

Comparison of Mechanical Properties of Concrete Paving Blocks Containing Sugarcane and Corn Leaf

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ABSTRACT

In this study, comparison of mechanical properties of concrete paving blocks mixed sugarcane and corn leaf by using ultrasonic pulse velocity and destructive testing. The sugarcane and corn leaf instead were used as cement replacement of 4, 6, 8 and 10 by weight of cement. The standard mix ratio of concrete blocks is (stone: sand: water) as follows: 3: 12: 8: 1.3 by weight of cement. The mechanical properties test such as compressive strength, water absorption, density and ultrasonic pulse velocity respectively. The results shown that the sugarcane leaf was used cement replacement 4 %wt. showed the optimized properties than the corn leaf, the concrete blocks ratio of (rock: sand: water: sugarcane leaf) was 2.88: 12: 8: 1.3: 0.12 based on standard ASTM. The compressive strength was 12.79 MPa, water absorption was 5.88%, density was 2,100.6 kg/m³ and ultrasonic pulse velocity was 0.2155 cm/μs respectively. For measurement with ultrasonic pulse velocity can be used to test the compressive strength and density as two important indices used for characterizing mechanical properties of concrete paver blocks. The compressive strength and density for measurement with ultrasonic pulse velocity can be used to test the compressive strength of the paver blocks.

Keywords: Mechanical properties, concrete paving block, ultrasonic pulse velocity, destructive testing

1. INTRODUCTION

Currently, thailand is an agricultural country. The agriculture of Thailand is regarded as important in driving the economy of the country. Under the circumstances, the economic development continue to use a variety of resources and unnecessary. So as a result of agricultural residues are unnecessary increase

accordingly. The majority of farmers are destroying agricultural wastes by incineration. This causes of incineration such as air pollution, soil degradation and impacts on human health, agriculture, and the environment. Concrete remains an indispensable construction material and allows engineers to evaluate many materials by incorporating them into concrete. For construction industry, maintainability and sustainable improvement aims primarily to protect environment by using alternative material, new methods, and recycling [1]. Concrete block pavements have become an attractive engineering and economical alternative to both flexible and rigid pavements. The strength, durability and aesthetically pleasing surfaces have made paving blocks attractive for many commercial, municipal and industrial applications such as parking areas, pedestrian walks, traffic intersections, and roads [2]. At the present time, non-destructive testing methods in building industry are mostly used for examination of concrete and reinforced concrete structures; specifically, concerned are hardness test methods (Schmidt impact hammers), local fracture methods (e.g. spine extraction methods), and dynamic methods such as ultrasonic pulse method or resonance method). Aforesaid non-destructive testing methods are used to determine strength of in built concrete as well as quantity, form and distribution of armature. Agricultural wastes a significant amount. Therefore, management and value-added agriculture. The benefits of such research agricultural wastes, including leaves, sugarcane and maize leaf replacement by volumes. For to test the mechanical properties of density, water absorption and compressive strength testing with ultrasonic pulse velocity. In order based on standard of concrete paving blocks and to be used in the construction materials.

2. MATERIALS AND METHODS

2.1 Cement

Ordinary Portland Cement (OPC) obtained from SCG Experience Company Limited of Thailand conforming to ASTM C150 standard was used. The chemical and physical properties of the cement are shown in Table 1.

Table 1 The chemical and physical properties of the cement Portland

SiO ₂ (%)	Al ₂ O ₃ (%)	Fe ₂ O ₃ (%)	CaO (%)	MgO (%)	K ₂ O (%)	Na ₂ O (%)	SO ₃ (%)	Loss of ignition (%)	Specific surface area (m ² /g)
20.80	4.70	3.40	65.30	1.50	0.40	0.10	2.70	0.90	0.38

2.2 Sand

Siliceous sand was used in this research program. The physical properties of sand are indicated in table 2.

Table 2 Physical characteristics of the sand used.

Density(g/cm ³)	Sand equivalent (%)	Fineness modulus	Granular class
2.62	89	2.08	0/2

2.3 Crushed stone

Crushed limestone was used in this research. The physical properties of crushed limestone is given in Table 3.

