



## Assessment of the Thermal Conductivity of Local Building Materials using Lee's Disc and Hot Strip Devices

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DOI: <http://dx.doi.org/10.33980/ajabs.2019.v07i02.002>

(Received 03 Sep, 2019; Accepted 25 Sep, 2019; Published 14 Oct, 2019)

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**ABSTRACT:** The thermal conductivity of building materials is an important property for engineering and for the analysis of insulating materials. In this work, the thermal conductivity of Kosso and mahogany wood were determined following the device of Lee's disk. The results were then compared with those obtained by the hot strip device. In this line, Lee's disk device was designed and validated experimentally. According to the analysis of the data from the two wood species tested, the thermal conductivity of Kosso (measurement in the open air with a moisture content of 13%) and mahogany wood (dry) obtained by the method of Lee drive, respectively, are  $(0.128 \pm 0.005) \text{W} \cdot \text{m}^{-1} \text{K}^{-1}$  and  $(0.120 \pm 0.009) \text{W} \cdot \text{m}^{-1} \text{K}^{-1}$  against respectively,  $(0.123 \pm 0.001) \text{m}^{-1} \text{K}^{-1}$  and  $(0.134 \pm 0.004) \text{m}^{-1} \text{K}^{-1}$ , obtained by the hot tape method. These results experimentally determined by the disk of Lee method are in good agreement with those obtained by the method of hot strip device. The calculation of the uncertainty of thermal conductivity was also done in this work.

**Keywords:** Hot strip; Lee's disc; thermal conductivity; insulating materials and building.

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**INTRODUCTION:** Recent studies showed that the building sector is the largest consumer of energy (43% of overall energy consumption) and is also responsible for 25% of emissions of greenhouse gases.<sup>1</sup> Added to the drastic rise in the cost of conventional construction materials whose implementation requires a high energy consumption with a negative impact on the thermal comfort and the environment. On the other hand, as part of the implementation of the PFSE, the General Directorate of energy (DGE) of the Department of energy, of oil research and mining, water and the development of energy renewable of Benin, has initiated a project to develop in code energy efficiency concerning among other things the improvement of the thermal characteristics of the materials and the choice of appropriate materials.<sup>2</sup> The characterization of materials by different methods of measurement has been many studies, A.DJOSSOU has put in place in the laboratory CTMAE, a new method called hot strip for the determination of the effusivity and conductivity heat according to content and water sawdust of simplified and stabilized earth bricks.<sup>3</sup> Mustapha BOUM-HAOUT<sup>4</sup> have worked on the thermal conductivity of

building materials of different sizes by the method of the boxes. But the authors who worked on the estimation of the thermal conductivity of materials using the disc of Lee rarely evaluated the uncertainties of better measures the few who have assessed him, proceeded by the logarithmic method with its limits.<sup>5,6,7,8</sup> This work is aimed setting up in the laboratory CTMAE, a device of disc of LEE who will be validated and used for the determination of the thermal conductivity of a few local building materials. The resulting thermal conductivity values will be compared with other methods while assessing measurement uncertainty.

**MATERIALS AND METHODS:** The large number of existing methods for the characterization of thermo-physical properties shows that there is no single solution for all problems.<sup>9, 10</sup> These methods are generally classified in two regimes namely one qualified permanent and other transitional. The methods in permanent regime is well suited to the measurement of thermal conductivity of insulating circles, are made from the first measurement techniques developed and remain widely used thanks to their wealthy experi-

mental implementations and their simple theoretical developments compared with other measurement methods. But one of their main limitations is the long period of experimentation required and the fact that they serve just for the measures of the thermal conductivity only. The Lee drive device is governed by this mode of operation. The transitional regime for its method is faster but less accurate than the steady-state method.<sup>11</sup> In addition, it allows to have access to two parameters. The tape device is not governing this operating mode.

Beside the steady state benefits listed above, the choice of the device is also motivated by the following points:

- Making available in the CTMAE laboratory a simple device for measuring thermal conductivity of the insulation of low thickness since the one available in the laboratory does not provide detailed measures for materials with low thickness.
- Applying a method of uncertainty assessment of measure other than the one found in the literature about the Lee drive device.

#### Design and Realization of the Lee Drive Device:

The designed Lee disk device consists of the following: Steam-to-steam room consists of two ports which allow one to get steam to the inside of the latter and the other hole represents the output of the steam. This room is made in copper because of its thermal conductivity and because this room will provide heat to the high copper disk. This piece being of cylindrical shape, we machined raw material whose diameter is 50 mm to the appropriate dimensions.

