KEPUTUSAN DEKAN FAKULTAS TEKNIK
UNIVERSITAS BUDI LUHUR
NOMOR :
K/UBL/FTK/000/032/10/24
TENTANG :
PENUGASAN KEGIATAN TRI DHARMA DAN PENUNJANG BAGI DOSEN
FAKULTAS TEKNIK UNIVERSITAS BUDI LUHUR
SEMESTER GASAL TAHUN AKADEMIK 2024/2025

DEKAN FAKULTAS TEKNIK UNIVERSITAS BUDI LUHUR

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2) Bahwa untuk meningkatkan profesionalitas dan kompetensi sebagai pendidik professional maka dipandang perlu untuk memberikan tugas-tugas tambahan/penunjang dalam lingkup kegiatan penunjang Tri Dharma;

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2) Undang-undang No. 12 tahun 2012 tentang Pendidikan Tinggi;
3) Peraturan Pemerintah (PP) Nomor 57 Tahun 2021 tentang Standar Nasional Pendidikan Nasional;
4) Peraturan Menteri Pendidikan dan Kebudayaan Republik Indonesia Nomor 3 tahun 2020 tentang Standar Nasional Pendidikan Tinggi;
5) Statuta Universitas Budi Luhur.
6) Keputusan Pengurus Yayasan pendidikan Budi Luhur Cakti Nomor K/YBLC/KET/000/020/001/24 tentang pengangkatan Saudara Dr. Putri Suryandari, S.T.,M.Ars sebagai Dekan Fakultas Teknik Universitas Budi Luhur.

MEMUTUSKAN

Menetapkan :
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b) **Publikasi Ilmiah** pada Prosiding, Jurnal/majalah/surat kabar dan sejenisnya;
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KETIGA : Kegiatan Tri Dharma yang tidak termasuk dalam surat keputusan ini akan memiliki penugasan tersendiri;

KEEMPAT : Keputusan ini berlaku sejak tanggal ditetapkan dan akan diubah sebagaimana mestinya apabila di kemudian hari terdapat kekeliruan.

Ditetapkan di : Jakarta
Pada Tanggal : 3 Oktober 2024
==== ====================
Dekan Fakultas Teknik

Dr. Putri Suryandari, S.T.,M.Ars

UNIVERSITAS BUDI LUHUR
FAKULTAS TEKNIK

Lampiran Surat Keputusan Dekan

Nomor   :   K/UBL/FTK/000/032/10/24

Tentang   :   Nama–Nama Dosen Fakultas Teknik Universitas Budi Luhur Yang Ditugaskan
              Melaksanakan Kegiatan Tri Dharma Perguruan Tinggi Semester Gasal Tahun Akademik 2024/2025

No.	NIP	NIDN	Nama Dosen	Program Studi
1	990010	0301066904	Dr. Putri Suryandari, S.T., M.Ars	Arsitektur
2	000031	0307097203	Ir. Tri Endangsih, S.T., M.Ars.,IPM	Arsitektur
3	010007	0328127702	Anggraeni Dyah S, S.T., M.T	Arsitektur
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11	870021	0301106004	Dr.,Ir. Nazori AZ, M.T	Teknik Elektro
12	990002	0331087201	Dr. Sujono, S.T., M.T	Teknik Elektro
13	090064	0310078701	Eka Purwa Laksana, S.T., M.T	Teknik Elektro
14	100033	0319028703	Peby Wahyu Purnawan, S.T., M.T	Teknik Elektro
15	880011	0302115701	Drs. Suwasti Broto, M.T	Teknik Elektro
16	170001	0329119401	Nifty Fath, S.T., M.Eng	Teknik Elektro
17	980002	0302046501	Dr. Ir. Jan Everhard Riwurohi, M.T	Teknik Elektro

Ditetapkan di   :   Jakarta
pada Tanggal   :   3 Oktober 2024

....
Dekan Fakultas Teknik

Dr. Putri Suryandari, S.T.,M.Ars

Date : October 07ᵗʰ, 2020

Letter of Acceptance

Dear : Ms. Inggit Musdinar Sayekti Sihing Yang Mawantu

Congratulations!
We are please to inform you that your abstract entitled : "**PERFORMANCE EVALUATION OF SUBGROUND PASSIVE COOLING SYSTEM WITH ECOTECH SOFTWARE SIMULATION CASE STUDY: PASIO CHRISTI CHURCH AT CIBUNUT, KUNINGAN, WEST JAVA**" submitted for 1ˢᵗ International on Sustainable Architecture and Engineering (ICoSAE), has been officially approved. Please submit full paper and prepare your 15 minute Oral Presentation.

