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FIELD RESEARCH ON SURFACE TEMPERATURE CHARACTERISTICS OF FABA BRICK USING SHADE AND WITHOUT SHADE

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ABSTRACT

In reality, brick is a building material used to make walls or walls. As the basic material is clay or clay which is then molded and burned at a certain temperature so that it turns hard like stone and will not soften again when exposed to water. One of the advantages is that it is strong and durable. However, one of the problems faced today is the supply of bricks as a material for making walls/panels which are mostly taken from productive rice fields. There are 3 (three) results of this study, firstly, the surface temperature profile of the east-oriented brick wall is 1.2% hotter than the temperature on the west side in sunny, cloudy and rainy weather. Second. The wall surface temperature profile in cloudy weather has a surface temperature of 64.4% hotter than the ambient air temperature with the research model using shade. And third, the study of the use of shading on the wall model made of FABA proves that it has a significant effect on the magnitude of the thermal value produced.

KEYWORDS

FABA Brick, Wall Surface Temperature, Field Research, Shade

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INTRODUCTION

In the last few years, the level of development in Indonesia has increased very rapidly, Indonesia is also the largest construction market in Southeast Asia. This is in line with the entry into the development period for facilities and infrastructure in Indonesia. Marked by the construction of new buildings in big cities and in the regions, Indonesia is currently in the phase of equitable distribution of the development process throughout the archipelago. With a large development, it will affect the need for construction materials which also increases. One of the most important materials is the use of brick material in structural work (Handaya & Sutandi, 2019). In reality, brick is a building material used to make walls or walls. As the basic material is clay or clay which is then molded and burned at a certain temperature so that it turns hard like stone and will not soften again when exposed to water. One of the advantages is that it is strong and durable. However, one of the problems faced today is the supply of bricks as a material for making walls/panels which are mostly taken from productive rice fields (Trianingsih & Hidayah, 2014). Despite targeted efforts to curb climate change, coal still ranks globally as the highest source of fuel used to generate electricity. By using these fossil fuels, coal fired power plants (CPP) also accumulate massive secondary waste products (such as fly ash (FA) and bottom ash (BA) (Spadoni et al., 2014).

Fly ash and bottom ash are waste products from the burning of pulverized coal in power plants which are facing increased production requiring large areas of land for disposal (Khanday et al., 2021). The characteristics of fly ash depend on the type of coal used, the combustion conditions and the temperature at which the coal is burned, the collector setup, the fuel-air ratio and other factors. As a study conducted by (Jurnal, 2017) , that they were informed that the use of FABA in several other countries with very supportive regulations, finally obtained a condition of achievement of using FABA up to 97%. From several citations by him, it is said that the use of Fly Ash has been successfully used in the construction industry since more than 50 years but so far its application is still limited due to lack of understanding about the characteristics of Fly Ash itself and the properties of concrete containing Fly Ash. By providing added value this waste ash can be reused either as the main ingredient or a mixture of building materials.

The use of Fly Ash (B409) and bottom ash (B410) FABA has been widely carried out, including the use as a substitute for aggregate in the production of bricks which has been developed by PLTU Paiton but still cannot be said to be perfect because it still has shortcomings. Meanwhile, Indonesia is currently increasing its infrastructure development. This is different from the conditions in several other countries that apply different regulations in the management of FABA, so that countries can use FABA up to 97%. Fly ash has been used successfully in the construction industry for more than 50 years but its application is still limited due to a lack of understanding of the characteristics of fly ash itself and the properties of concrete containing fly ash (Singh & Siddique, 2013).

By-products from the combustion of every one tonne of coal carried out by PLTU produce around 15% - 17% of Fly Ash and Bottom Ash, as stated by the Ministry of Environment and Forestry of the Republic of Indonesia (KLHK). The physical character of Fly Ash is a fine powder with pozzolanic properties. This property is in the form of a material that has a low CaO content, so it does not have a binding ability (Klarens et al., 2016). FABA from a PLTU activity is categorized as non-B3 waste, but the management requirements must still meet the standards and technical requirements set out and listed in the environmental document approval. As for Bottom Ash, it has a larger size than Fly Ash, which makes it easier for Bottom Ash to fall to the bottom of the furnace. Bottom Ash is shaped like river sand but with a coarser texture. On the basis of these characteristics, it is

the background to study the position of replacing clay by this material in the manufacture of bricks (Suseno et al., 2012).

Currently, fly ash is successfully used in the improvement of construction materials and is very well used in the agricultural sector to improve soil properties as well (Dwivedi & Jain, 2014). Fly ash can also be used in brick making, ceramic making, road construction, concrete production and other activities. The use of fly ash in the construction industry is not a new technology but is a developing technology in improving the quality of construction and environmental quality. The addition of fly ash to concrete provides economic, ecological and technical benefits (Hemalatha & Ramaswamy, 2017). Fly ash can be used in the manufacture of bricks where the bricks are made by burning, not burning, and preserved by steam and is the best alternative in its utilization (Yao et al., 2015). According to (Tiwari et al., 2016), Fly Ash is also suitable for use as a raw material in various industries because it is a material rich in oxides. Several alternative uses of FABA have been developed by PLTU Paiton.

The addition of Fly Ash to concrete provides economic, ecological and technical benefits. Concrete that has been mixed with Fly Ash which is tested in extreme cold weather has elasticity or resistance of 78 – 91 out of a scale of 100, because it has a relatively low dynamic elasticity so that it has better durability (Pushpalal et al., 2022). Meanwhile, bricks with a mixture of FABA have a better water absorption capacity of 0.3 - 6.1% compared to bricks without a mixture of FABA and have fire resistance of up to 30% (Sivakumar, 2005). In this study, the author uses FABA material that has met SNI standards and has passed the TCLP (Toxicity Characteristic Leaching Procedure) test which is a test on the environment, where it tests the level of toxicity produced by the product. The FABA brick itself is taken from the Paiton PLTU which has met the SNI standard and has passed the TCLP test. So, the materials used for this research are safe for the environment and the application of building materials.

