Available online www.jsaer.com

Journal of Scientific and Engineering Research, 2021, 8(6):49-54

Research Article

ISSN: 2394-2630
CODEN(USA): JSERBR

Influence of the Shape of the Borassus Rod on the Concrete-Borassus Adhesion

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Abstract The present scientific work aims to determine the type of Borassus rod shape that provides better adhesion with concrete. To achieve this objective, the pull out test was carried out on concrete-borassus specimens made for this purpose. The adhesion constraints have been determined. Before carrying out the actual pull out test on each type of test specimen, the characteristics of the aggregates used in the formulation of concrete by the Dreux Gorisse method were determined through appropriate laboratory tests. The compression test was carried out on twelve (12) 16/32 concrete specimens including 3 to 7 days, 3 to 14 days, 3 to 21 days and 3 to 28 days of curing age. The compressive strength of concrete at 28 days is 22.40 ± 0.33MPA. It emerges from the work that the rods of ronier notched on two sides adhere more to the concrete than all the other forms through its bond stress which is of the order of 80 ± 17,32 bars, greater than all the other stresses of " adhesion of which 70 ± 5 bars for the palm trees crenellated on two sides, 66,67 ± 11,54 bars for the sanded palm trees stems, 58,33 ± 2,89 bars for those notched on four sides, 45 ± 5 bars for those wound with annealed wire and 40,67 ± 1,15 bars for the rods of palm trees covered with small cubes. As for the control test piece, the single palm trees talk, its adhesion stress is of the order of 55 ± 5 bars. This made it possible to remember that the palm tree shapes notched on two sides, crenellated on two sides, silted up and notched on four sides are those which improve the concrete-Borassus Aethiopum bond.

Keywords Adhesion, Borassus, Constraint

1. Introduction

The valuation of local building materials is not only a solution to the persistent economic crisis in developing African countries (United Nations, 1997), but also has the advantage of providing a valid answer to the question of architectural heritage (STELLA Ayoko, February 2008). Among the local building materials, palm tree wood represents immense economic potential because it is classified as a timber species (FAO, 1991). The Borassus develops a strong mechanical resistance. It is a wood that can retain its integrity in use for centuries [1]. The palmetto exists in abundance in many wooded reserves in Africa. Several researchers have shown that palm tree wood is, among other things, widely used for making floor frames, joists for false ceilings, roof frames, support posts for straw huts and lintels in buildings [2]. Currently, the palm tree is mainly used in rural areas.

It is in this context that, during the last decades, research has shown the possibility of substituting steel by reinforcements of Borassus Aethiopum [1 ; 3 ; 8]. Thus, a lot of work has focused on the possibility of use in concrete, vegetal reinforcements such as the palm tree. But the big difficulty is the adhesion between the two materials [4 ; 5].

In order to determine the influence of the shape of the Borassus rod on the concrete-Borassus adhesion, the present work carried out at the Materials and Structures Laboratory (LAMS) of the Veréchaguine AK Higher School of Civil Engineering will consist of the determination of the bond stress through pull out tests carried out on various concrete-Borassus specimens [6].

2. Material and Methods

2.1. Material

It is essentially a MIGM brand pull out tester; and a hydraulic press for compression testing.

Figure 1: Pull out device (Standard SN EN 14488-4)

Figure 2 : Press for measuring the compressive strength

Figure 3: Single Borassus stems (controltubes)

Figure 4: Borassus stems covered with small cubes

Figure 5: Borassus stems wrapped in annealed wire

Figure 6: Borassus stems silted up with glue

Figure 7: Borassus stems notched on both sides

Figure 8: Borassus stems crenate on two sides

Figure 9: Borassus stems notchedon four sides

The main material used in this study is palmwood from the gallery forest of Pahou-Ahozon in southern Benin. It was produced from the palm trees notched on two sides, the palm trees crenellated on two sides, the palm tree stems silted up with glue, the palm tree stems notched on four sides, the palm tree stems rolled up of annealed wire, the palm tree stems covered with small cubes and the single palm tree stems having served as control test tubes. Thus, twenty-one Concrete-Borassus specimens were made at the rate of three (3) specimens of each type of shape. Aggregate characterization tests made it possible to formulate the concrete by the Dreux-Gorisse method. The concrete compression test was performed at 28 days of ripening age to determine its strength.