**Steam room**



**Figure 1: Steam chamber Copper discs.**

We made two disks namely the high drive and the low drive which are made of copper. The higher disk and the lower disk have a thickness of 10 mm and the same diameter as the room to steam (50 mm). These dimensions are not far from that used<sup>10</sup>. These disks are made of copper, because copper transmits heat. Moreover, in order to measure the temperature at the level of each disc, we have made a hole where a thermocouple is placed in each disc. An electronic balance of SARTORIUS BP 3100 S brand - ISO 9001 standard, with a maximum load of 3100 g  $\pm$ 1% was used for the measure of the mass of copper discs.



**Figure 2: Copper disc Distiller.**

The boiler in stainless steel is cylindro-conical in shape and is made with a Bender and a soldering station.



**Figure 3: Steam generator.**

**Support of the whole disks in copper-insulation-steam room:** The whole room to steam and both discs is in copper material. So therefore it must be a support that can withstand the efforts of this set in case where there is an exchange of heat between the latter and the support or in the worst of cases the exchange will be minimized. This bracket designed steel has three feet and a disc with three tapped holes in which the three legs are screwed. Between the whole room to steam-

drive copper and support are three insulations for small isolation materials.



**Figure 4: Support of all disks in copper-sample-room steam hose.**

It is here between the boiler and the steam room. It is essential to isolate the pipe so as not to waste energy. In this line, a flexible hose that would do the trick was bought in the local trade.



**Figure 5: The steam pipe PVC pipe.**

**Griddle or stove or gas fireplace:** The hot plate provides the energy necessary to heat the water in the boiler for the production of steam. This plate is made of non-deformable steel with heating elements distributed over the entire surface and the highest temperature is reached very quickly if it triggers the maximum power. Its enameled outer case is resistant to high temperatures and corrosive elements. This hot plate will work with a hybrid system (SBEE and solar). This will address power failure situations to ensure continuation of the experimentation. During the experimentation, this griddle has failed us so we had to use a gas fireplace in Oryx.



**Figure 6: Oryx gas fireplace.**

**Mounting of the designed device:** Installation of the device is as follows: the boiler is placed on a hot plate (a gas fireplace), the lower copper disc is placed on the stand. Then, the sample is placed on the lower drive until the upper disc in copper is placed on it. We then drop the room-to-steam on the upper disc. Finally, the pipe is placed between the outlet of the steam in the boiler level and the inlet of the steam in the steam room.



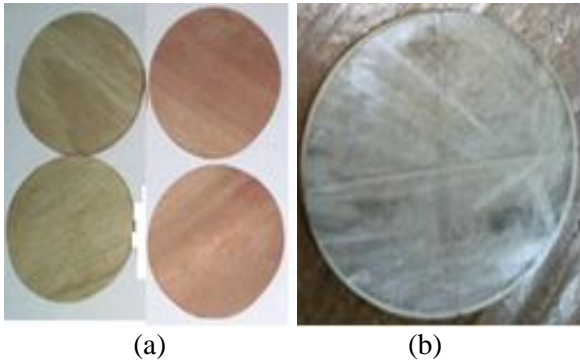
**Figure 7: Mounting of the experimental device of Lee drive.**

**Experiments with the Lee Drive device:**

**Materials characterized:** The materials selected to be characterized are Kosso and mahogany because they are the subject of many studies, even in the lab (CTMAE) where we conducted our experiment. In addition, these are materials are used in the construction of buildings both for the doors as well as a framing etc. The samples used have been machined approximately the same diameter as that of the disc Lee (50 mm) and a thickness of about 3 mm. The surfaces of the samples were also smooth for good thermal contact. It should be noted that the transfer of energy through the sample rate can be increased by keeping a small thickness and a large section. Keeping a small thickness means that the unit will quickly reach a steady state. For the second method that is the hot ribbon one, we also made two samples from two species of wood (Kosso and mahogany) in the form of a cuboid of dimensions  $(50 \times 30 \times 0.3) \text{ (mm)}^3$ . The resulting shape will be used for experimentation at the level of the hot tape because we want to compare the results given by the latter and those of the Lee disk device.