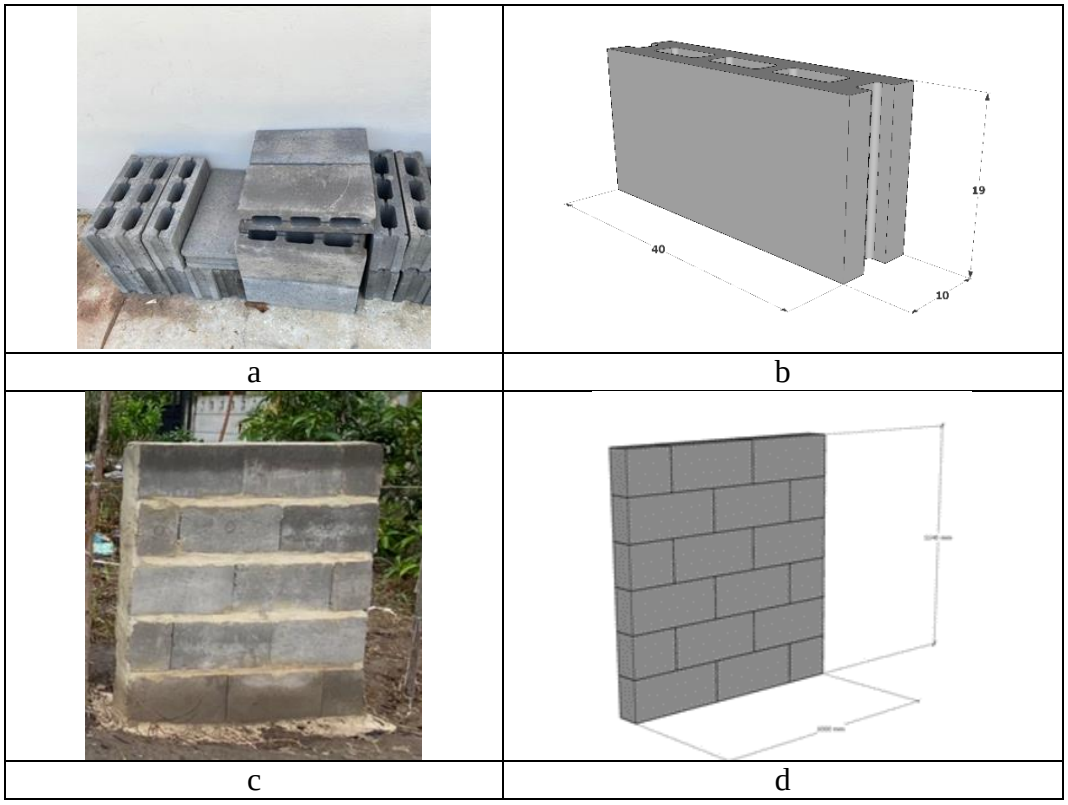
As in the background of the problem above, the status of FABA material in particular and as a building material has been confirmed by Government regulations. In the application of building design with an approach to the concept of Green or Environmentally Friendly Building, it is stated that one of the parameters is the aspect of recycling waste materials and the thermal/temperature effect of using the material in order to create a comfortable and safe interior environment. So the question in the research that we will examine is "To what extent is the thermal character of the wall material in the form of FABA bricks in the extreme conditions of the micro-climate in the field directly? and how far is the difference between the use of the material to its thermal value?". And in this research, we have obtained brick material made from this coal waste, which has so far been developed by PLTU Paiton.

RESEARCH METHOD

a). Object of research

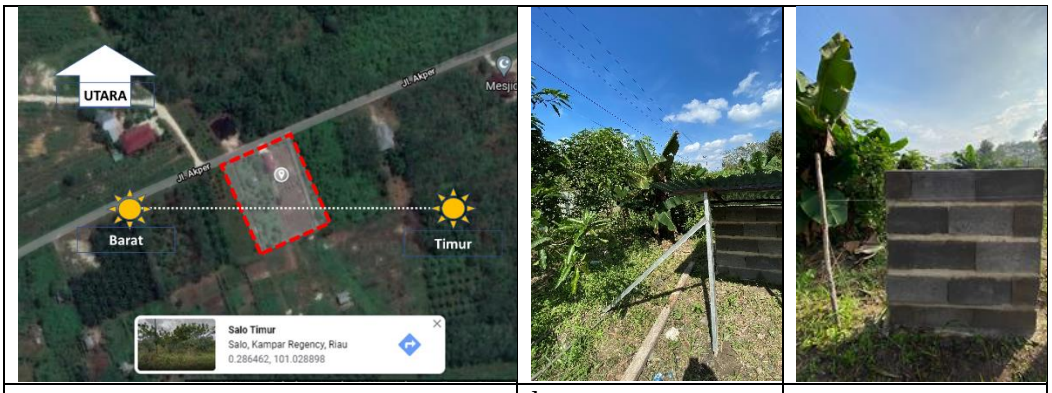
- First, the object of the research is using FABA brick wall material that has been processed/printed with certain dimensions (40x10x19cm) at the Java-Bali Steam Power Plant (PLTU PJB) Paiton, Probolinggo, East Java (see picture 01).
- Second, the FABA brick blocks are arranged into a wall with a size of 1.00m x 1.00m x 0.1m. Due to the implementation of this further research being constrained by the progress and in the era of the COVID-19 pandemic, the implementation was carried out in the area closest to the researcher on Akper Street, Bangkinang City District, Kampar Regency, Riau City (0°17'11.3" North Latitude 101°01 '44.0" East Longitude).

• Third, the object that has been formed into a block of brick wall is placed in an area/field that is free from obstructions, with the aim that the object can be exposed to sunlight from morning to evening optimally. (see figure 02).
• Fourth, measurements will be taken between FABA brick walls using a shade and not using a shade where the shade is made of zinc with dimensions of 180x80cm with a thickness of 0.2cm.



a b c d

Figure 01: (a,b) Object and dimension sketch of FABA brick unit and (c,d) Illustration of FABA brick wall construction

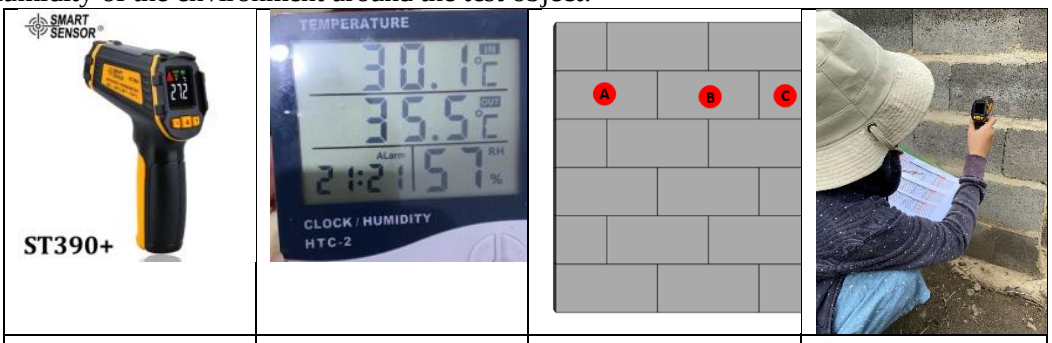


a b c

Figure 02. (a) The situation of the research location in the city of Riau, (b) Visualization of objects facing west using a shade (c). Visualization of objects facing East without Shade

b). Measuring tools

There are two principal measuring instruments used in this observation, namely the Infrared Thermometer S7391 measuring instrument used to measure the wall surface temperature. And a digital thermometer is used to determine the air temperature and humidity of the environment around the test object.