Then, the pull out test itself was carried out on each specimen [6] and the pressure values read on the manometer were converted into stresses according to the calibration sheet. The different aron tree stems according to their shape are thus presented in figure 3 to 9.

The ready-made specimens used for the pull out tests are as follows:

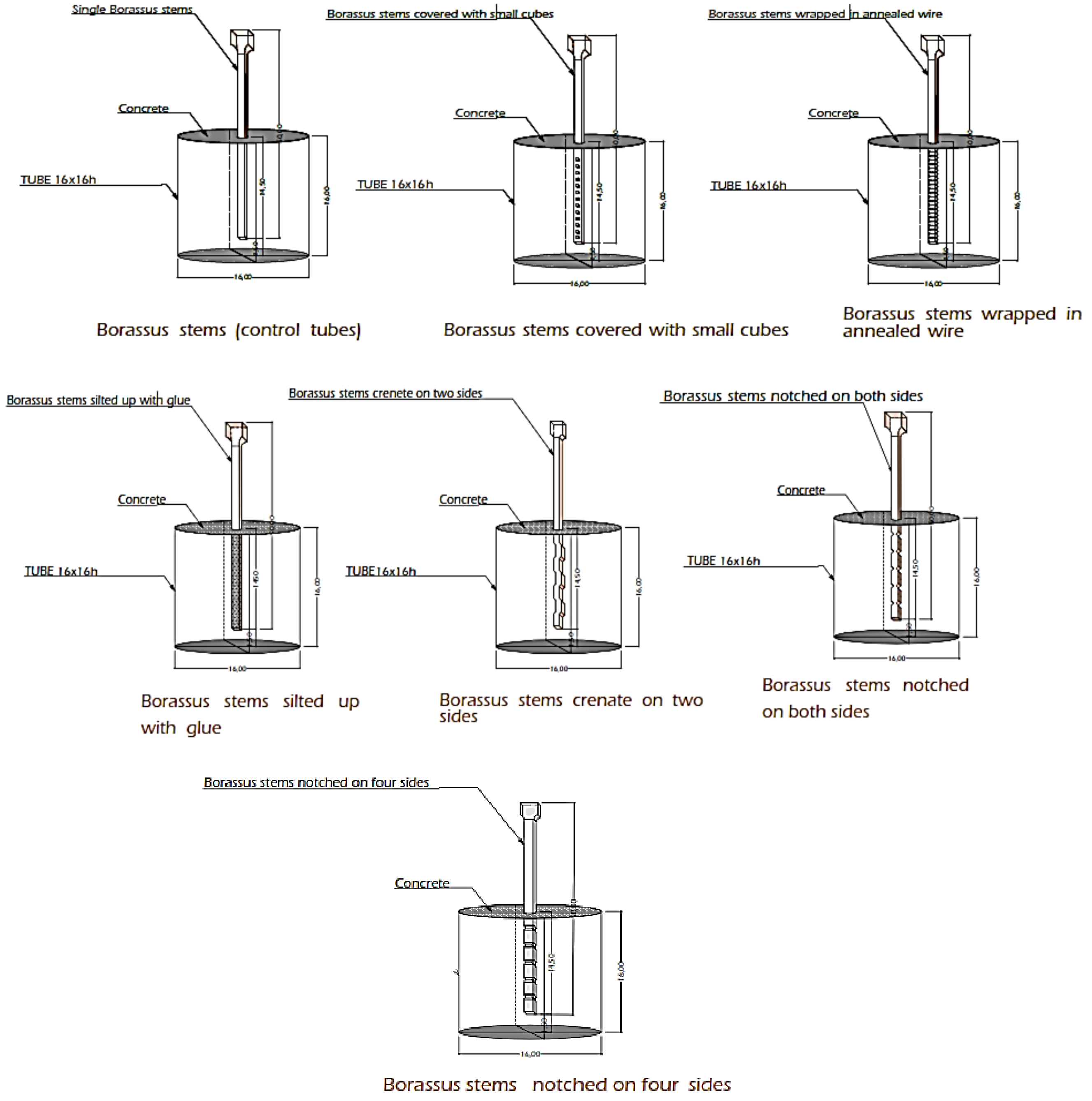

Figure 10: Different types of test specimens to be used for carrying out the pull out test

2.2. Description of the test specimen placement process

Once the different shapes of rods have been made, we proceed to make the concrete for the different specimens, in accordance with the results from the concrete formulation study. While respecting the different sealing lengths of the palm tree stems in the molds, we fill the latter with the concrete previously made, taking care to vibrate it [6].