Table 3 Physical characteristics of the crushed limestone used.

Specify gravity	Compacted bulk density (kg/m ³)	Particle density (g/m ³)	Fineness modulus	Moisture content (%)
2.78	1896	2.78	2.49	2.5

3. Design Mix

The standard mix proportion ratio of concrete blocks was (cement: stone: sand: water) as follows: 3: 12: 8: 1.3 by weight of cement. The percentage weight of

sugarcane and corn leaf were used as replacement of 4%, 6%, 8% and 10% by weight of cement. Fixing the w/c ratio at 0.43 is shown in Table 4. A schematic diagram of the preparation is shown in Fig. 1.



Fig. 1 Schematic diagram of preparation for Paver blocks containing Sugarcane and Corn Leaf.

Table 4 Mix proportions.

Ratio (kg)	Standard (0%)	4%	6%	8%	10%
Cement	3	2.88	2.82	2.76	2.70
Crushed stone	12	12	12	12	12
Sand	8	8	8	8	8
Water	1.3	1.3	1.3	1.3	1.3
Sugarcane leaf/corn leaf	-	0.12	0.18	0.24	0.30
Total	24.3	24.3	24.3	24.3	24.3

4. TESTING METHODS

For compressive strength test, water absorption, density and ultrasonic pulse velocity test paver block of dimensions 600x600x500 mm were casted. The sugarcane and corn leaf instead were used as cement replacement of 4, 6, 8 and 10 by weight of cement. The samples were cured in water at 7 and 28 days. The tested properties of the paver block such as compressive strength, water absorption, density and ultrasonic pulse velocity according to ASTM C140, C90, C138, and C597 [3-6], respectively. In each category three cubes were tested and their average value is reported.

5. RESULTS AND DISCUSSION

5.1 Water absorption

The water absorption values of the concrete paver blocks at the age of 7 and 28 days are determined and the results were presented in Fig.1. From fig.4 it is observed that the concrete mixed with sugar cane and maize leaf content are increased from 4% to 10% water absorption is increasing. Compared to the standard paver block there is a increment of 5.654% and 5.88% at the age of 7 and 28 days respectively. The percentage of water absorption of concrete mixed with sugar cane and maize leaf, each leaf ratio is low than the control sample, as shown in Fig. 2.

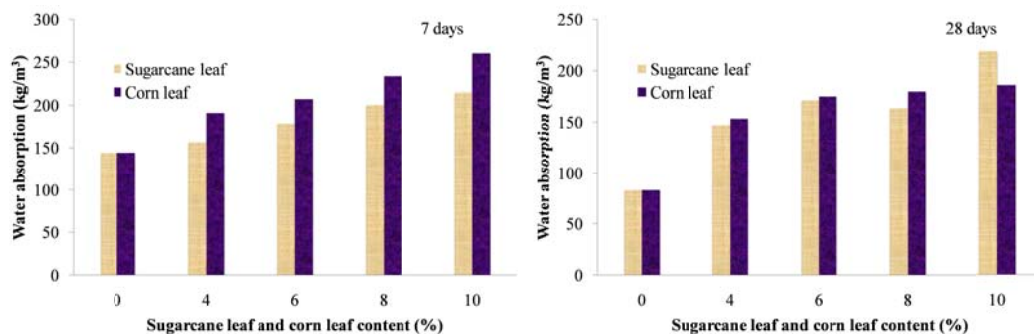


Fig.2 Water absorption at 7 and 28 days for Paver blocks containing Sugarcane and Corn Leaf.

5.2 Compressive strength

The compressive strength values of the concrete paver blocks at the age of 7 and 28 days are determined and the results were presented in Fig. 2. From fig.2. it is observed that the compressive strength of concrete paver block is decreasing with the increase for containing sugarcane and corn leaf content compared to standard concrete paver block at 7 and 28 days. Concrete paver blocks are replaced by sugar cane leaf to compression of

compressive strength higher than replaced by maize leaf. A higher percentage of replacement resulted in lower compressive strength. The increment in the compressive strength of 4% sugar cane leaf content based on standard ASTM C140 at 7 and 28 days respectively. The ratio of sugarcane and maize leaf instead of 4% of the compressive strength of 2.67 MPa and 12.79 MPa at 7 and 28 days respectively, as shown in Fig. 3.