Good Luck for your Presentation. See you in Webinar 1ˢᵗ International on Sustainable Architecture and Engineering (ICoSAE).

Ulinata, ST.Ars., MT
Chair of 1ˢᵗ ICoSAE, Jakarta

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Performance evaluation of sub ground passive cooling system with Ecotech software simulation (Case study: Pasio Christi Church at Cibunut, Kuningan, West Java)

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Performance evaluation of sub ground passive cooling system with Ecotech software simulation (Case study: Pasio Christi Church at Cibunut, Kuningan, West Java)

I Musdinar* and R A Ardli

Program Studi of Architecture at Universitas Budi Luhur, Jakarta, Indonesia

*inggit.musdinar@budiluhur.ac.id

Abstract. The church in Cibunut, Kuningan, West Java has implemented a sub ground passive cooling system in its renovated building in 2018. This sub ground passive cooling system has not been widely applied in tropical regions, however the church is trying to implement it. This system is supported by making air wells and flowing cold air through distribution pipes into the room. Because not many people have implemented this system, performance evaluation through an ecotect software simulation is used to determine the success of the system in cooling the room. The research was carried out with the following steps: (i) Data collection in the form of CAD drawings of Cibunut Church building, (ii) Simulation using ecotect software, and (iii) Analysis of simulation results with thermal comfort standards in the tropics. The results of this study are conclusions from the results of simulations and analyzes, as an illustration in applying of the sub ground passive cooling system. This research helps illustrate the difference between buildings that have not applied sub ground passive cooling and buildings that have applied sub ground passive cooling.

1. Introduction

A good building design will be able to adapt to the environment in which the building is built. Indonesia has a humid tropical climate, and it requires a high enough energy consumption for building operations, namely the building cooling system, if the building is not planned properly. One of the major energy consumption is used to cool buildings for humid tropical climates [1].

Sub ground passive cooling is a passive cooling system that is carried out by channeling cold underground temperatures into the building [2]. This system has been used in several church buildings in subtropical area. Cibunut Church, trying to adapt and implement this cooling system into its building.
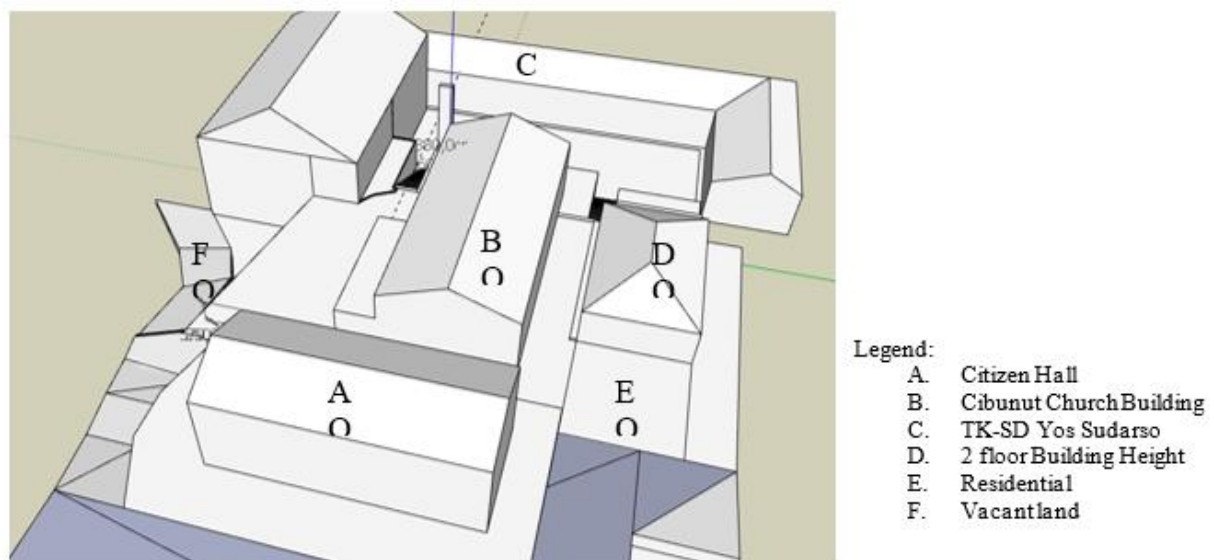
Even though the implementation of the sub ground passive cooling system is usually carried out in temperate areas. Therefore, it is very interesting to research the sub ground passive cooling system that is applied to the Cibunut Church building.

