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The Study Feasibility in Production Roof Tile from Bagasse Fiber Mixed Maize Husk Fiber

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Abstract : The purpose of this research is to study the feasibility of using roof tiles made from the combination of bagasse and maize fibers. The ratio of bagasse and maize husk fibers was 50/50 wt%. Three kinds of binders were used including urea formaldehyde (UF), phenol formaldehyde (PF) and polymeric isocyanate (PMDI). Bagasse and maize husk fibers were mixed with each binder and fabricated samples by compression molding technique. Sample preparation and characterization were carried out according to TISI 876-2547. Density of roof tiles from bagasse and maize husk fiber was 600-800 kg/m^3. MOR and MOE were 225-270 MPa and 44.5-68 GPa, respectively. Thermal conductivity was 0.012-0.015 W/m K and thermal resistance was 0.289-0.345 m^2 K/W. From the results, PMDI would be used as a binder for making roof tiles from bagasse and maize husk fibers. The roof tiles could be applied as thermal insulation and building construction materials.

Introduction

Natural fibers are light weight, biodegradability and high value of specific strength. Natural fibers are valuable for applied in various applications such as reinforced polymer composites in automotive and building construction. Bagasse and maize husk fibers are from agricultural wastes. They are natural resources and promising for developed to useful products. In this study, bagasse fibers and maize husk fibers were made as roof tiles using various kinds of binders. Physical properties, mechanical performance and thermal properties of roof tiles from bagasse and maize husk fiber were investigated in order to apply as thermal insulation and other applications.

Experimental

Materials

Bagasse and maize husk fiber were used with ratio of 50/50 wt%. Three kinds of binders were 10% of urea formaldehyde (UF), 13% phenol formaldehyde, (PF) and 7% polymeric isocyanate (PMDI).

Sample Preparation

Fibers were cut, grinded, washed and dried. The fibers were measured average pH and acid buffering capacity. After that the fibers were mixed with each binder and hardener then subjected to compression molded in a 100 tons hot press machine. The size of the sample was 400 mm wide, 400 mm long and 5 mm thick.

Characterization

The samples were carried out on physical and mechanical testing including, density, moisture content, water absorption, modulus of rapture and elasticity, impact strength and thermal conductivity. All test methods were done according to TISI 876-2547, TISI 535-2540 and JIS A 5908-2003.

Results and Discussion

Table 1 summarizes physical properties of roof tiles made from bagasse and maize husk with various binders. From the results, density and moisture content of the roof tile using PMDI binder are the highest values as compared to another. Density and moisture content of roof tiles could be considered to the compaction of fibers and the binders as well as volume of void.

Table 1 Density and moisture content of roof tiles with various binders.

Binders	Density (kg/m^3)	Moisture content (%)
UF	600.96	2.07
PF	664.14	3.87
PMDI	800.40	4.08

Figure 1 shows thickness swelling of roof tiles with various binders after immersed in water for 1 and 24 hours. It can be seen that roof tiles using PMDI as a binder exhibited the lowest thickness swelling after immersion for 1 hour. It might be due to good compaction between fibers and PMDI binder. However, the thickness swell of PMDI binder roof tile were

higher than roof tile from UF binder after immersion for 24 hours. The highest values of thickness swelling for 1 and 24 hours were found in roof tile using PF as a binder. It could be indicated that bagasse and maize husk fibers were not good compaction with PF binder. The order of binders for lower of thickness swell in these roof tiles was UF, PMDI and PF, respectively.

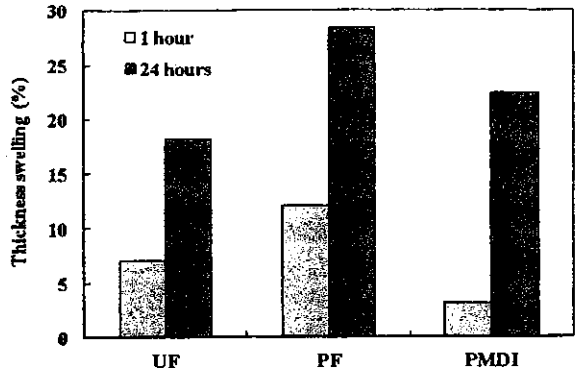

Figure 1 Thickness swelling of roof tiles with various binders for 1 and 24 hours.

Mechanical properties of roof tiles with various binders are presented in Table 2. Modulus of rupture (MOR) of the roof tiles using PMDI binder showed the highest values, followed by PF binder and UF binder. MOR of the roof tiles was influenced by networking of binder and fibers in the roof tiles as well as void volume. UF binders and the fibers were good compaction and good in networking inside the roof tile, which aided stress distribution and good transferred stress after received the loading.

Table 2 Mechanical properties of roof tiles with various binders.

Binders	MOR (MPa)	MOE (GPa)	Impact strength (J)
UF	222.75	68.80	1.93
PF	249.87	44.52	0.55
PMDI	270.27	59.39	0.64

Table 3 tabulates thermal conductivity and thermal resistance of roof tiles with various binders. Thermal conductivity and thermal resistance values of roof tiles using UF and PF were almost similar while thermal conductivity and thermal resistance of roof tile using PMDI were the lowest. These thermal properties were depended on materials density and the thickness of insulations. The roof tile with PMDI binder was good in thermal insulation while it was poor in thermal resistance. Therefore, it was good heat transferred from inside and outside temperature. However, it could not protect heat from outside the building construction.

Table 3 Thermal properties of roof tiles with various binders.

Binders	Thermal conductivity (W/m K)	Thermal resistance (m^2 K/W)
UF	0.013	0.345
PF	0.015	0.348
PMDI	0.012	0.289

Conclusions

Roof tiles from bagasse and maize husk fibers were successfully prepared. Three kinds of binders exhibited the difference in physical, mechanical and thermal properties of the roof tiles. The roof tiles using PMDI binder showed the highest values in density and modulus of rupture and the lowest values of thermal conductivity and thermal resistance. Therefore, roof tiles from bagasse and maize husk fibers would apply as thermal insulation and building construction materials.

References

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