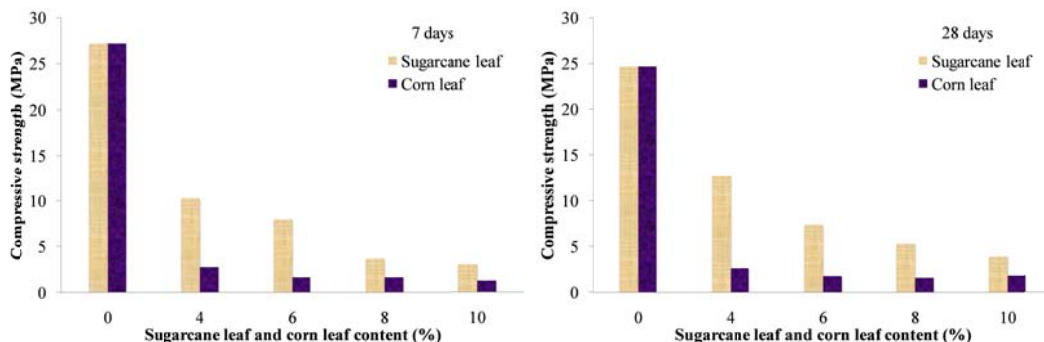


Fig. 3 Compressive strength at 7 and 28 days for Paver blocks containing Sugarcane and Corn Leaf.

5.3 Density (Unit Weight)

The density values of the concrete paver blocks at the age of 7 and 28 days are determined and the results were presented in Fig. 2. The density of the concrete block is less than the control in every aspect ratios replaced by a cane or maize leaf. The density of concrete paver block is decreasing with the increase for containing sugarcane and corn leaf content compared to

the control concrete paver block at 7 and 28 days. Concrete paver blocks are replaced by sugar cane leaf to compression of density higher than replaced by maize leaf. A higher percentage of replacement resulted in lower density. The density of mixed sugarcane leaf in the range of 1993-2105 kg/m³ and 2016-2117 kg/m³ at 7 and 28 days respectively. The density of mixed maize in the range of 1947-2026 kg/m³ and 1950.4-2114 kg/m³ at 7 and 28 days respectively, as shown in Fig. 4.

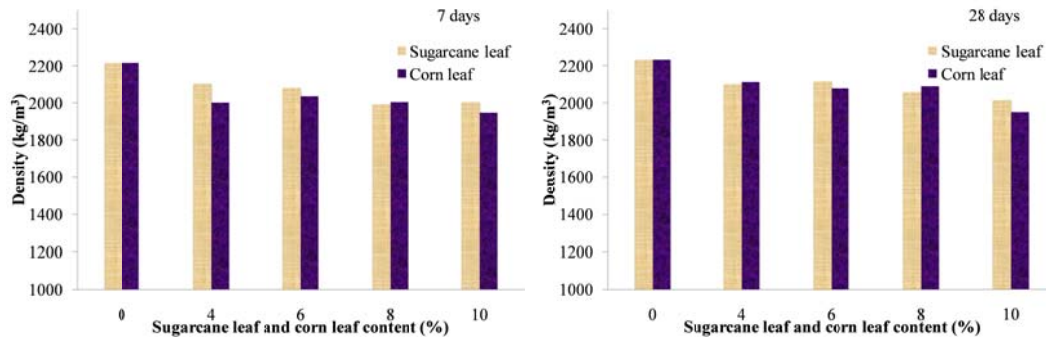


Fig. 4 Density at 7 and 28 days for Paver blocks containing Sugarcane and Corn Leaf.