Here is the location data of the Pasio Christi Church, Cibunut on this following table 1. And also it illustrated on the next figures 1.

Table 1. Location data of the Cibunut Church.

1.	The Location	Cibunut Hamlet, Cirukem Village, Garawangi District, Kuningan Regency, West Java
2.	Geographical Location	At coordinates 7 ° 01'54.6 "S 108 ° 29'57.2" E
3.	Land Area	536.33 m2
4.	Land Form	Rectangle
5.	Land Size	18.38 m X 29.17 m
6.	West Boundary	Yos Sudarso Kindergarten-SD School
7.	South Boundary	Yos Sudarso Kindergarten-SD School and Vacant Land
8.	East Boundary	Citizens Hall, 2 Floor building height
9.	North Boundary	Residential area, with a building height of 1 Floor

Legend:
A. Citizen Hall
B. Cibunut Church Building
C. TK-SD Yos Sudarso
D. 2 floor Building Height
E. Residential
F. Vacant land

Figure 1. Illustration of the contours of the Cibunut Church location and the surrounding buildings.

In planning and implementing renovations there are several considerations. One of them is how to create a church building that meets thermal comfort with low operating costs. So the renovation is done besides aiming to rejuvenate the church building, is to redesign the church which has a passive cooling system.

2. Physical data of research object

In the building before it was renovated, the Pasio Christi Cibunut Church has a land area of 536.33 m2 and a building area of 227 m2. After undergoing renovations, this church has expanded the building to 290 m2. Apart from changes in area, the orientation of the building has also changed. Previously the church building faced East, and after renovation, the orientation of the building changed to the West. Apart from changes in orientation, there is also a change in building height. The old Cibunut church building has an outer roof height of 7.8 m with an interior ceiling height of 4.6 m.

The 1st floor consists of the main room or place for the people, the altar, the sacristy, the meeting room, the confession room, and the secretariat, all of which are on 1 floor level except the elevated altar + 0.60.
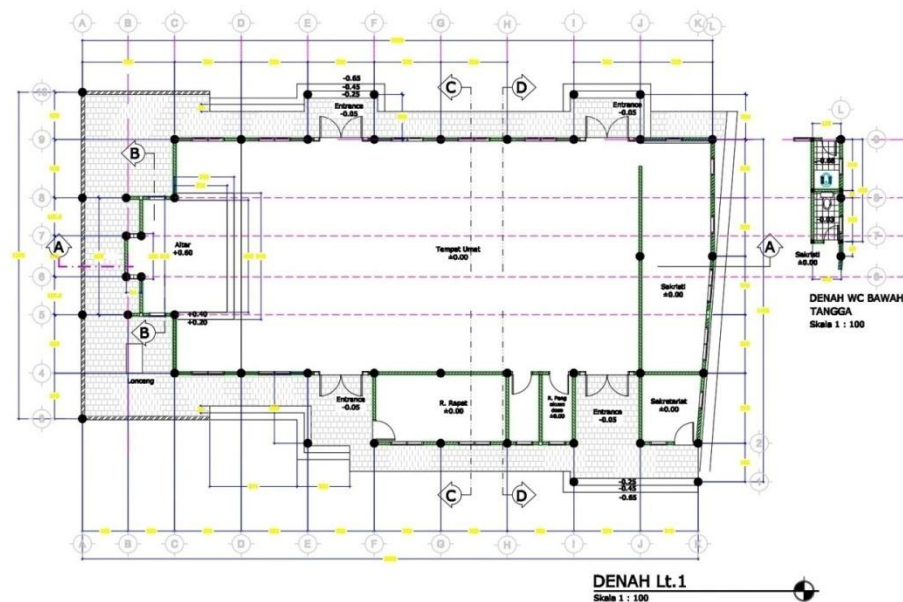
Figure 2. First floor plan drawing.