a	b	c	d

Figure 03. (a,b) Measuring tools used, (c,d) Position of measuring point

c). Measurement Stage

Coherently, the stages in conducting field measurements are as follows:

- First, after the block units are arranged into a wall area measuring 1.00m x 1.00m, which is composed of 5 layers with 2.5 bricks each layer, and its position is faced in the right direction of East-West orientation (front side and back side of the wall), then a sample of 3 (three) positions of the measuring point is determined, both on the front of the wall and 3 positions for the measuring point on the back.
- Second, at each measuring point, infrared shots were fired manually 3 times with a duration ranging from 10-15 seconds/shot and were carried out at 60 minute intervals from 06.00 WIB to 18.00 WIB.
- Third, three measuring data (wall surface temperature, ambient air temperature and humidity) were obtained in hot, cloudy and rainy weather conditions. This research lasted for 3 months.
- Fourth, after all measurement results are tabulated, then this data is then analyzed partially (each time period) and compares the three measurement methods in which the model uses an accuser or does not use a shade so that the answers to this researcher's questions are obtained.

RESULT AND DISCUSSION

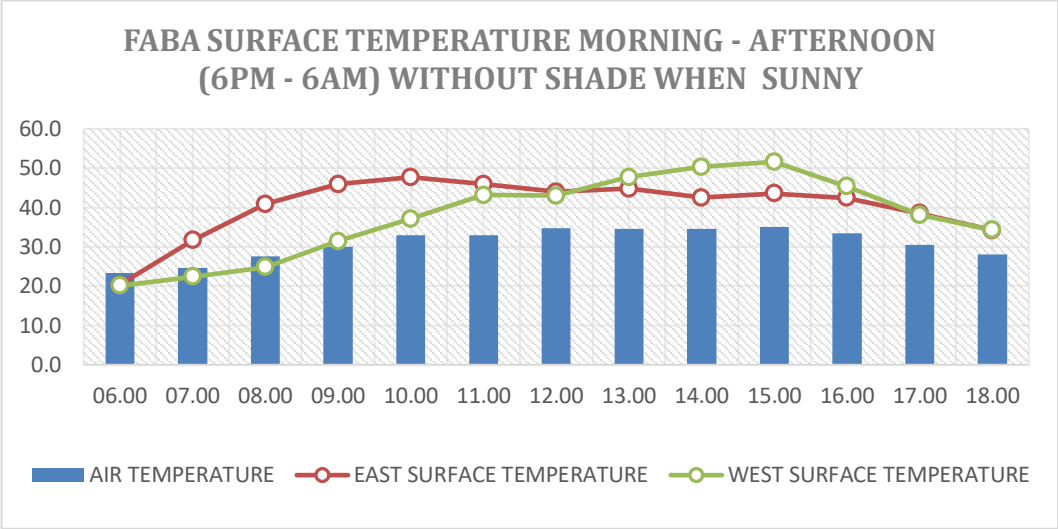
The weather factor is limited to the climate of a location, because this is also used as one of the parameters, it has a very significant effect on measuring the value generated in field measurements and the use of shade factor in this study is also a parameter for measuring the value generated in field measurements to determine the temperature value. the resulting wall surface and compared with those that do not use shade with the same climatic conditions in the same location and place.

The chosen method enriches the results of knowledge in general and in particular related to the exploration of materials from FABA in general or in particular FABA bricks from the production of PLTU Paiton.

A. Measurements in sunny weather with research methods without shade

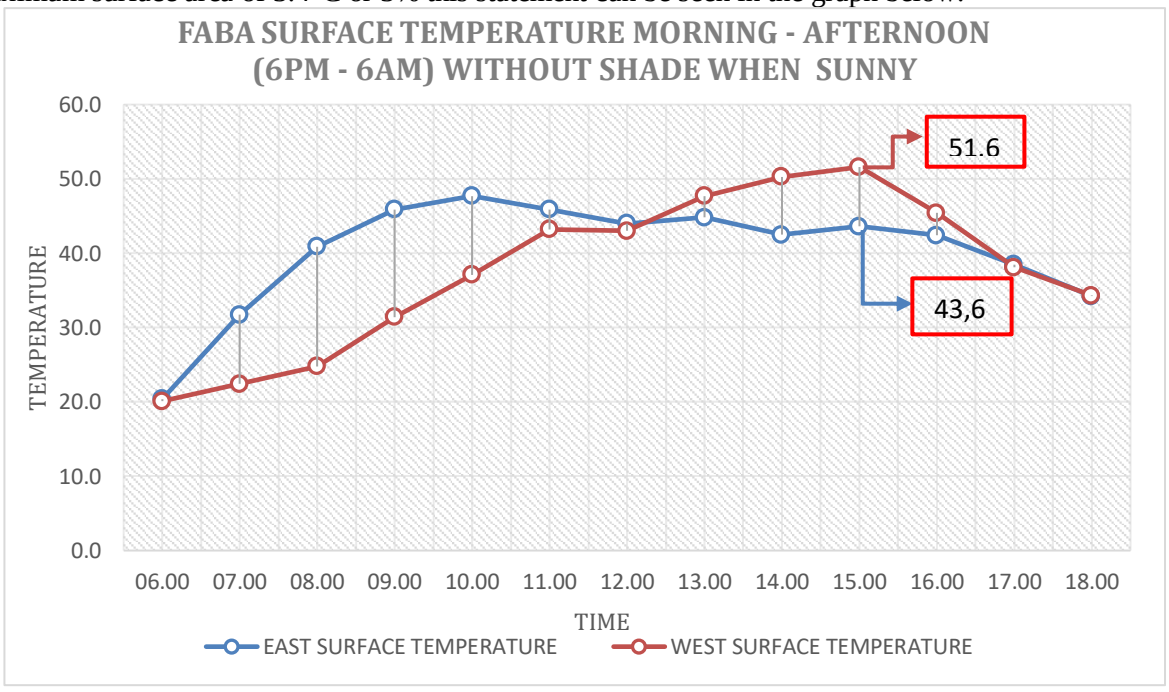
The results of field measurements show that the surface temperature of the FABA wall facing east has a difference of 0.3% with the west surface temperature in the morning

where the surface temperature of the FABA wall is not too far from the surface temperature comparison. The surface temperature of the FABA wall rose stably from the East and West orientations following the air temperature at the research site, which can be seen in graph 01.