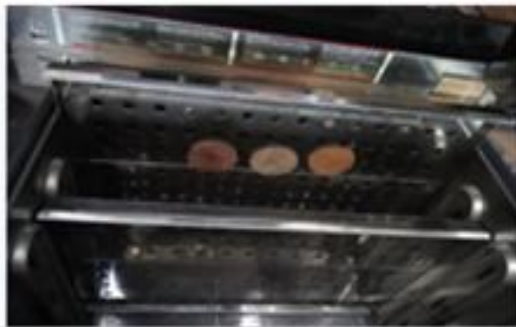
Our study will not focus on the conductivity of wet material since it is recommended to use the method of steady state to test a dry sample. In the case of wet materials, the transitional method is more appropriate.<sup>12</sup> For this reason, we used a ventilated oven, of

brand MEMMERT D06060 with a temperature range of 30 to 225°C and a register of ventilation calibrated from 0 to 6, to determine the anhydrous mass of samples in order to infer the moisture content average of samples during tests. The scale used to measure the mass of copper discs is also here used to measure the mass before and after testing at the level of the oven.

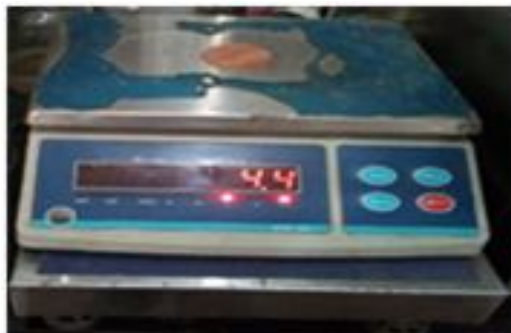


**Figure 8: (a) wood samples (b) Plexiglas sample.**

In order to ensure the reliability of the experimental design and the effective applicability of the Lee disk method, we first experimentally determined the thermal conductivity of a Plexiglas sample taken as a weakly conductive reference material of heat, whose thermophysical properties are well known. To achieve this, we machined a specimen of plexiglass in the shape of a disk of thickness 5 mm and diameter 50 mm. The specimens to be tested are shown in Figure 8a.



(a)



(b)

**Figure 9: (a) sample to be tested in the oven (b) Taking the mass of sample to be tested.**

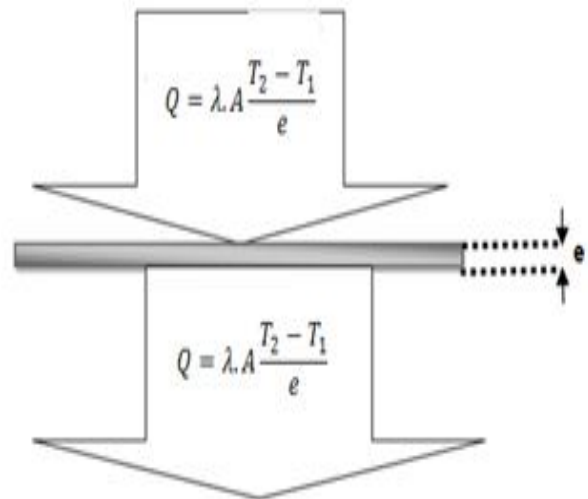
The following formula was used to calculate the water content of each sample:

$$W_e = \frac{m_h - m_s}{m_s} \times 10 \quad (1)$$

**Lee's disc procedure: Theory:** Lee's Disc Experiment determines an Effective Value of Thermal Conductivity for insulation of materials such as glass, cardboard, etc. An insulating material of similar diameter and thickness is placed between two disks of the same thermal conductivity (of the same metal) and the installation is allowed to reach a steady state, so that the heat lost by the disk below the convection is the same as the heat flow through the insulating material. The temperature of the upper disc and that of the lower disc are saved. The insulating material is removed and the lower metal disk can heat up to the temperature above. Finally, the steam chamber and the top disc are removed and can be replaced by a disc made of a good insulator. The lower metal disk is then allowed to cool down the lower disk to room temperature. The temperature of the lower metal disk is recorded during cooling. This device is governed by the following equations:

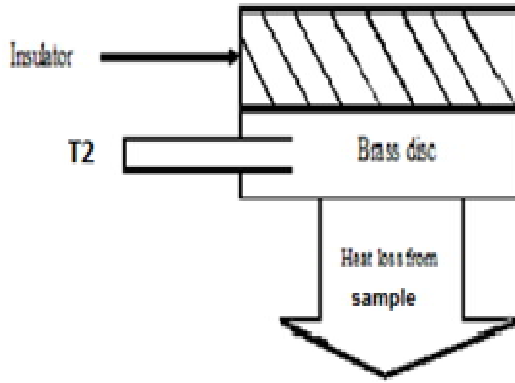
In the stationary state, the amount of heat (Q) transmitted by conduction through the sample is given by:

$$Q = \lambda \cdot A \frac{T_2 - T_1}{e} \quad (2)$$



**Figure 10: Illustration of the heat input by conduction and that transmitted by the sample in steady state.**

The temperatures measured by thermocouples are constant when the device is in steady state. Then, the speed of heat through the copper disk must be equal to the rate of heat loss due to cooling of the bottom of the disk<sup>13</sup> by air convection. By measuring how fast the copper disk cools to constant temperature, the heat lost by the copper disk can be determined. It is shown in Figure 11 if the disc cools down at a rate so:



**Figure 11: Insulator - lower disk for cooling<sup>11</sup>.**

By measuring  $\left(\frac{dT}{dt}\right)_{T_2}$  and  $(T_2 - T_1)$  by the device, we can determine the thermal conductivity  $\lambda$  of the sample by (10)

$$\lambda = \frac{mce}{A(T_2 - T_1)} \left(\frac{dT}{dt}\right)_{T_2} \quad (3)$$

Supposing that,

$$T = f(t) \quad (4)$$

$$\frac{dT}{dt} = f'(t) \quad (5)$$

At steady state,  $T = T_2$

$$T_2 = f(t_2) \quad (6)$$

$$t_2 = f^{-1}(T_2) \quad (7)$$

Therefore,

$$\left.\frac{dT}{dt}\right|_{T=T_2} = f'(t)|_{t=t_2} = f^{-1}(T_2) \quad (8)$$

From here on, we will make an exponential regression of the temperature with respect to the cooling curves which will give us access to  $\left(\frac{dT}{dt}\right)_{T_2}$  is  $T = \alpha e^{-\beta t}$ ,  $\alpha$  and  $\beta$  are the parameters of the regression curve and then we have :

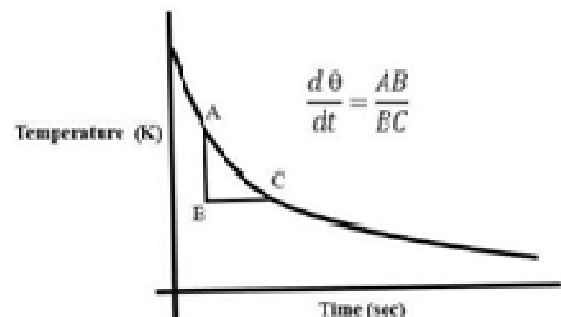
$$f'(t_2) = -\alpha\beta e^{-\ln\left(\frac{\alpha}{T_2}\right)} \quad (9)$$

$$\lambda = \frac{4m.c.e.\beta.T_2}{\pi d^2(T_1 - T_2)} \quad (10)$$

**Experimental Protocol of Lee's Disc Device:** The experimental protocol for the measurement of insulating materials on the Lee disk device is as follows:

- For water into the boiler a little below its steam outlet and put the boiler on the heating plate that will be turned on for steam production;
- Take the mass of the copper metal disc using a scale and note also its specific heat.

- Measure the diameter of the sample to be characterized using a Vernier caliper if possible calculate its surface:  $A = \pi r^2$  ;
- Measure the thickness of the sample to be characterized using calipers at 5 different parts then take the average value of this thickness;
- The mounting of the experimental device is shown in Figure 7. The thermal contact of the sample with the metal discs here in copper is improved with thermal paste;
- The steam passes from the distant boiler through a pipe to enter the steam chamber through the inlet made on it. The device is isolated from the heat of the boiler. The temperatures  $T_1$  and  $T_2$  metal discs (top disc and lower disc) are monitored respectively. these temperatures are about to become stable,  $T_1$  and  $T_2$  are recorded at an interval of 5 minutes until they remain constant: this is the stable part of the experiment ;
- Remove the upper metal disc and insulation, the steam chamber is now placed directly on the lower metal disc. Wait until the temperature of the lower disc rises 7 ° C above its steady state temperature of the lower copper disc;
- Remove the steam chamber and wait for 2 to 3 minutes for the heat distribution to be uniform over the disc;
- Place an insulating material on the lower disc. The metal disc is then allowed to cool. During cooling, the temperature of the metal disc is recorded every 30 seconds until the temperature falls to about 5-10 ° C of that of steady state, which makes it possible to trace the cooling curve of the lower copper disc.



