



Journal of Architectural Research and Education

Journal

homepage: <https://ejournal.upi.edu/index.php/JARE/index>



Building Glass Block as An Alternative Material for Natural Lighting in the Classroom of Raudatul Atfal Islam Terpadu Al-Uswah Without Distracting Children's Concentration Due to Wide Opening

Alingga Syaudina¹, Jibril Abdillah², Kunthi Herma Dwidayati³, Syira Insani⁴, Tazkiyah Maharani Nursiam⁵

^{1, 2, 3, 4, 5} Universitas Pendidikan Indonesia

*Correspondence: E-mail: syira.insani2002@gmail.com

ABSTRACT

Kindergarten is a formal education pathway for early childhood aged 4-6 years. Creating a comfortable classroom for learning as well as playing is one of the efforts to support good quality education. A room with adequate lighting is one of solution to create a comfortable classroom for learning and playing. The general solution to overcome this is to create a wide opening so that 250 lux light this is a Indonesian Nasional Standard (SNI class lighting) can enter the classroom. On the other hand, a wide opening has the potential to break the concentration of studenta because it can make children often look out of the window so that the concentration of student learning is disturbed. The comfort of learning and reading is important in the classroom. Optimizing natural lighting is the best solution to provide comfortable learning and reading for students. Therefore, this study aims to ensure that natural lighting enters the classroom by standardizing the use of the classroom (250 lux) in order to maximize reading comfort even better by changing the wall material to glass blocks as a means to enter natural light. So that, the incoming light can be in accordance with existing standards. Glass block is a good material for bringing natural light into the classroom without introducing a visual environment into the classroom. This is to keep the children focused on learning in class. This research was conducted using the literature study method and quantitative descriptive analysis obtained from

ARTICLE INFO

Article History:

Submitted/Received 8 Mar 2023
First Revised 15 August 2023
Accepted 20 January 2024
First Available online 1 April 2024
Publication Date 1 April 2024

keywords:

kindergarten,
glass block,
natural lightning

direct observation and then simulated with the Dialux evo 9.2 software. The simulation results show that there are several spots that do not meet the SNI standard. The recommendation given is to add glass blocks at several points in the classroom. Each class gets sufficient lighting.

Copyright © 2024 Indonesian University of Education

1. INTRODUCTION

Kindergarten Children usually do learning and play activities in the classroom. In the classroom, children need sufficient light to carry out these activities with a minimum of 250 lux with natural lighting to reduce electricity usage (SNI 03-6197-2000). The solution is to add windows so that natural light enters according to the standard (Dora, 2011). However, when learning, children will get visual distractions because their eyes sometimes look out of windows. To overcome this problem, the researcher proposes to use glass block as an alternative material for windows to enter natural light without distracting children's concentration when studying in class. According to Law Number 20 of 2003 concerning the National Education System, early childhood education is an effort aimed at fostering children from birth to the age of six which is carried out through the provision of educational stimuli to shape physical growth and development. and spiritually in order to have readiness in entering further education (Sugiyanto, 2011). To support this, we need a comfortable study room for children to learn and play at the same time. One of them is by incorporating sufficient natural light into the classroom.

By incorporating natural lighting into the classroom, children will be comfortable doing their learning activities as well as being able to increase children's joy and enthusiasm (Sugiyanto, 2011). Sunlight that enters the room can give a warm impression, adding to the joy and enthusiasm in the room (Bean, 2004: 193). Sufficient natural lighting is very important to be included in the classroom in order to create a comfortable and conducive room. Natural lighting is lighting that exists because of the sun or the dome of the sky (Gupta, 2017). There are two kinds of light, namely direct and indirect light, as the reflection of sunlight by clouds and objects around it. Incorporating natural light into the classroom usually uses indirect light will reflect light throughout the room (Mangunwijaya, 1980). This study aims to introduce indirect light into the classroom in RA IT Al-Uswah Pasirian so that children get sufficient and comfortable lighting for playing and learning.

To introduce indirect natural light into the classroom so that 250 lux is achieved, the researcher proposes to replace the wall material with glass block so that light can still enter while the child can stay focused on learning in the classroom (Mangunwijaya, 1980). Glass Block is a double-sided glass wall bulkhead. Glass block is a material made of thick glass with an opaque appearance that is different from ordinary glass (Adryanta, 2008). Glass block has functional properties for many things, can be used as a wall, as a privacy buffer, illumination (Antonius Richard, 2021). Glass block serves to enter natural light into the room with maintained privacy. In other words, light can still enter, but visual distractions from the outside don't come in (Setiawan, 2023). So, the main objective of the research is to introduce natural light into the classroom by replacing the walls with glass blocks so that it is achieved in accordance with the standardization of classrooms based on the Indonesian National Standard, namely 250 lux while the children stay focused on learning without being distracted by other things outside the classroom because the nature of the glass block is different from ordinary windows (SNI 03-6197-2000).