5.4 Ultrasonic pulse velocity

Experimental results of ultrasonic pulse velocity for concrete paving blocks are presented in Fig. 5. The values decrease with increasing of sugarcane and corn leaf content compared to standard concrete paver blocks at 28 days. The ultrasonic pulse velocity of concrete paver block is decreasing with the increase for containing sugarcane and corn leaf content compared to the control concrete paver blocks at 28 days. This results can be related to decreasing density of the concrete paving blocks. The pulse velocity for concrete paving blocks containing sugarcane leaf content values range from 0.1514 cm/μs to 0.2155 cm/μs and concrete paving blocks containing corn leaf content values range from 0.1396 cm/μs to 0.1579 cm/μs at 28 days. Clearly the effects are not large while sound travels faster in a more compact medium.

$$m y = 0.000264x^2 - 1.026x + 999.48 \quad (1)$$

Paver blocks replaced by sugarcane leaf:

$$y = 0.000587x^2 - 2.37x + 2,400.27 \quad (2)$$

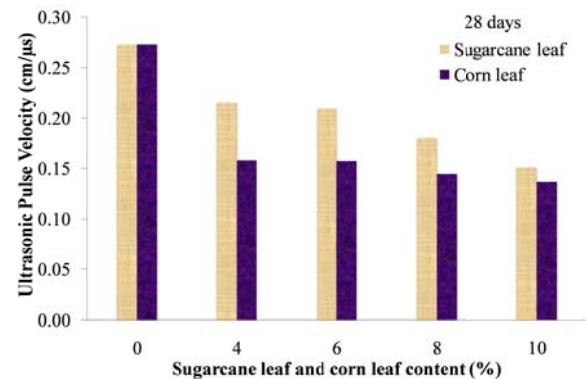


Fig.5 Ultrasonic pulse velocity at 28 days for Paver blocks containing Sugarcane and Corn Leaf.

5.5 Relationship between Density, compressive strength and ultrasonic pulse velocity

5.1.1 Relation between compressive strength and density

The correlation between the compressive strength and density for all mixtures is shown in Fig. 6 (a). If a power relationship is fitted to all data, the following equation will be obtained:

Paver blocks replaced by sugarcane leaf:

Where y is the 28-day compressive strength in MPa and x is the 28-day density in kg/m³. Coefficient of determination (R²) of this proposed relation is 0.92 for concrete paver blocks replaced by sugarcane leaf and 0.98 for paver blocks replaced by corn leaf highly satisfactory; see Fig. 6 (a). It is clear that the compressive strength of concrete paver blocks is proportional to its density; the higher the density, the

higher the compressive strength.

5.1.2 Relation between compressive strength and ultrasonic pulse velocity

Compressive strength and ultrasonic pulse velocity are known as two important indices used for characterizing mechanical properties of concrete paver blocks. It has been reported that ultrasonic pulse velocity can be estimated from compressive strength of concrete namely:

$$\text{Paver blocks replaced by sugarcane leaf:} \\ y = 176.5x - 25.54 \quad (3)$$

$$\text{Paver blocks replaced by corn leaf:} \\ y = 179.0x - 24.61 \quad (4)$$

Where y is the 28-day compressive strength in MPa and x is the 28-day ultrasonic pulse velocity in cm/ μ s. Coefficient of determination (R^2) of this proposed relation is 0.898 for paver blocks replaced by sugarcane leaf and 0.98 for paver blocks replaced by corn leaf highly satisfactory; see Fig. 6 (b). It is clear that the compressive strength of concrete paving blocks is proportional to its ultrasonic pulse velocity; the higher the ultrasonic pulse velocity, the higher the compressive

strength.

5.1.3 Relation between density and ultrasonic pulse velocity

Density and ultrasonic pulse velocity are known as two important indices used for characterizing mechanical properties of concrete. It has been reported that ultrasonic pulse velocity can be estimated from density of concrete paving blocks namely:

$$\text{Paver blocks replaced by sugarcane leaf:} \\ y = 176.5x - 25.54 \quad (5)$$

$$\text{Paver blocks replaced by corn leaf:} \\ y = 179.0x - 24.61 \quad (6)$$

Where y is the 28-day density in MPa and x is the 28-day ultrasonic pulse velocity in cm/ μ s. Coefficient of determination (R^2) of this proposed relation is 0.898 for paver blocks replaced by sugarcane leaf and 0.98 for paver blocks replaced by corn leaf highly satisfactory; see Fig. 6(c). It is clear that the density of concrete paving blocks is proportional to its ultrasonic pulse velocity; the higher the ultrasonic pulse velocity, the higher the density.