**Figure 12: Curve showing cooling of the upper-disk<sup>11</sup>.**

- Use the previously noted data to plot the cooling curve with the cooling time on the abscissa

and the temperature of the lower metal disk on the ordinate. We draw the tangent to this curve at constant temperature  $T_2$  the slope of this tangent gives the cooling rate at this stable temperature  $T_2$ .

The hot ribbon device is studied in more detail by [3] but we will briefly describe the practical realization of the measures at the level of this last one.

The hot ribbon device experienced in our work consists of a flat rectangular heating resistor of 5 cm long and 1.5 cm wide, a temperature recorder and a stabilized power supply. The heating element is of the "Minko" type of thickness  $e_s = 0.22 \text{ mm}$  and electrical resistance  $R_e = 43.4 \Omega$ . A thermocouple with a diameter of about 0.1 mm is fixed in the center of the resistor. The stabilized power supply makes it possible to impose a constant flux across the heating element. Using the thermocouple and the recorder, raise the temperature in the center of the ribbon. Figure 13 shows a view of the hot ribbon experimental device used. The recording is done every second ( $dt = 1s$ ).

We go back to the thermal conductivity of the sample by plotting the temperature variation of the hot wire ( $T_s(t) - T_s(t=0)$ ) over time, as a function of ( $\ln(t)$ ) the curve obtained represents a line whose slope  $\frac{\varphi_0}{4\pi\lambda L}$ . In addition, the ribbon is subjected to a voltage of 6V which gives  $\varphi_0 = \frac{U^2}{R}$



**Figure 13: Experimental device of the hot strip.**

At the level of the hot ribbon device, we will only present the result of the measurements that led to the estimation of the thermal conductivity of Kosso. The thermal conductivity of mahogany wood will be chosen in<sup>14</sup>, since it was the object of a study in this article.

**Uncertainty on the measurement of thermal conductivity:**

**The measurement uncertainty achieved in the case of the hot strip device:** We will evaluate the measurement uncertainty at this level by the following formula:

$$\sigma^2 = \frac{1}{N} \left[ \frac{1}{N-1} \sum_{i=1}^3 (\lambda_i - \bar{\lambda})^2 \right] \quad (11)$$

**Uncertainty of measurement in the case of hot strip** We will quantify these errors by using the uncertainty propagation formula. Based on the expression of thermal conductivity, we have:

$$\lambda = k \frac{e\beta T_2}{d^2(T_1 - T_2)} \quad (12)$$

With  $k = \frac{4mc}{\pi}$

$$\lambda = f(e, \beta, T_1, T_2, d) \quad (13)$$

$$u_c^2 = \left(\frac{\partial \lambda}{\partial e}\right)^2 u^2(e) + \left(\frac{\partial \lambda}{\partial \beta}\right)^2 u^2(\beta) + \left(\frac{\partial \lambda}{\partial T_1}\right)^2 u^2(T_1) + \left(\frac{\partial \lambda}{\partial T_2}\right)^2 u^2(T_2) + \left(\frac{\partial \lambda}{\partial d}\right)^2 u^2(d) \quad (14)$$

$$\left(\frac{\partial \lambda}{\partial e}\right)^2 = \left(\frac{k\beta T_2}{d^2(T_1 - T_2)}\right)^2 \quad (15)$$

$$\left(\frac{\partial \lambda}{\partial d}\right)^2 = \left(\frac{-2ke\beta T_2}{d^3(T_1 - T_2)}\right)^2 \quad (16)$$

$$\left(\frac{\partial \lambda}{\partial T_1}\right)^2 = \left(\frac{ke\beta T_2}{d^2(T_2 - T_1)^2}\right)^2 \quad (17)$$

$$\left(\frac{\partial \lambda}{\partial T_2}\right)^2 = \left(\frac{ke\beta T_2}{d^2(T_2 - T_1)^2}\right)^2 \quad (18)$$

$$\left(\frac{\partial \lambda}{\partial T_2}\right)^2 = \left(\frac{ke\beta T_1}{d^2(T_1 - T_2)^2}\right)^2 \quad (19)$$

$$\left(\frac{\partial \lambda}{\partial \beta}\right)^2 = \left(\frac{keT_2}{d^2(T_1 - T_2)}\right)^2 \quad (20)$$

$$T = \alpha e^{-\beta t} \quad (21)$$

$$\ln(T) = -\beta t + \ln(\alpha) \quad (22)$$

Let  $y = \ln(T)$  So we have

$$y = -\beta t + \ln(\alpha) \quad (23)$$

$$S_{y/\beta}^2 = \frac{\sum_{i=1}^{n_1} (y_i - y_{pi})^2}{n_1 - 2} \quad (24)$$

$$S_{y/\beta}^2 = \frac{\sum_{i=1}^{n_1} ((\ln(T))_{exp} - \ln(T))_{mod}^2}{n_1 - 2} \quad (25)$$