2. LITERATURE REVIEW

2.1. Definition of Kindergarten

The word Kindergarten comes from the German language, "kinder" means children and "garten" means garden (Zoromski, 2019). Kindergarten is an educational institution that refers to preparing early childhood education for children before attending elementary school. The place where children learn social behavior and develop basic literacy and

cognitive skills. In kindergarten the children can learn while playing, according to the learning principles that must be applied in kindergarten (Fhatri & Arrosyad, 2023). They learn to obtain information and reading codes such as recognizing sounds, shapes of letters and words, and understanding reading material (Hidayati et.al, 2023). They learn the alphabet and how to read simple words. They also develop better motor skills by doing exercises such as puzzles and crafts.

2.2. Definition of Glass Block

Glass block or glass block is a material that functions to create a natural lighting system in a dwelling (Dikaputera, 2021). This material can be used as a substitute for windows that can channel light but not glare. Glass block is also popular for aesthetic purpose (Soehartono et.al, 2010). Generally, cement and brick walls are a tight light barrier, but with glass block walls will be more beautiful and strong. Besides that, glass blocks also help illuminate space and reduce the use of lights. Apart from that, from an economic point of view, glass block material has advantages in production and maintenance costs because the cost is quite low.

2.3. Kindergarten or educational building Standard Parameter

In this study, the Indonesian National Standard (SNI) No. 03-6197- 2000 was used as a lighting level parameter in the classroom building.

3. RESEARCH METHOD

The techniques used to collect data are measurements on objects and simulations that refer to case studies. The software used simulate natural lighting on this building is SketchUp 2020 and DIALux Evo 9.2. Based on sketchup index 2020 is a 3D modeling computer program for a broad range of drawing and design applications and DIALux evo 9.2 is the worldwide standard in lighting design software. The initial stage of simulation is to create a floor plan using SketchUp 2020 referring to the area of space carried out in the measurement of elementary school buildings. It uploads to DIALux evo 9.2 *and makes it in 3D, after which it simulates the natural lighting that can fit into any of its rooms. After that the analysis is then done to identify between which classrooms are exposed to light well and exposed to light that is not good. In this study, the Indonesian National Standard (SNI) No. 03-6197- 2000 was used as a lighting level parameter in the classroom building. In addition, the method used is to study literature through literature studies in this case, theory and knowledge about natural lighting factors become a study. This research process includes five stages, namely:

3.1. Identify the Problem

According to Suriasumantri, problem identification is the initial stage of mastery of the problem where the object of research in certain relation can be recognized as a problem. Problem identification is the first stage of problem solving when we find a problem that we can recognized in our research object.

After the researchers observed directly at RA IT Al-Uswah, a problem was found. The problem is in some classes at RA IT Al-Uswah is the lack of lighting if the lamp are not turned on in the morning until evening. So, increasing natural lighting is one of solution as well as energy saving.

3.2. Literature Review

Snyder (2019) says, literature review is a research methodology that aims to collect and extract the essence of research previousny and analyzes several overviews of experts written in the text. Literature review is very useful to find out the result of research that are relevant to this research. Literature review has a role as a foundation or basis for various types of research because the results of the literature review provide an understanding of

the development of knowledge, sources and generates the creation of new ideas and is useful as a guide for specific field of research. So, in this research, literature review is very useful to find out the result of research that are relevant to this research.

3.3. Simulation : The Measurement to Collect Data

According to Khosnevis (1994). Simulation is The application process builds a model of a real system or proposed system, conducts experiments with the model to explain the behavior of the system, studies the performance of the system, or to build a new system according to th desired performance. Simulation is the right one to take data without always having to directly research in existing places.

The next step is the researcher build the shape of the RA IT Al-Uswah Pasirian building by trying to equalize the actual condition in existing building. The floor plan were made using the Sketch Up 2020 application. Then, the floor plans were exported to the Dialux Evo 9.2 application to make buildings that resemble existing building. After that, the classrooms are simulated by adjusting the date and location of existing building to identify wich between classes with sufficient light (above 250 lux) and insufficient light (below 250 lux) (SNI 03-6197-2000).