While the 2nd floor does not completely follow the 1st floor, only a part is made like a balcony at the back with open railings leading to the altar. The rooms on the 2nd floor are choir rooms and the placement of a set of gamelan instruments as accompaniment to the choir and are equipped with a warehouse for storing equipment.
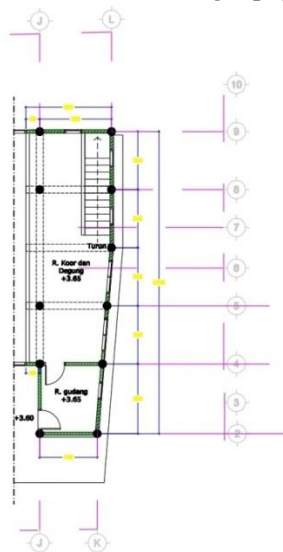
Figure 3. Second floor plan drawing.
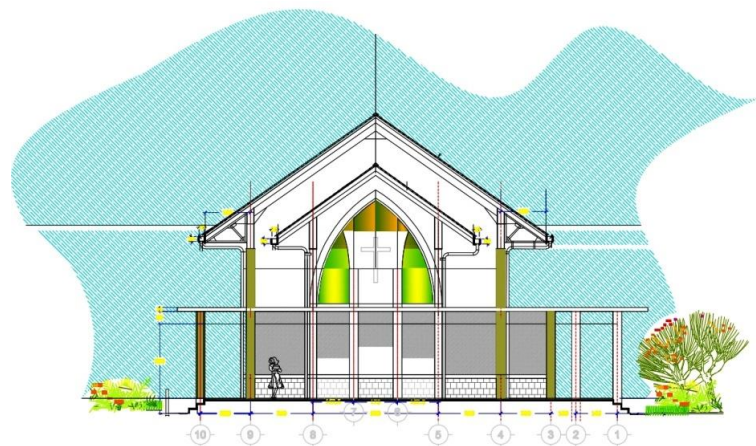

Figure 4. Left elevation.

Left side view or seen from the west side is at the same time the outside view of the altar. In this area there is also a bell tower which is located a little distance from the main church building.

The south side is the direction facing the front and the main access to the church building. Therefore, this side is used as the front of the church. On the south side there are 2 doors. The door on the left is for access to the front row seats, while the door on the right is for the back row. In the section without windows (openings) is the confession room.

Figure 5. Front elevation.

To create a simulation object in the Ecoctect software, a cut-out image is needed to determine the height of the building in the field and what materials each space-forming element uses, namely floors, walls, and ceilings.


| (a) | (b) |
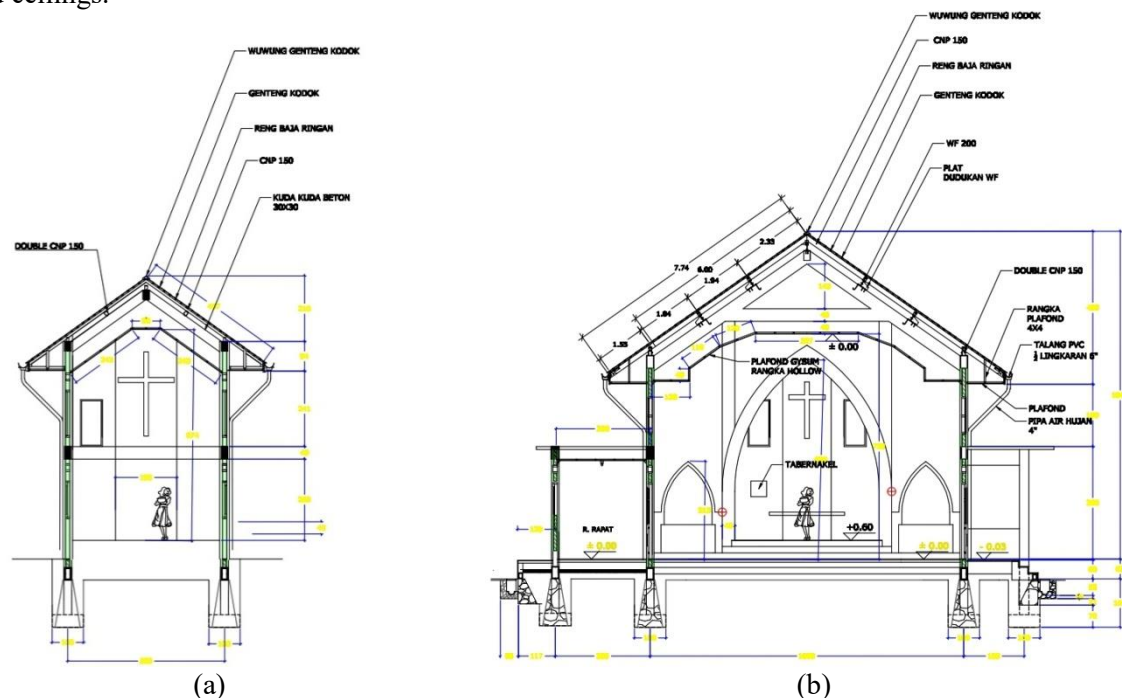
Figure 6. (a) A-A Section of the church, and (b) B-B Section of the church.