Now let's look for the typical uncertainties on each variable. Typical uncertainties on thicknesses and diameters of samples are evaluated as follows are valued by the relationship:

$$u(e) = \sqrt{\frac{1}{N} \left[ \frac{1}{N-1} \sum_{i=1}^N (e_i - \bar{e})^2 \right]} \quad (26)$$

$$u(d) = \sqrt{\frac{1}{N} \left[ \frac{1}{N-1} \sum_{i=1}^N (d_i - \bar{d})^2 \right]} \quad (27)$$

We used two types of K thermocouple. So  $u(T_2) = u(T_1)$ . The thermocouples used are of type K. According to the manufacturers, they have an accuracy of  $\pm 0.1^\circ\text{C}$  temperature in  $^\circ\text{C}$ .

$$u(T_1) = \frac{PrécTh}{\sqrt{3}} \quad (28)$$

The standard error committed on  $\beta$  is :

$$u^2(\beta) = \frac{\left( Sy/\beta \right)^2}{\sum_{i=1}^n (t_i - \bar{t})^2} \quad (29)$$

## RESULTS AND DISCUSSION:

**Validation of Lee's disk device:** The reference material used to validate this device of Lee's record is plexiglass.

**Determination of the slope of the plexiglass cooling curve:** We will trace the cooling curve of the low disk in the case of Plexiglas. This curve will undergo an exponential regression. The equation of the regression curve gave us parameters that allowed us to determine the rate of cooling.

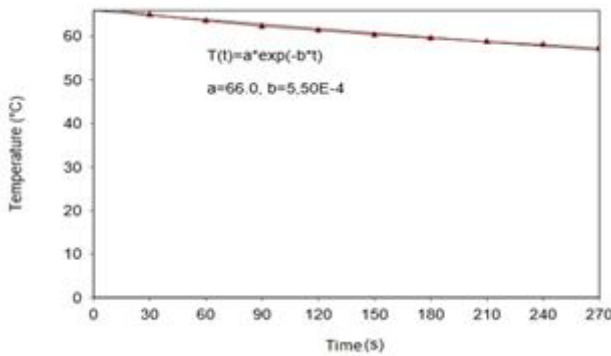


Figure 14: Cooling curve in the case of plexiglass.

Table 1: Plexiglas Sample Parameters and Measured Values.

Mass of the lower disk (kg)		0.1773			
Specific heat of the disc ( $Jkg^{-1}K^{-1}$ )		385			
Surface of the disc section ( $m^2$ )		0.0019625			
Curve adjustment parameter	Thickness of the sample ( $\times 10^{-3}$ m)	Steady state temperature ( $^\circ\text{C}$ )	Thermal conductivity ( $Wm^{-1}K^{-1}$ )		$\lambda$
			$\alpha$	$\beta$	
66	0.00055	4	92.5	64.4	<b>0.183</b>

**Comparison of the calculated thermal conductivity of Plexiglas with its standard value:** The value of the thermal conductivity of Plexiglas calculated from the measurements made on the Lee's device and recorded is very close to that provided by the literature,  $0.183 Wm^{-1}K^{-1}$  calculated against  $0.184 Wm^{-1}K^{-1}$  given by the literature. In other words, the relative error committed by this device with respect to the value of the literature is about 0.5%. This value justifies the validity of the experimental device of the Lee disk set up. It should be noted that the tests were carried out three times and the variability obtained was almost the same.

## Measurement of the thermal conductivity of wood species with designed device:

### Determination of the slope of the cooling curve of wood: Mahogany and Kosso:

**Mahogany Wood:**

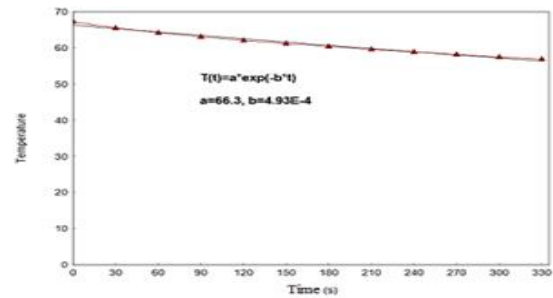


Figure 15: Cooling curve in the case of mahogany.