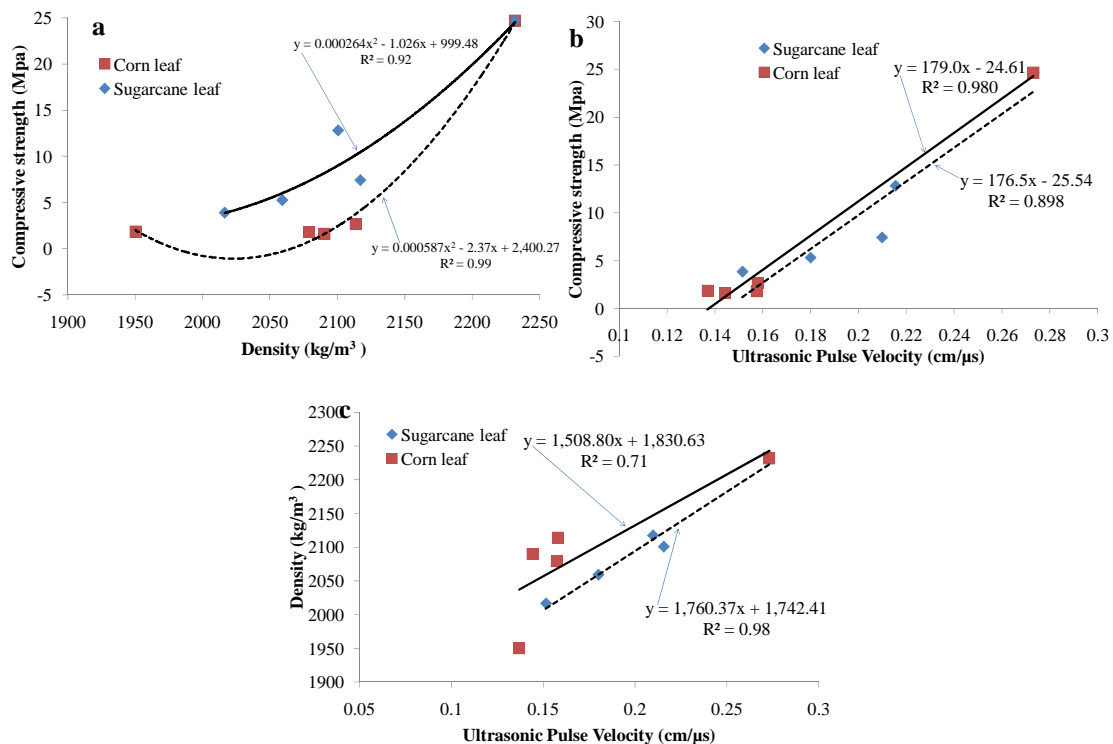


Fig. 6 Relationship between (a) compressive strength and density; (b) compressive strength and ultrasonic pulse velocity; (c) density and ultrasonic pulse velocity.

6. CONCLUSION

From this study the following conclusion can be drawn:

1. The compressive strength of concrete paver block is decreasing with the increase for containing sugarcane and corn leaf content compared to standard concrete paver block at 7 and 28 days. Concrete paver blocks are replaced by sugar cane leaf to compression of compressive strength higher than replaced by maize leaf.

2. The percentage of water absorption of concrete mixed with sugar cane and maize leaf, each leaf ratio are low than the control sample and based on standard ASTM.

3. The density of concrete paver block is decreasing with the increase for containing sugarcane and corn leaf content compared to the control concrete paver block at 7 and 28 days. Concrete paver blocks are replaced by sugar cane leaf to compression of density higher than replaced by maize leaf.

4. The ultrasonic pulse velocity of concrete paver block is decreasing with the increase for containing sugarcane and corn leaf content compared to the control concrete paver blocks.

5. For measurement with ultrasonic pulse velocity can be used to test the compressive strength and density as two important indices used for characterizing mechanical properties of concrete paver blocks.

7. ACKNOWLEDGEMENTS

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