Graph 01 FABA Wall Surface Temperature in the Morning - Evening (06.00-18.00) In Sunny Weather Conditions Without Shade

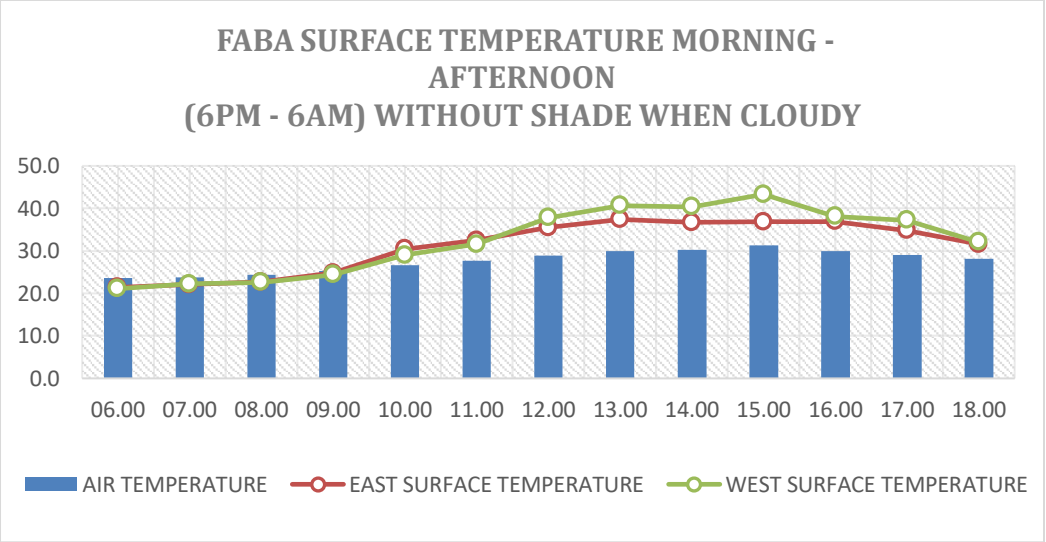
Sunny weather conditions produce the maximum temperature generated by the wall surface in the model without shade, which is 51.6°C in the western orientation. the maximum surface area of 3.4°C or 3% this statement can be seen in the graph below.



Graph 02 FABA Wall Surface Temperature in the Morning - Evening (06.00-18.00) In Sunny Weather Conditions Without Shade

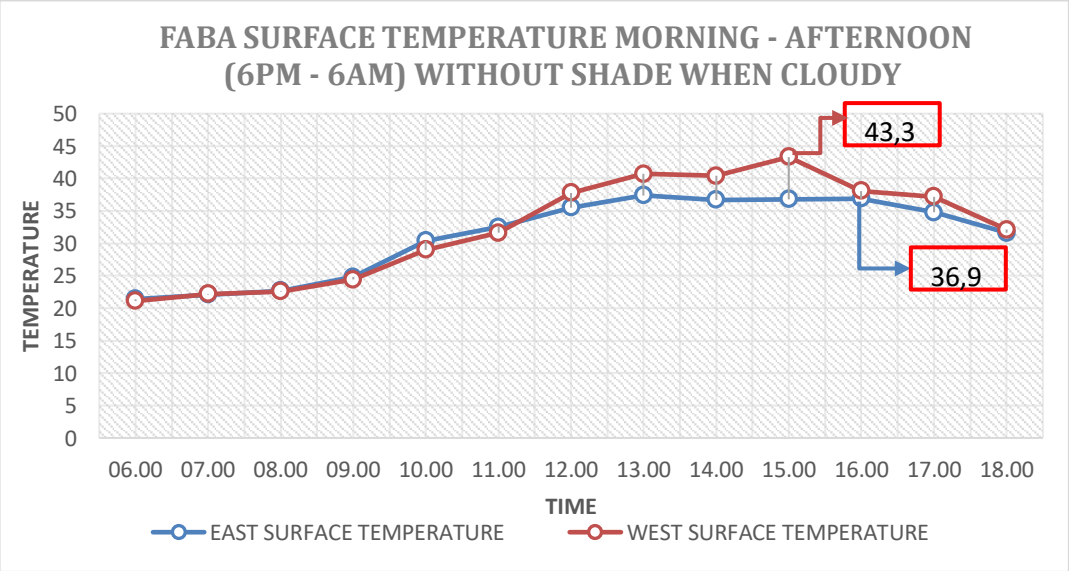
B. Measurements in cloudy weather with research methods without shade

In field measurements with cloudy weather conditions the difference in the morning between the east and west orientations has a difference of 0.2%. The surface temperature began to slowly rise slowly starting at 10.00 following the air temperature at the research location, both the eastern surface temperature and the western surface temperature can be seen from the graph below.



Graph 03 FABA Wall Surface Temperature in the Morning - Evening (06.00-18.00) On Overcast Weather Conditions Without Shade

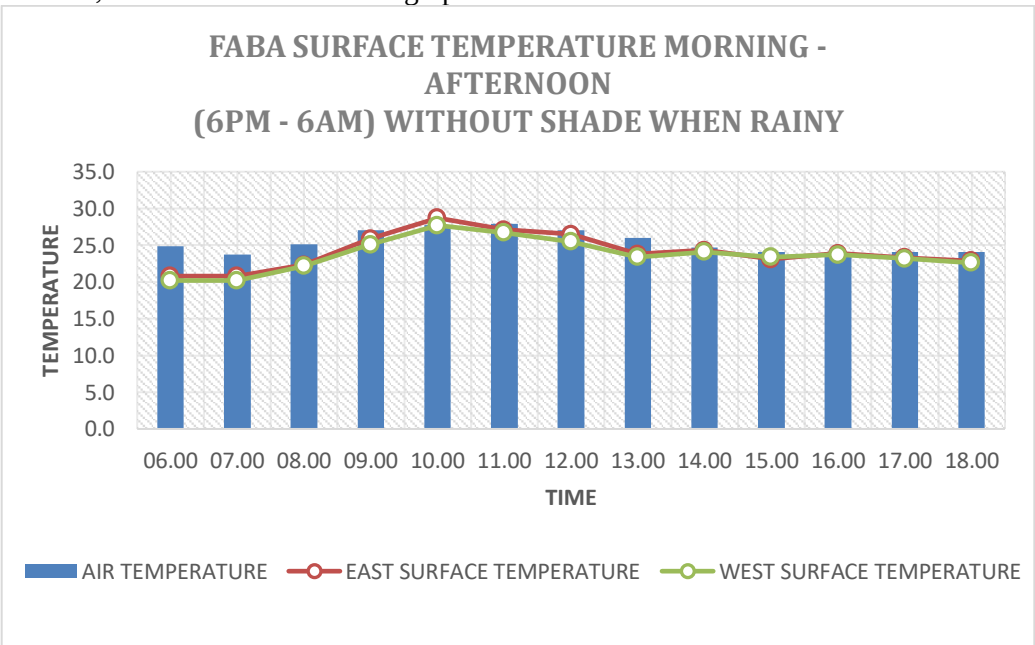
The maximum surface temperature occurs at 15.00 at orientation facing west with a surface temperature value of 43.3°C while the eastern surface temperature has a maximum temperature of 36.9°C at 16.00 from the difference between the two maximum temperatures resulting in a value of 4.1 or 4 %, this can be seen in the graph below.