Initially, the implementation of sub ground passive cooling at Cibunut Church took into account the contours of the location. The vent is placed in the retaining wall on the west side and then flowed through an air tube embedded under the building. The air that enters the ground is then cooled by the soil at a certain depth. Then the cooled air flows into the room through the distribution pipe.

The air pipe that is used to bring cold air into the church room is divided into several points, and the position is planted under the building for the flat section of the pipe and buried in the wall for the vertical pipe. The points of distribution holes in the church room are 9 points. Of the 9 points, it is divided into 2, namely: 2 points are on the altar, and 7 points are in the community room. The distribution points can be seen in the following figures.
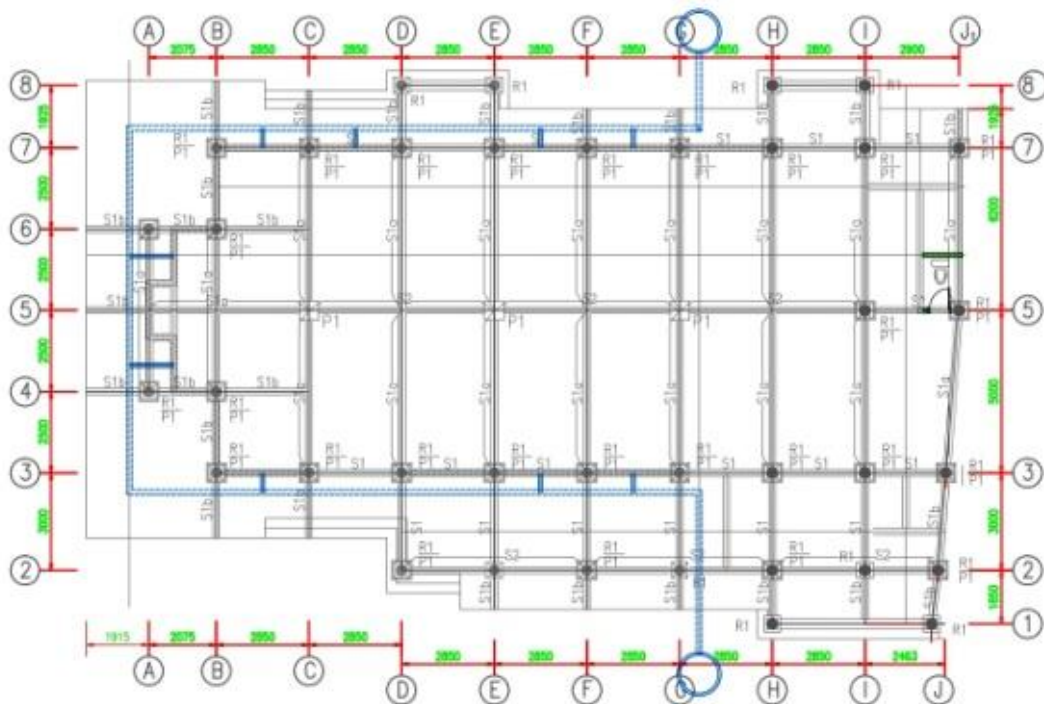
Figure 7. The air pipe network plan is represented by a blue line.

The sub ground passive cooling system at Cibunut Church consists of 2 air wells on the north and south side of the church building. Then from the well the air is flowed through a main pipe with a diameter of 5 inches with a total length of 53.62 m and distributed to a room with a branch pipe measuring 3 inches.