Table 2: Mahogany Sample Settings and Measured Values.

Mass of the lower disk (kg)		0.1773			
Specific heat of the disc ( $Jkg^{-1}K^{-1}$ )		385			
Surface of the disc section ( $m^2$ )		0.0019625			
Curve adjustment parameter	thickness of the sample ( $\times 10^{-3}$ m)	Steady state temperature ( $^\circ\text{C}$ )	thermal conductivity ( $Wm^{-1}K^{-1}$ )		$\lambda$
			$\alpha$	$\beta$	
66.3	0.000493	3.2	91.4	62.5	<b>0.12</b>

Diameter of the sample  $d_{Acadj} = 5$  cm

**Kosso:**

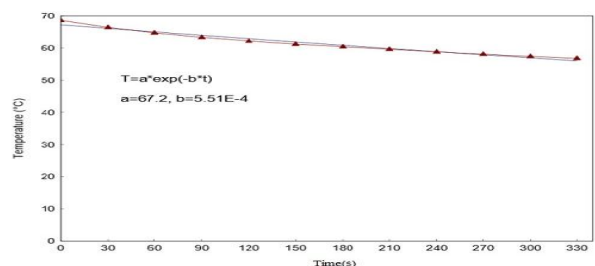


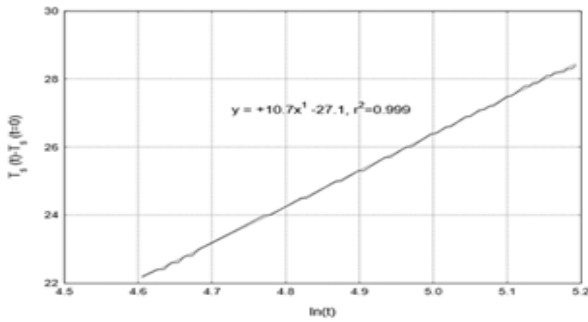
Figure 16: Cooling curve in the case of Kosso.

**Table 3: Sample parameters in Kosso and measured values.**

Mass of the lower disk (kg)					0.1773
Specific heat of the disc (Jkg <sup>-1</sup> K <sup>-1</sup> )					385
Surface of the disc section (m <sup>2</sup> )					0.0019625
Curve adjustment parameter		thickness of the sample (× 10 <sup>-3</sup> m)	Steady state temperature (°C)		thermal conductivity (Wm <sup>-1</sup> K <sup>-1</sup> )
α	β	e	T <sub>1</sub>	T <sub>2</sub>	λ
67.2	0.000661	2.75	90.7	64.2	<b>0.128</b>

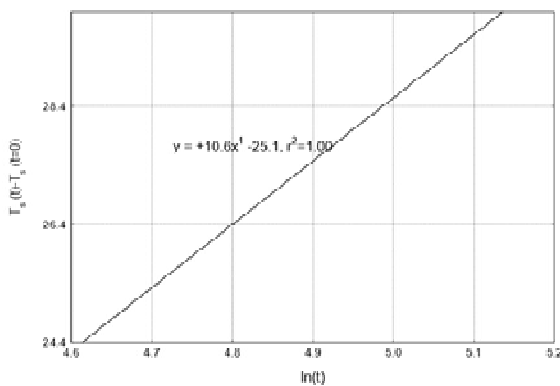
It should be noted that each of the three experiments lasted an average of 2.5 hours.

**Measurement of Thermal Conductivity of Kosso Wood with Hot Strip Device:** We present the curves of three successive tests of thermal conductivity measurements of Kosso wood (water content of 13%), which were made with the hot strip device.



**Figure 17: Estimation of the thermal conductivity of Kosso during the first test.**

$\phi_0 = \frac{6^2}{43.4} = 0.83$  and the slope is 10.4  
We get,  $\lambda_1 = 0.124 \text{ W/m}^{-1}\text{K}^{-1}$



**Figure 18: Estimation of the thermal conductivity of Kosso during the second test.**

We find the same :  $\lambda_2 = 0.125 \text{ W/m}^{-1}\text{K}^{-1}$  because the slope is equal to 10.6. In the same way we find  $\lambda_3 = 0.122 \text{ W/m}^{-1}\text{K}^{-1}$   
Finally we have:

$$\bar{\lambda} = \frac{\lambda_1 + \lambda_2 + \lambda_3}{3}$$

$$\bar{\lambda} = 0.1236 \text{ W/m}^{-1}\text{K}^{-1}$$

After carrying out the thermal conductivity measurements with the two devices, it was found that the duration of experimentation of the Lee disk is on average 2.5 hours while that of the hot strip is about 3 minutes.