Graph 04 FABA Wall Surface Temperature in the Morning - Afternoon (06.00-18.00) On Overcast Weather Conditions Without Shade

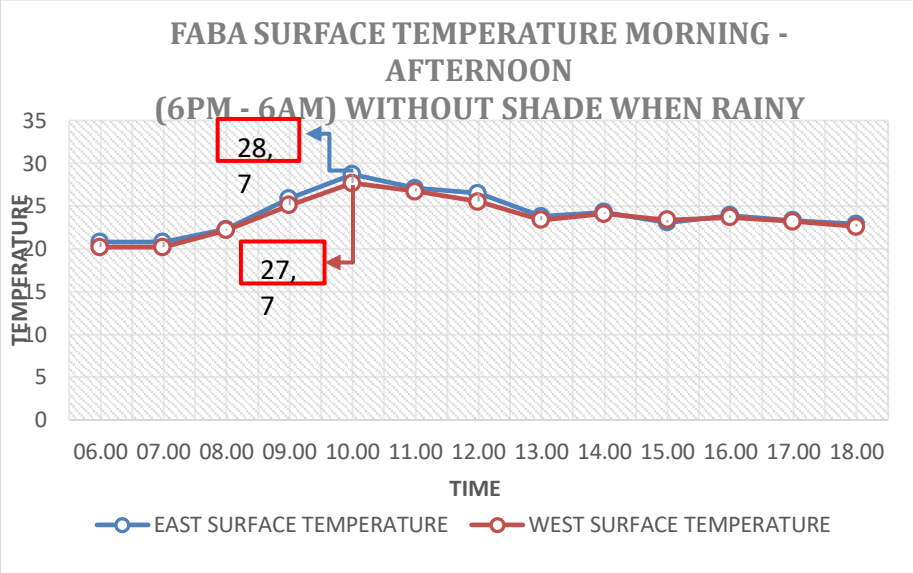
C. Measurements in Rainy Weather with Research Methods Without Shade

In the results of measurements in the field with rainy weather conditions, the surface temperature of the FABA wall which is oriented to the East has a difference of 0.6% compared to the West surface temperature, the surface temperature produced in this roofless research model is below the air temperature at the research location where the average temperature is at the research location, which is 29°C, while the average temperature produced by the object of research, both west and east orientations is 26.5°C – 28.7°C, which can be seen in the graph below.



Graph 05 FABA Wall Surface Temperature in the Morning - Evening (06.00-18.00) In Rainy Weather Conditions Without Shade

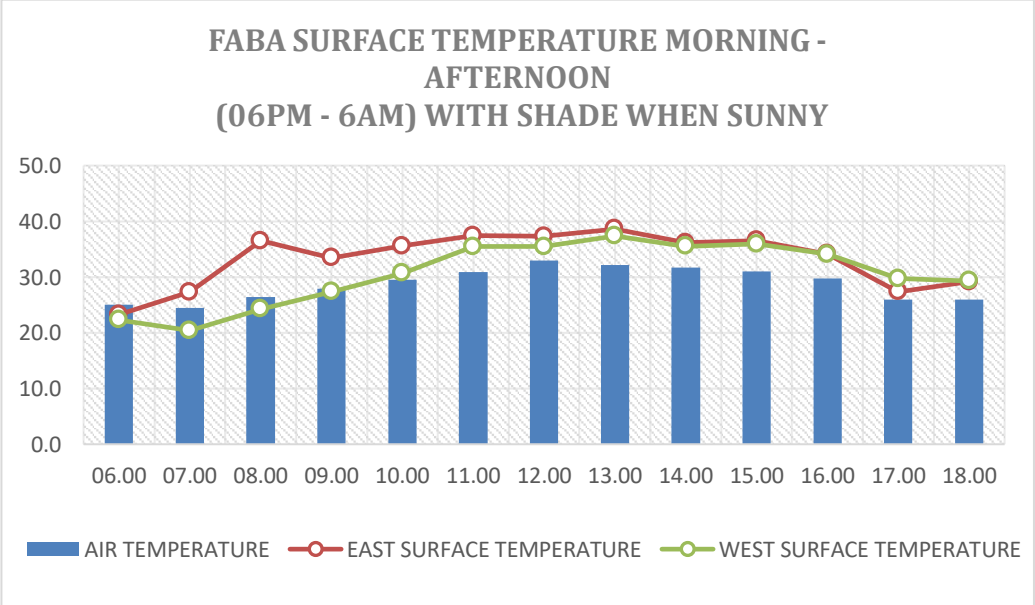
The maximum temperature generated on the surface of the eastern orientation wall is 26.5°C at 12.00 and for the western surface temperature it has a maximum temperature of 25.5°C at 12.00, the difference between the two is 1%, the resulting temperature is almost the same as the temperature. in the morning. This can be seen in the graph below.



Graph 06 FABA Wall Surface Temperature in the Morning – Evening (06.00-18.00) In Rainy Weather Conditions Without Shade

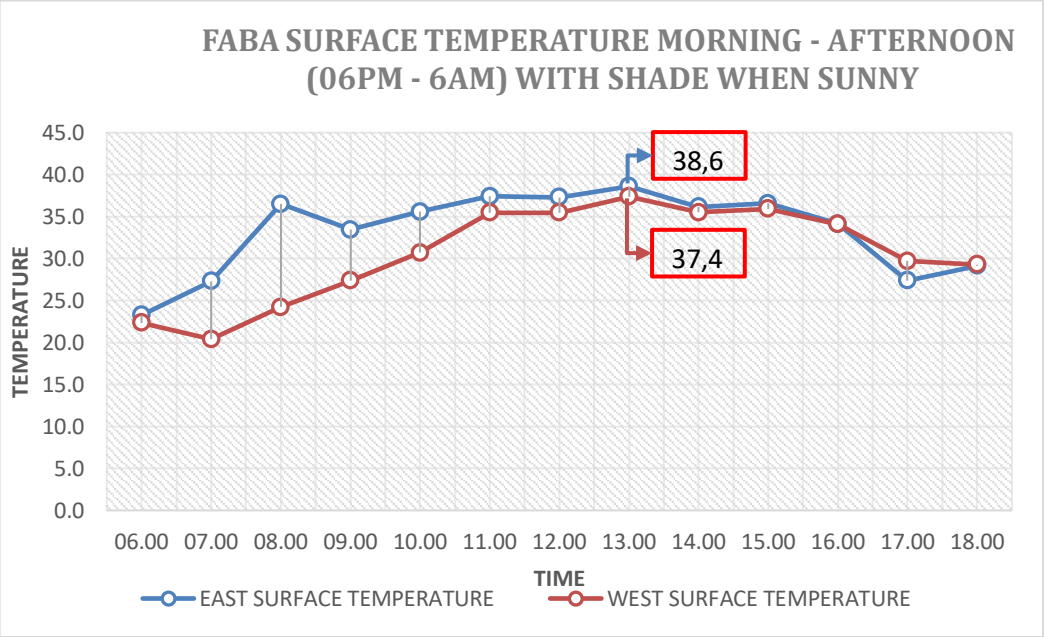
D. Measurement in Sunny Weather with Research Methods Using Shade