3.4. Re-simulation

After the researcher found out which class with sufficient light (above 250 lux) and class with insufficient light (below 250 lux), the researcher changed and added glass block componenets to the insufficient light class walls) (SNI 03-6197-2000). The glass block material used has certain specifications determined by the researcher. Then, the researcher re-simulated to prove whether the glass block is able to incorporating natural light into the classrooms so that it reaches 250 lux or not) (SNI 03-6197-2000).

3.5. The Result

The result of resimulation wich states that glass block is effective or not as an alternative material for natural lighting.

4. RESULTS AND DISCUSSION

4.1. Analysis Object

The object of analysis is RA IT Al-Uswah Pasirian, Lumajang, East Java.



Figure. 1. RA IT Al-Uswah Pasirian

DiaLux simulations are carried out 2 times: when the children enter class, at 08.00 am and when the children return home, at 11.00 am in the afternoon. The determination of the simulation hours is based on the Standard of Learning Time for PAUD (TK KB TPA SPS), which is 900 minutes in one weekThe simulation was taken on February 1, 2021 with clear skies. The simulation was carried out in that month because the sunlight was not always radiated optimally due to the weather which often rained. The classroom has an area of 30 m² with an average group of 10 children per class. The classroom walls are white oyster

with a reflection factor of 85%. Light enters the classroom through plain glass measuring 43" x 31" (110 cm x 80 cm) with a visible light transmission (VLT) of 90%.

4.2. Simulation

The picture below is a floor plan from RA IT Al-Uswah Pasirian using Dialux evo 9.2. The RA IT Al-Uswah room is divided into 11 rooms, namely, the teacher's office, the multipurpose room, the canteen, the playgroup, class A1, Class A2, Class A3, Class A4, Class B1, and Class B2.



Figure. 2. Floor plan RA IT Al-Uswah Pasirian

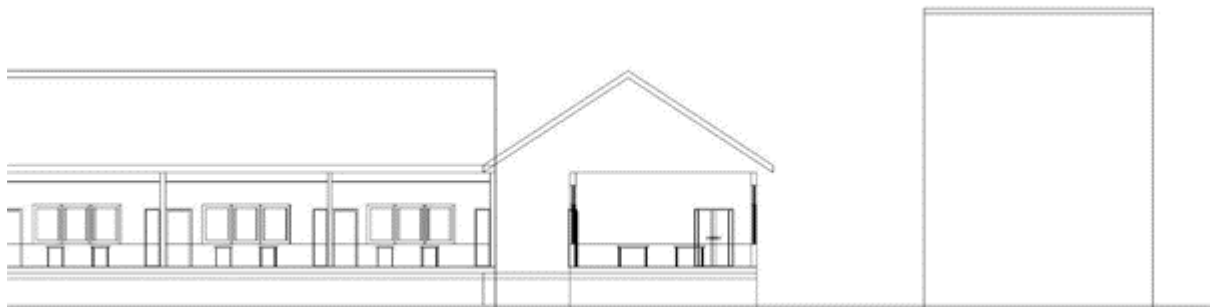


Figure. 3. Section RA IT Al-Uswah Pasirian

In this study, only a part of the room was simulated, namely Class A1, Class A2, Class A3, Class A4, Class B1, and Class B2. The picture below is the state of class B1 and class B2 when there are not learning activities.



Figure. 4. Class B1



Figure. 5. Class B2

After we build the shape of RA IT Al-Uswah Pasirian building by trying to equalize the actual condition in existing building, the classrooms are simulated by adjusting the date and location of existing building to identify which between classes with sufficient light (above 250 lux) and insufficient light (below 250 lux) with Dialux Evo 9.2 application.

The lighting simulation result can be seen through a lux meter with different colors starting from black to white. The black color indicates the absence of light in the room being tested, while white color is the highest amount of lux of light entering a room. We hope that every classroom can be illuminated with light with color quality above 250 lux and below 5000 lux so that the room does not overheat (Kurniasih, 2019).