3. Methods

This research will use a simulative approach, which is assisted by using Ecotect software to find out how the sub ground passive cooling system performs in the church building in Cibunut [3]. The simulation results will be analyzed and juxtaposed with the theory of ideal thermal comfort in the tropics. From the results, it is hoped that it will help to find ways and can be a guide in the design of sub ground passive cooling systems.

The sequence or steps of the research carried out in this study are in accordance with the following flowchart.
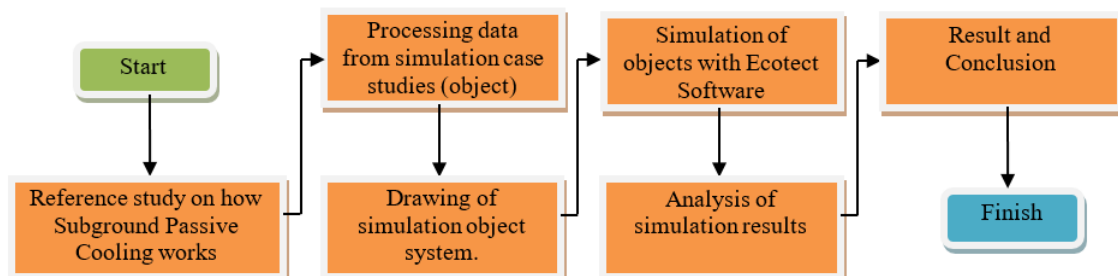
Figure 8. Research steps.

The first thing to do is collect reference sources on how sub ground passive cooling works. Then collect location data and physical data of the Cibunut Church building. From the physical data of the building, it is continued by making a 3D model. The next step is to simulate using the Ecotect software. The simulation uses a 3D model that has been created and fills in the location data.

After the 3D object is ready, the material is embedded according to the real conditions of the church building (*figure 9*). The floor with ceramic material, the wall with 10 cm concrete brick material which is glued with instant cement which is then plastered and draped, and the roof with ceramic tile material and complete with a ceiling that adjusts the slope roof.
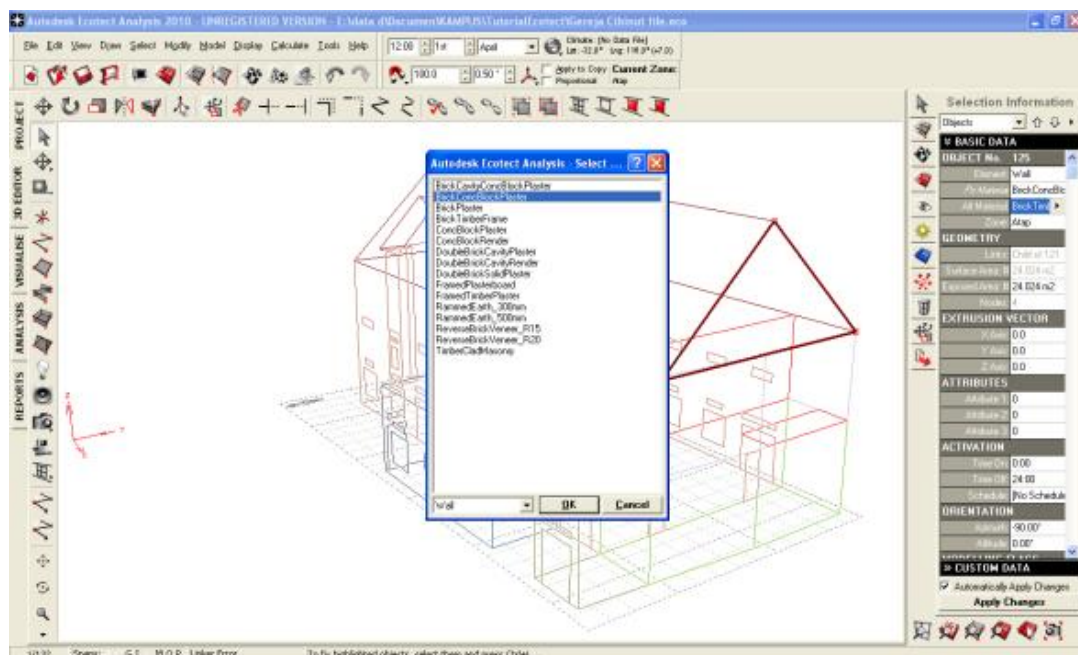
Figure 9. Setting the floor, wall and ceiling material at Ecotect 2010.