Based on the results of measurements in the field with sunny weather conditions and hot sun with a model using a cover/shade, it shows that the difference in surface temperature produced in the morning has a surface temperature difference of 3.3%, where the eastern surface temperature produces a temperature of 23.4°C at 06.00 while at the western surface temperature at



Graph 07 FABA Wall Surface Temperature in the Morning – Evening (06.00-18.00) In Sunny Weather Conditions Using Shade

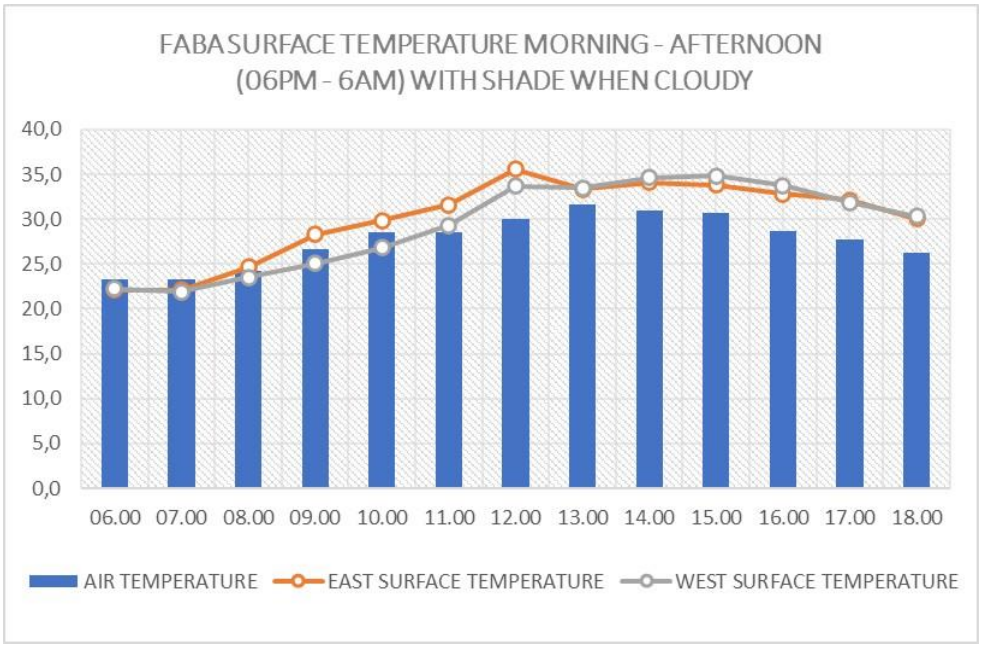
The measurement results for the maximum wall surface temperature produced in the east orientation are 36.4°C at 13:00 and for the west surface temperature it has a maximum temperature of 36.2°C at the same time, the difference ratio for the two is 0.2%. This can be seen from the graph below.



Graph 08 FABA Wall Surface Temperature in the Morning – Evening (06.00-18.00) In Sunny Weather Conditions Using Shade

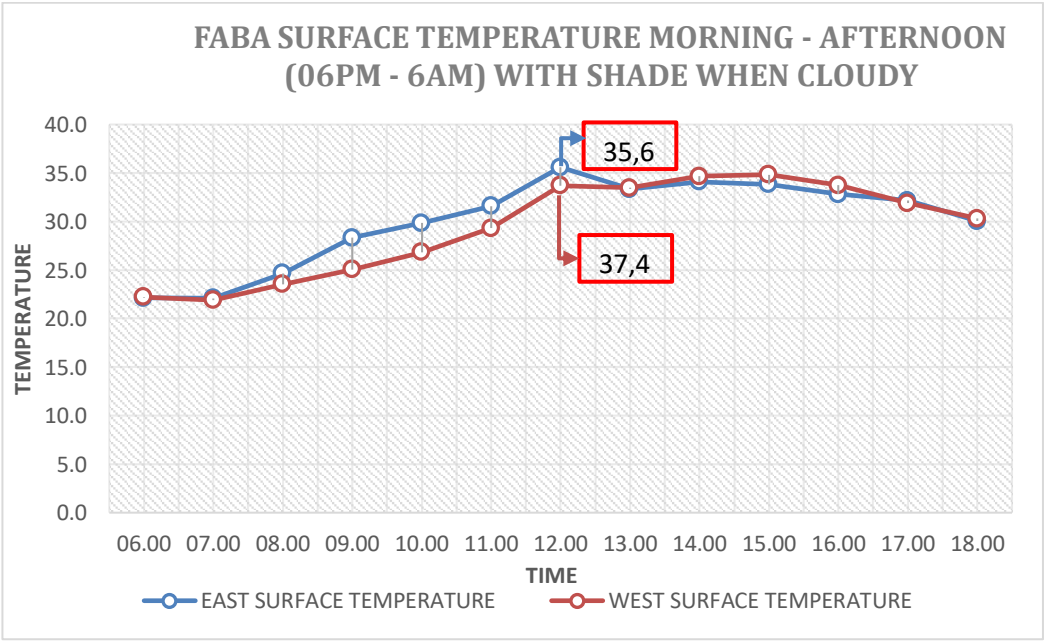
E. Measurement in Cloudy Weather with Research Methods Using Shade

The weather conditions in a cloudy position with respect to the surface temperature of the FABA wall facing east have a difference of 0.1% compared to the west surface temperature, the east and west surface temperatures rise slowly following the air temperature around the study site. The temperature produced in cloudy weather conditions does not differ that much from sunny weather conditions. This can be seen in the graph below.