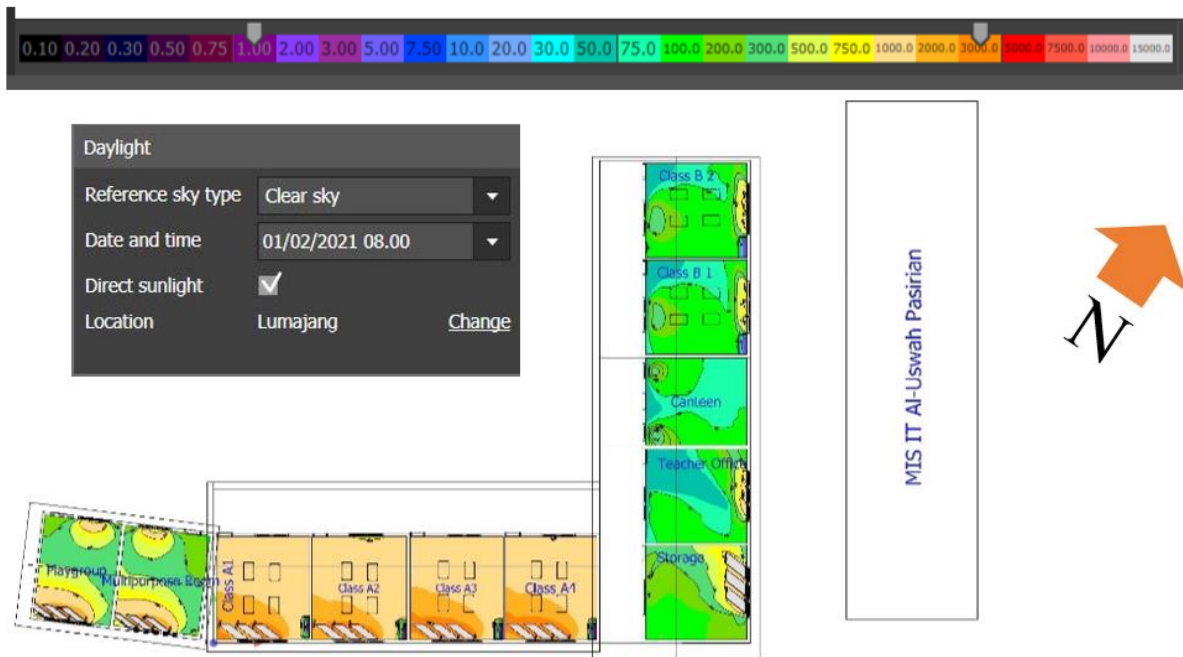


Figure 6. Simulation at 08.00 am

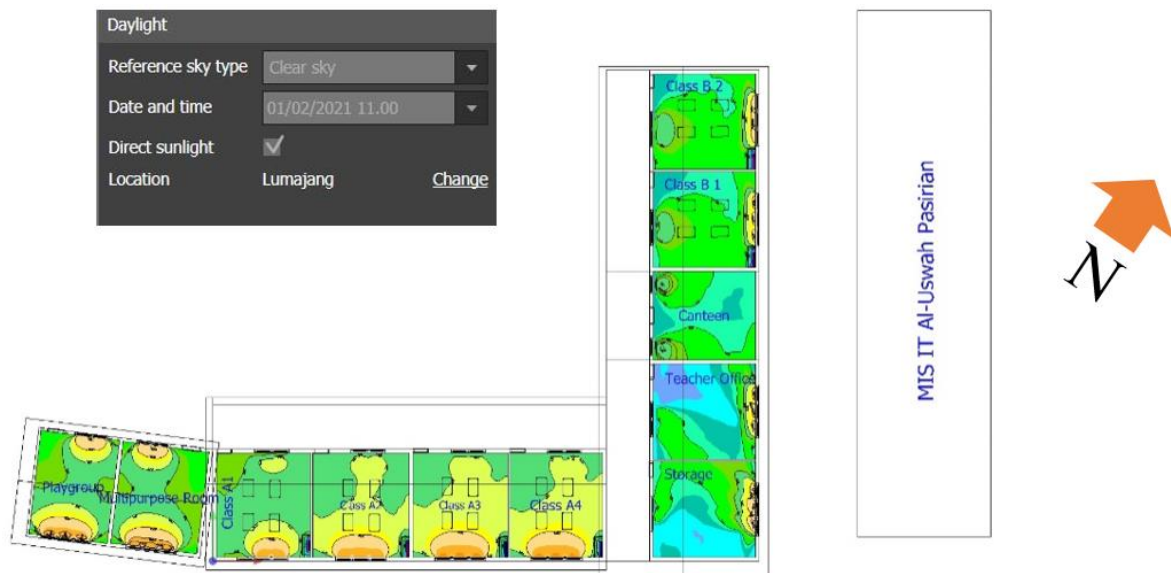


Figure 7. Simulation at 11.00 am

The picture above is the result of the first simulation taken at two times, namely 08.00 and 11.00. The simulation was carried out on February 1, 2021. The simulation is carried out when the sky is clear. Direct sunlight also included, location is adjusted to the coordinates of RA IT Al-Uswah Pasirian, Lumajang, which is located at longitude 113.6, latitude -8.12, north

alignment 21.75, and time zone (UTC+07:00) Bangkok, Hanoi, Jakarta.