**Uncertainty on Two Coefficients of Thermal Conductivity: Case of hot strip device:**

*Kosso Wood:*

The standard deviation is given by the formula (11):

$$\sigma^2_{\bar{\lambda}_K} = \frac{1}{3} \left[ \frac{1}{3-1} (0.124 - 0.1236)^2 + (0.125 - 0.1236)^2 + (0.125 - 0.122)^2 \right]$$

$$\sigma_{\bar{\lambda}_K} = \pm 0.001$$

Thermal conductivity  $\bar{\lambda}_{Kru} = 0.1236 \pm 0.001 \text{ (W/m}^{-1}\text{K}^{-1})$

The conductivity of Mahogany wood is derived from<sup>16</sup> is  $\bar{\lambda}_{Aru} = 0.134 \pm 0.004 \text{ (W/m}^{-1}\text{K}^{-1})$

**Case of Lee's disk device:** The values of the different expressions for estimating uncertainty in the case of Lee's disk are given in the following table.

**Table 4: Different parameters for assessing uncertainty.**

Samples	$u^2(e)$	$u^2(d)$	$u^2(T_1)$	$u^2(T_2)$	$u^2(\beta)$
Kosso	1.06E-08	6.34E-08	0.00333	0.00333	8.9405E-10
Mahogany	5.84E-08	1.186E-07	0.00333	0.00333	3.9121E-10
Samples	$\left(\frac{\partial \lambda}{\partial e}\right)^2$	$\left(\frac{\partial \lambda}{\partial d}\right)^2$	$\left(\frac{\partial \lambda}{\partial T_1}\right)^2$	$\left(\frac{\partial \lambda}{\partial T_2}\right)^2$	$\left(\frac{\partial \lambda}{\partial \beta}\right)^2$
Kosso	2227.20	29,44	0.0188	0.0353	240
Mahogany	1375.23	22.53	0.0176	0.0301	240.70

From the table below we have at:

for the Kosso wood  $\lambda_{ko} = 0.128 \pm 0.005$

for the Mahogany wood  $\lambda_{Aj} = 0.12 \pm 0.009$

**Comparison of the results of the Lee Disc and those of the Hot Trip:**

**Table 5: Comparison of the results given by the two devices.**

Thermal conductivity λ(W/m <sup>-1</sup> K <sup>-1</sup> )		
	Lee's disc device	Hot ribbon device
Mahogany	0.12±0.009	0.134 ± 0.004 <sup>12</sup>
Kosso	0.128±0.005	0.123 ± 0.001



**CONCLUSION:** The fundamental objective of this work was to measure the thermal conductivity of some local building materials with Lee's disk type conductivity meter and to compare the results to those obtained using the hot strip ribbon method. To do this work, Lee's disk device was designed and experimentally validated. For the two tested species of wood, the data analysis shows that the thermal conductivities of Kosso wood (free air measurement with a water content of 13%) and mahogany wood (dry wood) obtained by Lee's disk method are, respectively,  $(0.128 \pm 0.005)W.m^{-1}K^{-1}$  and  $(0.120 \pm 0.009)W.m^{-1}K^{-1}$  against respectively  $(0.123 \pm 0.001) m^{-1}K^{-1}$  and  $(0.134 \pm 0.004) m^{-1}K^{-1}$  obtained by the hot strip method. These results show that the device designed can be used for measuring the thermal conductivity of insulating mater

**NOMENCLATURE:**

Q	Heat flux
K	Thermal Conductivity ( $W/m^{-1}K^{-1}$ )
T	Temperature (K)
t	Time (s)
m	Mass of cast iron metal disc (kg)
C	Specific heat of metal disc ( $JKg^{-1}K^{-1}$ )
D	Diameter of the specimen slab (m)
e	Thickness of the specimen slab (m)
T <sub>1</sub>	Temperature of upper metal disc
T <sub>2</sub>	Temperature of lower metal disc
A	Cross section area of specimen slab( $m^2$ )
m <sub>h</sub>	Wet mass of the sample (kg)
m <sub>s</sub>	Dry mass of the sample (kg)
W <sub>e</sub>	Water content of the sample (%)

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