Graph 09 FABA Wall Surface Temperature in the Morning – Evening (06.00-18.00) on Cloudy Weather Conditions Using Shade

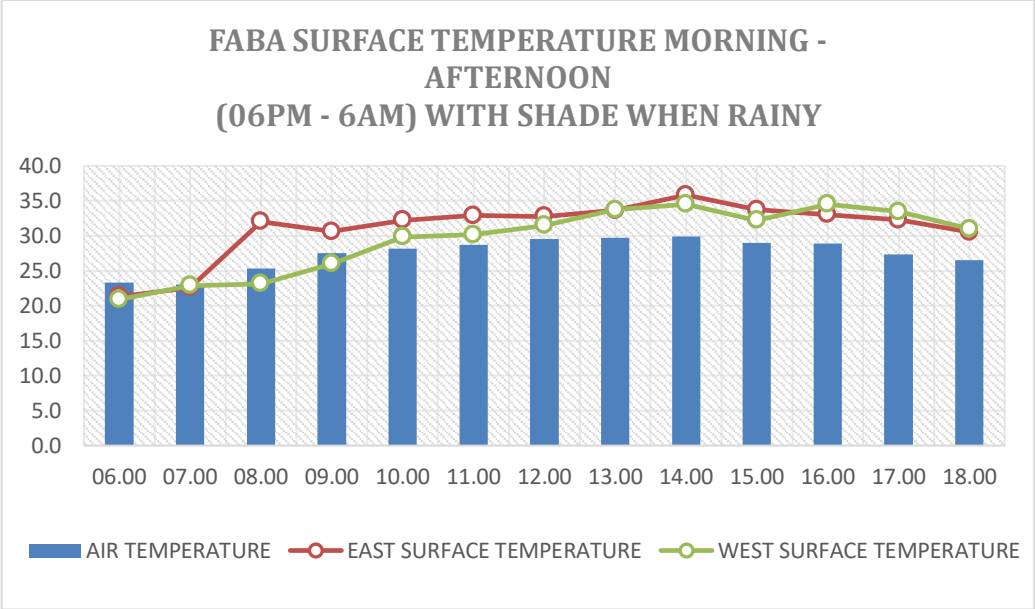
The results of FABA wall measurements in the morning to noon from 06.00 - 18.00 the maximum temperature produced by the east-oriented wall is 35.6°C at 12.00 and for the surface temperature in the west it has a maximum temperature of 34.8°C at 15.00. The difference between the two maximum temperatures is 0.4%, this can be seen in the graph below.



Graph of 10 FABA Wall Surface Temperatures in the Morning – Evening (06.00-18.00) on Cloudy Weather Conditions Using Shade

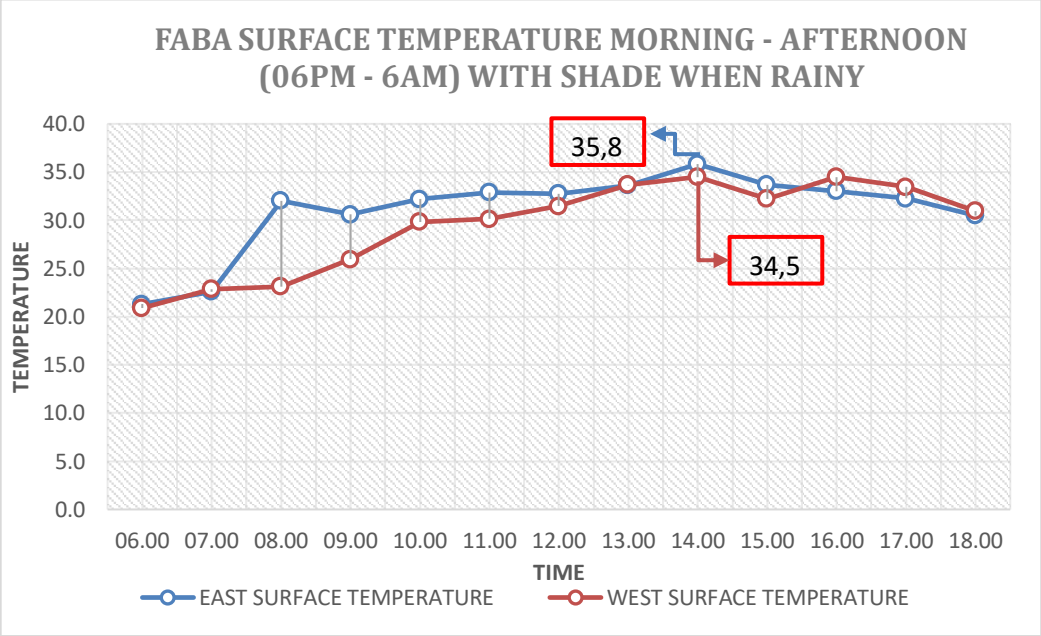
F. Measurement in Rainy Weather with Research Methods Using Shade

Based on the results of measurements in the field with conditions in the rain the surface temperature of the FABA wall facing east has a difference of 0.4% from the temperature of the west surface wall. The air temperature at the research location when it rains has an average temperature of 31.7°C while the average temperature produced by the research object, both east and west orientations produces a temperature of 35.6°C, this shows that the air temperature in the surrounding location is not too affect the wall surface temperature with a model using a shade in rainy conditions. This can be seen in the graph below.



Graph 11 FABA Wall Surface Temperature in the Morning – Evening (06.00-18.00) In Rainy Weather Conditions Using Shade

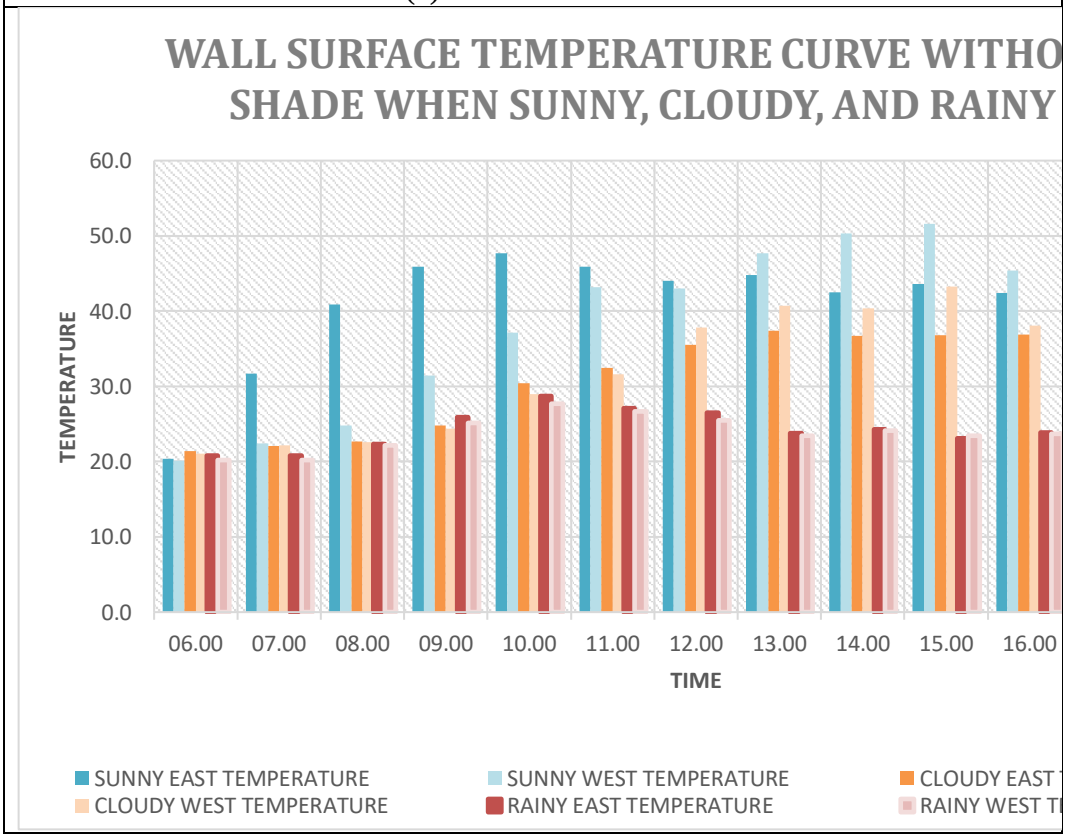
The maximum temperature produced by the east-oriented wall surface is 35.8°C at 14.00, while the western temperature has a maximum temperature of 34.5°C at the same time. The difference in the maximum temperature ratio is 1.3%, this can be seen from the graph below.