At 08.00, the results show that there are 4 classes above 250 lux, namely class A1, class A2, class A3, class A4 which in the lux parameter describes dominance of orange and there are 2 classes that still lack natural light of 250 lux which is described by the dominance of light green color which in the lux parameter describes 100 lux and also the blue and cyan color in class B1 and class B2 corners, At 11.00, the results were relatively the same with a simulation carried out at 8, there are 4 classes above 250 lux, namely class A1, class A2, class A3, class A4, but different in lux parameter color which was dominated by light green with more yellow and there are 2 classes that still lack natural light of 250 lux which is described by the dominance of light green color which in the lux parameter describes 100 lux and also the blue and cyan color in the B1 and class B2 corners.

date : 01/02/2021		Time Simulation	
No.	Room	08.00	11.00
1	Class A1	3484 lx	488 lx
2	Class A2	2909 lx	649 lx
3	Class A3	3281 lx	720 lx
4	Class A4	3296 lx	707 lx
5	Class B1	177 lx	181 lx
6	Class B2	184 lx	201 lx

: <250 lux
 : >250 lux

Figure 8. Simulation Table Before Simulation

The table simulation show that there are 2 classrooms that still have not reached the SNI lighting standard (250 lux), namely Class B1 (at 8 and 11 am) and Class B 1 (at 8 and 11 am). So, additional openings are needed to allow more sunlight to enter the classroom so that 250 lux is achieved at both times.

4.3. Re-Simulation with Glass Block

The recommendation in this research is to add a rooster sandblast glass block measuring 7.5" x 7.5" (190 x 190 x 95 mm) next to the window with a visible light transmission (VLT) of 80%. In each class, an average of 180 units will be installed for each class. The price of the glass block used is the price that is in accordance with the market price of this type of glass block, which is Rp. 15,000.00. Furthermore, a re-simulation was carried out by adding glass blocks at several points in Class B1 and B2. Due to the limitations of the glass block notation in DiaLux, Glass Block is assumed to have fixed windows which with the specifications of double glazing and laminated safety glass on the inside so that the visible light transmission (VLT) similar to sandblast glass block.



Figure 9. Sandblast Glass Block
Source : www.ksttiles.com



Figure 10. Sandblast Glass Block
Source : www.ksttiles.com

The picture below shows the plan for laying glass blocks on the classroom walls. Each class is given 180 units of clear glass blocks which are placed next to the existing classroom windows. Even though the sandblast glass block is a little transparent, it's still enough to

obscure visual distractions from the outside.

