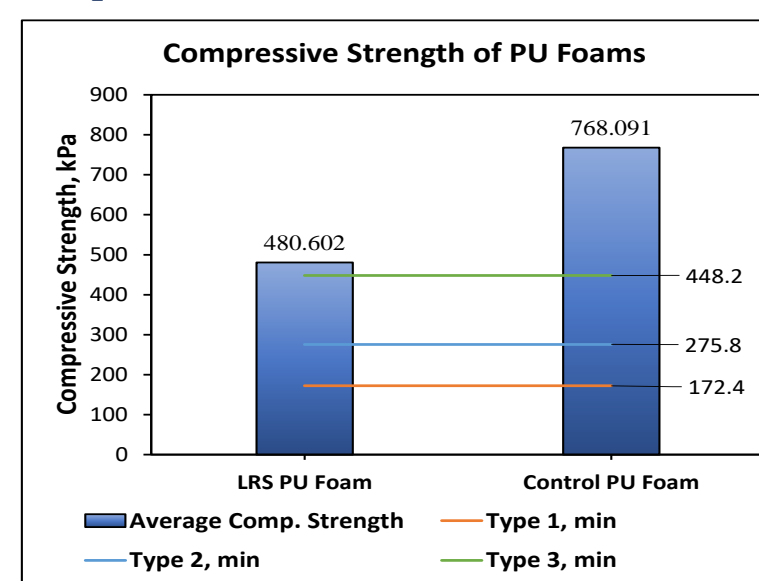
### PHYSICAL AND MECHANICAL PROPERTIES OF LRS-BASED RIGID PU FOAMS IN COMPARISON WITH THE STANDARD SPECIFICATIONS



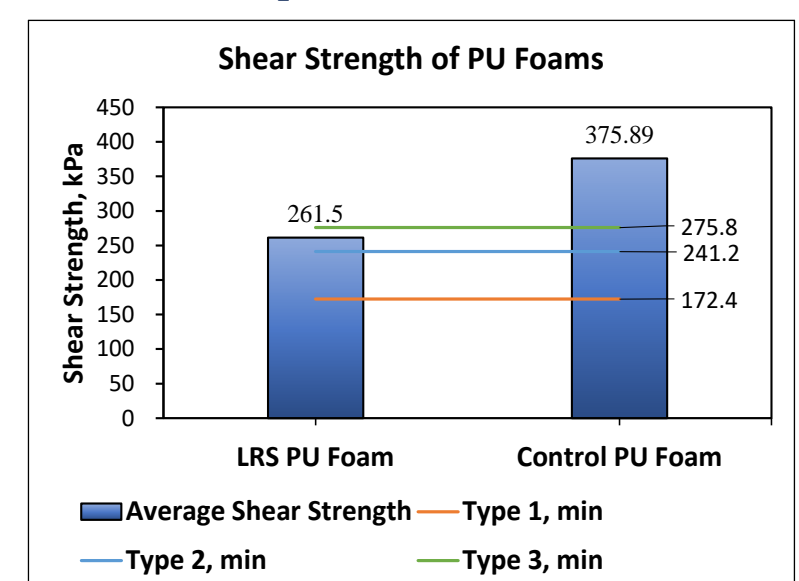
**Fig. 1** -Density of PU foam samples in comparison with the standard requirements



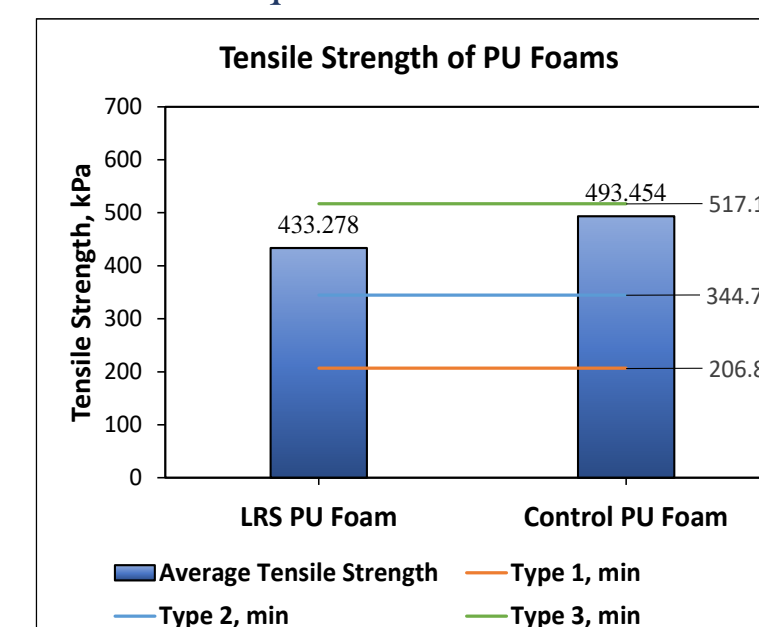
**Fig. 2** – Thermal conductivity of PU foam samples in comparison with the standard requirements



**Fig. 3** –Compressive strength of PU foam samples in comparison with the standard requirements



**Fig. 4** –Shear strength of PU foam samples in comparison with the standard requirements



**Fig. 5** –Tensile strength of PU foam samples in comparison with the standard requirements