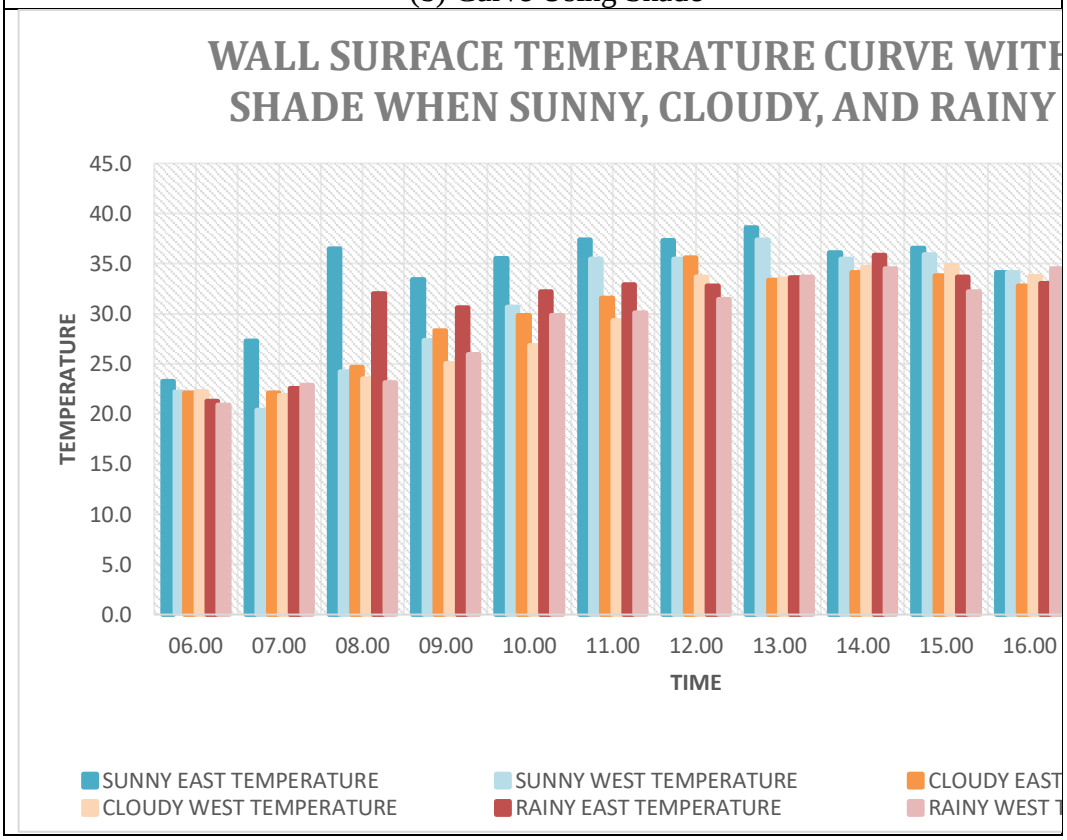
Graph 12 FABA Wall Surface Temperature in the Morning – Evening (06.00-18.00) In Rainy Weather Conditions Using Shade

Comparative Analysis Between 2 (Two) Model Objects

(a) Shadeless Curve



(b) Curve Using Shade



Graph 13 (a) Unshaded Curve; (b) Curve Using Shade

In the comparison section of the profiles of the two FABA wall surface temperatures, both using and not using shade, observing the same weather conditions, namely sunny, cloudy, and rainy. This can be seen in graph 13 above

- A sunny atmosphere without using a shade has a warmer surface temperature of 79.6% compared to the surface temperature under the same conditions using a shade, which is 61.4%.
- While in cloudy weather without using a shade, the surface temperature is 78.6% warmer, while in a cloudy atmosphere using a shade it is 64.4% warmer.
- In rainy conditions, the surface temperature is 79.2% cooler without using a shade, and when using a shade, the temperature is 65.5% warmer.

From the curve above shows the difference in temperature, this can also be influenced by the use of shade or not. If you look at the surface temperature without a shade, it is hotter than if you use a shade by showing a temperature difference of 14.8% where the measurement is carried out in sunny and cloudy weather conditions, this is in contrast to rainy conditions where the temperature in rainy conditions in the model using the shade is hotter. ,1% compared to the model that did not use shade. This shows that the humidity factor on the wall that does not use shade where the wall will be cooler because rainwater falls directly on the wall surface, resulting in a cooler wall surface temperature than the surface temperature that uses shade.

CONCLUSION

Some notes from the measurement of wall objects using shade and not using shade in sunny, cloudy and rainy weather: The surface temperature profile of the east-oriented wall is 1.2% hotter than the west-oriented wall. Meanwhile, in a cloudy atmosphere, the surface temperature is 64.4% hotter than the ambient air temperature. And the back wall is only 0.8% hotter than the front wall. And in the rainy atmosphere, the surface temperature is 78.7% cooler. While the difference between the surface temperature of the front and rear walls is 13.2% cooler for the front.

While some notes from the measurement of wall objects without using shade in sunny, cloudy and rainy air: The surface temperature profile of a wall oriented to the west is 0.3% hotter than the wall oriented to the east. Meanwhile, in a cloudy atmosphere, the surface temperature is 78.6% hotter than the ambient air temperature. And the back wall is only 0.3% hotter than the front wall. While the difference between the surface temperature of the front and rear walls is 0.6% cooler for the back.

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