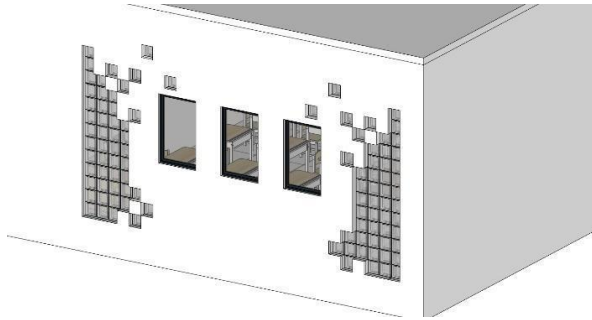


Figure 11. Glass Block Facade Design axonometry

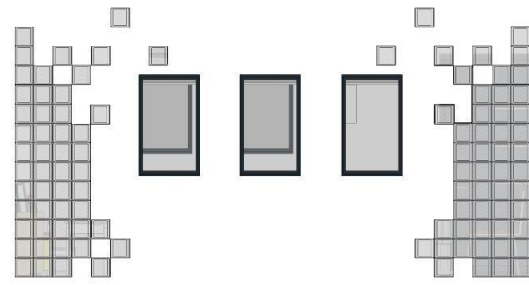


Figure. 12. Glass Block Facade Design

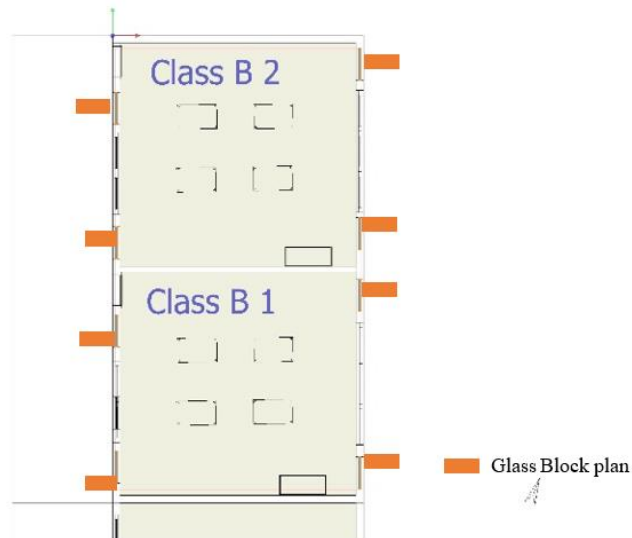


Figure 13. Glass Block Plan

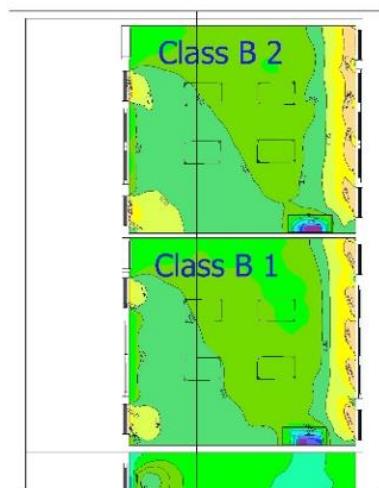


Figure 14. After Simulation 08.00 AM



Figure 15. After Simulation 11.00 AM

The picture above is a simulation result after adding glass block. This simulation was carried out at the same time with the first simulation before adding glass block, namely at 08.00 am and 11.00 am on 1 February 2021 with clear sky.

At 08.00 am, the simulation results show that there is a color change in class B1 and class B2. In each class the color of blue is almost non-existent, the light green color begins to decrease, and the moss green and yellow color begins to increase. At 11.00 am, the simulation result almost same with simulation at 08.00 am, namely there is a color change in class B1 and class B2. In each class the color of blue is almost non-existent, the light green color begins to decrease, and the moss green and yellow color begins to increase. This indicates that there is a significant change in the classrooms with the addition of glass blocks in the least amount of natural light entering the classroom without adding new windows that can disturb the concentration of the children.

date : 01/02/2021		Time Simulation	
No.	Room	08.00	11.00
1	Class A1	3484 lx	488 lx
2	Class A2	2909 lx	649 lx
3	Class A3	3281 lx	720 lx
4	Class A4	3296 lx	707 lx
5	Class B1	177 lx	181 lx
6	Class B2	184 lx	201 lx

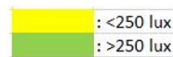
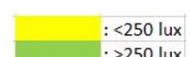


Figure 16. Simulation Table 1st

date : 01/02/2021		Time Simulation	
No.	Room	08.00	11.00
1	Class A1	3484 lx	488 lx
2	Class A2	2909 lx	649 lx
3	Class A3	3281 lx	720 lx
4	Class A4	3296 lx	707 lx
5	Class B1	353 lx	363 lx
6	Class B2	400 lx	418 lx

Figure 17. Simulation Table 1st
Simulation

Looking at the table data obtained from the re-simulation above, there are changes in class B1 and Class B2, namely natural light entering class B1 which was originally 177 lux at 08.00 AM dan 184 lux at 11.00 AM to 363 lux at 08.00 AM and 418 lux at 11.00 AM. So, The simulation results show that there is a significant change in natural lighting in each room after being given a glass block. The conclusion is all the classrooms get sufficient lighting, namely above 250 lux. So, the addition of glass block material is quite successful.

4.4. 3D Visualization + Rendering with Enscape

The picture below is a visualization of the lighting of the four classes (class A1, Class A2, Class B1, Class B2) when added glass blocks with an aesthetic arrangement experiment. The state of the class is visualized using Sketch Up 2020 with rendering using Enscape and has been adjusted to the time and geographical location of RA IT Al-Uswah Pasirian. The design and additional furniture such as chairs and tables in the classroom were added to add more aesthetic element of the room as well as suggestions to the manager of RA IT Al-Uswah to make class more comfortable for studying.