2.3. Carrying out the pull-out test

In accordance with Standard SN EN 14488-4, the test specimen was placed, while ensuring the flatness and plumbness of the latter, in the pull out test machine, the manometer of which was calibrated at prior [6]. These various settings having been made, we proceed to the actual test on the specimen.

Figure 11: Layinga test specimen in the pull out machine

Figure 12: View showing a crack in the concrete after testing

Figure 13: View showing the break between the stem and the concrete marked by the tearing of the annealed wire after pull out test

2.4. Method of calculating of the adhesion stress

The maximum bond stress (τ_{ad}) sought at j days of age is equal to the quotient of the variation in the maximum axial force by the perimeter of the palm tree multiplied by the sealing length: $\tau_{ad} = \frac{\Delta F_{max}}{p} = \frac{\Delta F_{max}}{4\ x\ C\ x\ Ls}$

3. Results and Discussion

Table 1: Summary of the characteristics of aggregates

Characteristics	Lagunar Sand	Gravel Mono Roll	Cement
Fineness modulus	1.94	-	-
Uniformity coefficient	3.46	1.94	-
Coefficient of curvature	0.93	0.95	-
Specific density (g/cm^3)	2.56	2.46	-
Apparent density (g/cm^3)	1.53	1.56	3.10
Density « sss »	2.125	2.604	1.00
Percentage absorption	16.250%	2.169%	-

Table 2: Quantity of materials for a test piece cylindrical 16/32 for concrete formulation

Sand (Kg)	5.12
Gravel (Kg)	6.27
Cement (Kg)	2.19
Water (Kg)	1.22

Table 3: Results of the compression test on the cylindrical specimens

N°	Crushing Day	Compressive Strength of Concrete (MPA)			Medium Compressive Strength (MPA)
		Cylinder 1	Cylinder 2	Cylinder 3	
1-	07 days	10.5	9.5	10.75	10.25±0.54
2-	14 days	15.5	14.90	15.75	15.38±0.36
3-	21 days	21.5	20.75	20.5	20.91±0.42
4-	28 days	**21.95**	**22.5**	**22.75**	**22.40±0.33**

Table 4: Comparison of constraints according to the different types of Borassus treatment

N°	Types of Stems	Breaking Stresses (bars)			Average Breaking Stresses
		Test piece 1	Test piece 2	Test piece 3	
1	Single Borassus stems (control tubes)	60	50	55	55±5
2	Borassus stems covered with small cubes	40	40	42	40.67±1.15
3	Borassus stems wrapped in annealed wire	50	40	45	45±5

4	Borassus stems silted up with glue	80	60	60	66.67±11.54
5	Borassus stems crenate on two sides	75	70	65	70±5
6	Borassus stems notched on both sides	100	70	70	80±17.32
7	Borassus stems notched on four sides	55	60	60	58.33±2.89

From the analysis of the results obtained after the various tests, it emerges that the adhesion between the concrete and the borassus is better with the Borassus stems notched on two faces as shown in the table and the histogram below:

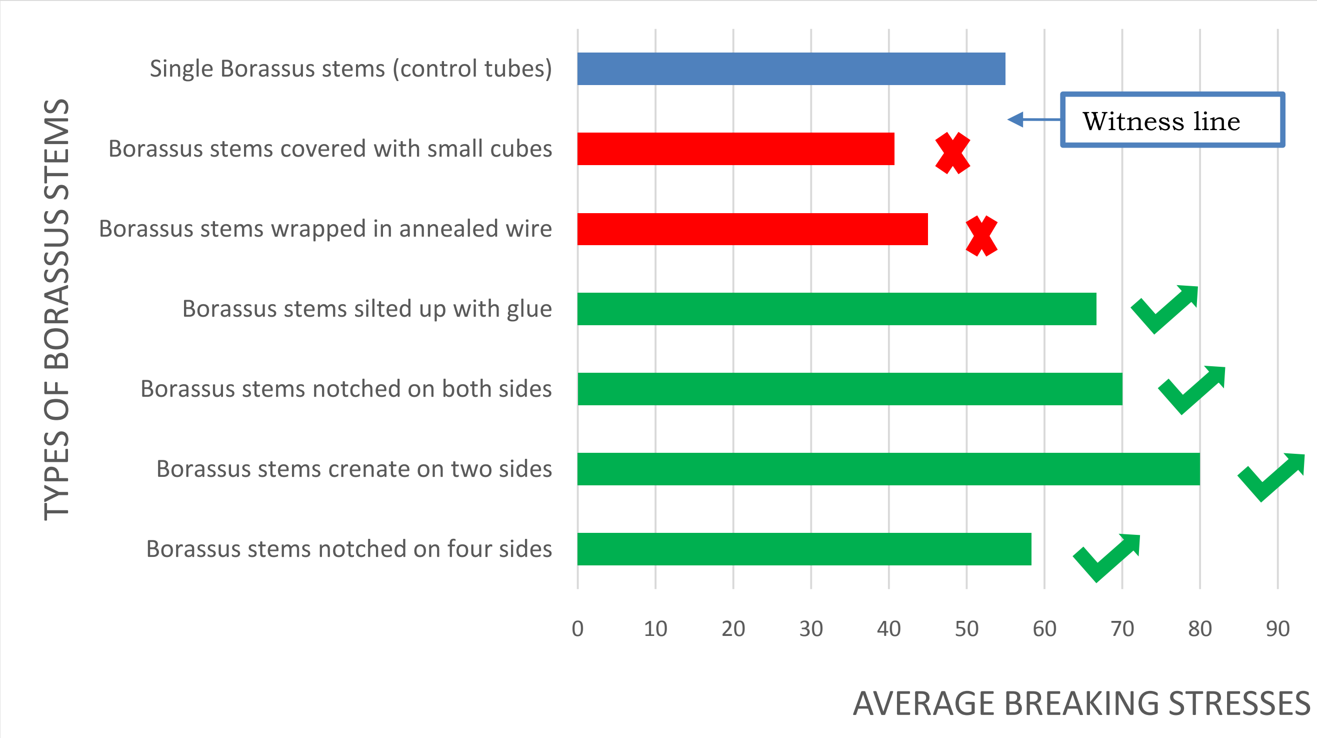

Figure 14: Histogram of comparison of stresses according to the different types of Borassus stems

The histogram in Figure 2 points out that by taking the control test piece based on simple Borassus stems with an adhesion stress of the order of 55 ± 5 bars, the test pieces containing the Borassus stems notched on two faces with a breaking stress of 80 ± 17,32 bars, crenellated on two sides with a breaking stress of 70 ± 5 bars, sanded with glue with a breaking stress of 66,67 ± 11,54 bars, notched on four sides with a breaking stress of 58,33 ± 2,89 bars pass the control line. On the other hand, the rods wound with annealed wire with a breaking stress of 45 ± 5 bars, covered with small cubes of Palmyra with a breaking stress of 40,67 ± 1,15 bars do not reach the permitted limit.

We could therefore suggest that the Béton - Borassus association be banned, covered with palm tree cubes using glue and rolled up annealed wire for the fact that for the first, the small cubes come off quickly of the rod and for the second, the wire is torn from the rod during the application of tensile forces.

Rods notched on four sides do not resist as much as those notched on two sides because the notches made on all four sides reduce the median section of the rod subjected to the tensile stress and by ricochet reduces the bond stress of the concrete with this type of shape of the borassus.

4. Conclusion

In total, twenty-one concrete specimens fitted with Borassus stems were produced at the rate of three specimens per rod shape. These shapes were made with the aim of determining which one best improves the adhesion

between the concrete and the palm tree. To do this, we carried out the pull out test in order to determine the adhesion stresses of the different shapes of palm trees adopted and to make a comparison between them.
The results thus obtained confirm that the notched shape of the palm tree adheres more to the concrete than all the other shapes studied.
This experiment complements the various results in the study of prestressed Borassus reinforced concrete [7].

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