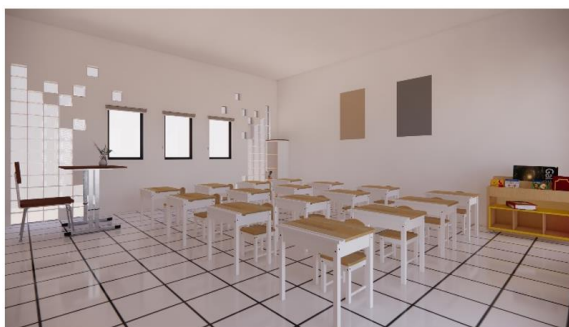


Figure 18. Class B 2 at 08.00 am

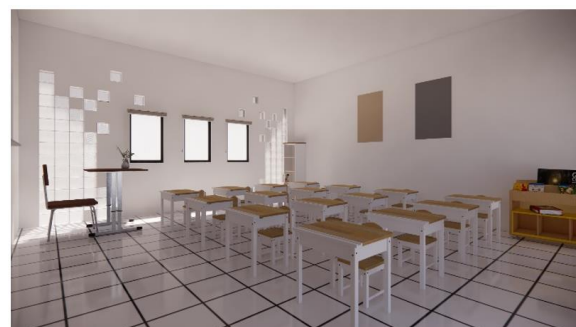


Figure 19. Class B 2 at 08.00 am

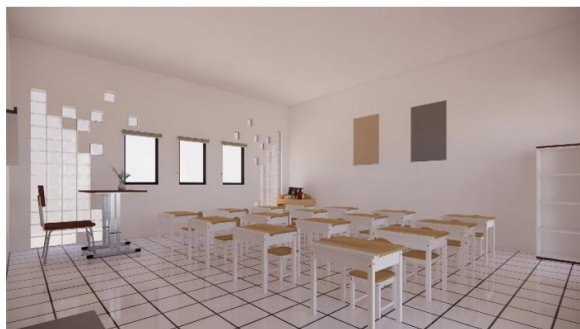


Figure 20. Class B 2 at 08.00 am

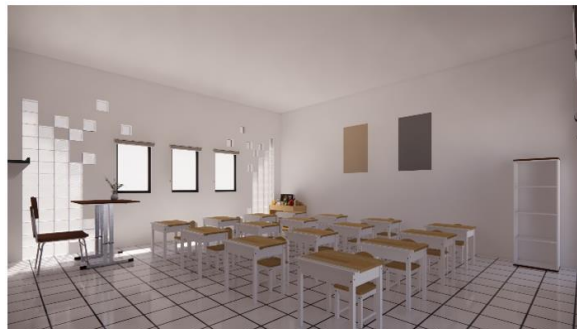


Figure 21. Class B 2 at 11.00 am

5. CONCLUSION

For classes that get insufficient natural lighting (below 250 lux), the researcher suggest to changing the walls into glass block walls rather than turning the walls into windows because glass blocks walls are able to keep natural lighting entering the classroom without incorporating visual distractions from outside the class. So that the concentration of the children is not disturbed at the same time the visual appearance of the class is more attractive.

The placement of the glass block adapts to existing wall components such as windows, doors, and others. The placement of glass blocks should also be concerned with aesthetic elements such as the placement of glass blocks, wich at the top of the arrangement are increasingly scattered like the design above, not just monotonous square shape so that children get a more attractive visual appearance of the class.

For classes that sometimes get very high lux, it can use window covering components. The components is a curtain which is one of the interior elements that has a function as a cover as well as a room sweetener that can add to the aesthetic impression. Roller blinds can also be a window covering option. Roller blinds are modern curtains that function as window coverings to protect the classroom from the effects of excessive sunlight. Roller blinds are more effective because the way to open the curtains is easier with just a pull, there are even roller blinds that already use an automatic remote control.

Even though the classroom is illuminated with sufficient light, in real conditions there are obstacles that prevent natural light from entering the classroom optimally so that the existence of glass block walls seems useless. One of these obstacles is when the weather conditions on certain days are not as bright as usual, namely when the sky is cloudy or rainy. Overcast and even raining can cause enough light that initially enters the room (above 250 lux) to maket he room dark so that students cannot study comfortably. One of these insufficient light can be overcome by using artificial lighting in the form of LED lamp or. LED lamps has several advantages and disadvantages, the advantages are : Energy efficient because the use of LED lamps can cut electricity costs in your home significantly, last longer because LED lamps can last up to 60 thousand hours compared to ordinary light bulbs wich only last 1.500 hours, relatively safe because these lamps provide almost no heat, and can stay cool when it's on, environmentally friendly made form non-toxic materials, LED lamps are known to be environmentally friendly, while the disadvantages of LED lamps are : The price is relatively expensive compared to CFL lamps, cannot be used as heating lamps LED lamps do not producce ultra violet (UV) rays so they do not emit enough heat to warm livestock such as chickens, much less compared to other types of lamps, so, for people who want to put this lamps in the open, then LED is not right choice.

After going through the simulation process, any natural lighting does not have to replace

the walls with large and wide windows. However, this can be overcome by the use of appropriate replacement materials, one of which is the replacement of openings with glass block material on the classroom wall. This is appropriate because glass block material can transmit natural lighting, but still maintain the concentration of children's learning activities. So, the use of glass block walls is a great solution to overcome the lack of natural lighting without introducing visual.

ACKNOWLEDGEMENTS

This article was supported by the Ministry of Education, Culture, Research, and Technology of Republic Indonesia. Grant numbers 317/UN40.LP/PT.01.03/2021 under LPPM-Universitas Pendidikan Indonesia.

REFERENCES

- Adryanta. (2008). *Kaca Sebagai Struktur Pada Bangunan*. Departemen Arsitektur, Fakultas Teknik Universitas Indonesia. Depok, Jakarta
- Dikaputera, R. "Glass Block 101 – Refraction House" uploaded by Glass Block Mulia, 17 Sep. 2021, <https://www.youtube.com/watch?v=-qZSqE0Rj7A&t=65s>. Accessed 1 December 2021
- Dora, P. E. *Optimasi Desain Pencahayaan Ruang Kelas SMA Santa Maria Surabaya*. Dimensi Interior, vol. 9 (2013) No. 2; 69- 79
- Fhatri, Z., Arrosyad, M. I (2023). *Interactive Multimedia's Learning In Institutions of Early Childhood Education*. KINDERGARTEN: Journal of Islamic Early Childhood Education, 6(1), 1-13
- Gupta, A. (2017). *Building a Green Home Using Local Resources and Sustainable Technology in Jammu Region—A Case Study*. Energy Procedia, 115, 59-69.
- Hidayati, N., Meliani, F., Yuliyanto, A., Sofiasyari, I., Muzfirah, S (2023). *Strategies in Introduction Emergent Literacy for Early Childhood in Early Childhood Education*. KINDERGARTEN: Journal of Islamic Early Childhood Education, 6 (2), 113-121
- Khosnevis, Behrokh. 1994. *Descrate System Simulation*. New York : McGraw Hill
- Kurniasih, S., & Saputra, O. (2019). *Evaluasi Tingkat Pencahayaan Ruang Baca pada Perpustakaan Universitas Budi Luhur, Jakarta*. Jurnal Arsitektur ARCADE, 3(1), 73–79. <https://doi.org/10.31848/arcade.v3i1.136>
- Mangunwijaya, Y. B. (1980). *Pasal-Pasal Penghantar Fisika Bangunan*. Gramedia.
- Setiawan, Alvin (2023). *Apa Itu Glass Block: Pengertian, Fungsi, Kelebihan dan Jenis-jenisnya*. Accessed from <https://www.detik.com/properti/tips-dan-panduan/d-7046052/apa-itu-glass-block-pengertian-fungsi-kelebihan-dan-jenis-jenisnya>.
- SNI 03-6197-2000. Konservasi energi pada sistem pencahayaan.
- Soehartono, F., Kristanto, L., Nurdiah, Esti Asih (2010). *Quantity of Light Trough Glassblock Wall*. In: The 11th International Seminar on Sustainable Environment and Architecture, October, 14-15, 2010, Surabaya.
- Sugiyanto (2011). *Karakteristik Anak Usia SD*. Accessed from <https://lmsspada.kemdiktisaintek.go.id>
- Synder, Hannah (2019). Literature review as a research methodology: An overview and guidelines. *Journal of Business Research*, 104, 333-339
- Zorowski, K. "Why is kindergarten called kindergarden?" uploaded by Michigan State University, 20 Dec. 2019, <https://www.canr.msu.edu/news/why-is-kindergarten-called-kindergarden>. Accessed 4 Februari 2023