This study tested a church building that applies sub ground passive cooling and then simulated it in 2 types of models, one without a ground cooling system and the other with ground cooling. With the results of the daily average temperature in the building.

4. Results

Evaluation is carried out based on the results of comparison of data analysis with reference to SNI, ASHRAE standards regarding thermal and visual comfort standards. The building performance indicators seen are thermal comfort and visual / lighting comfort. The parameters used are dry air temperature (Tdb), wet air temperature (Tg), humidity (RH) and wind speed (Va).

According to SNI 03-6572-2001, thermal comfort in the tropics is divided into three criteria, namely; cool comfort with operative temperature (To) $20.50\,°C \sim 22.80\,°C$, optimal comfort with to $22.80\,°C \sim 25.80\,°C$ and warm comfortably with to $25.80\,°C \sim 27.10\,°C$.).

The Ecotect 2010 simulator does not yet include weather data for Indonesia, so the closest one to the closest climate is Bangkok +7. The 3D objects that have been prepared are made in 2 types to differentiate them. The first 3D object is the Cibunut Church building without the Sub Ground Passive Cooling system. Meanwhile, the second 3D object is the Cibunut Church building complete with the Sub Ground Passive Cooling system.

After the 3D object is ready, the material is embedded according to the real conditions of the church building, namely the floor with ceramic material, the wall with 10 cm con block material which is glued with instant cement which is then plastered and draped, and the roof with ceramic tile material and complete with sloping ceiling.

Currently the Cibunut Church building faces south, equipped with 2 main doors. On the south side there is also a large terrace that allows movement in and out of users. When viewed from the sun path simulation results, throughout the year the southern area of the building will be covered by shadows from the church building itself. So it is quite shady and suitable when designated as the front side of the building.

In this simulation, windows and doors are left without material and in the form of openings (voids). Likewise, the condition when the church building is functioning, does not use Air Conditioner, only uses a ceiling fan, and the position of the doors and windows remains open. And the existing spaces are distinguished by zone colors.

Time measurements are made by taking 4 different days in 1 year round with an explanation of the following conditions:

- On July 21 as a simulation sample for the dry season, with conditions on a sunny morning, hot daytime and no rain at night.
- On September 14, as a simulation sample at the peak of the dry season, with conditions on a sunny morning, hot daytime and no rain at night.
- On December 22 as a simulation sample for the rainy season with cloudy mornings, drizzling rainy days and cloudy nights.
- On May 4 as a simulation sample of the transition from the rainy season to the dry season, with conditions in the morning sunny, hot afternoon, and rainy at night.
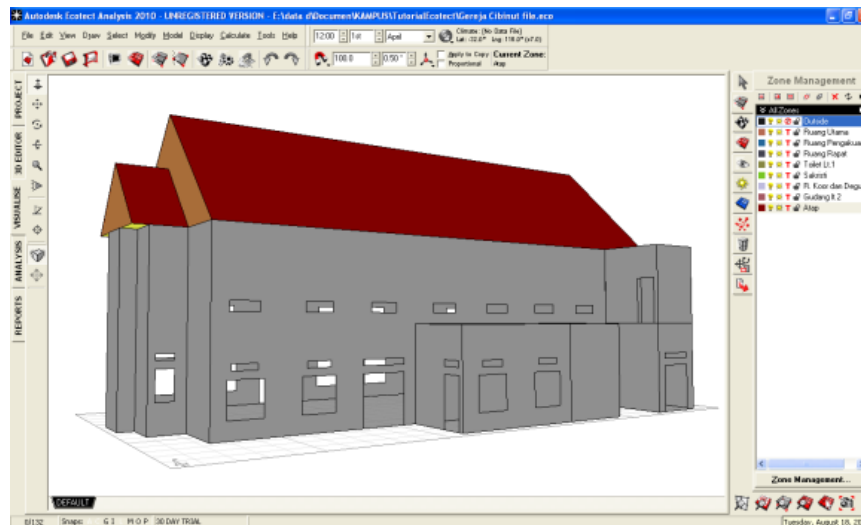

Figure 10. 3D objects with door-window voids.

4.1. Thermal simulation without sub ground passive cooling system

The building object with material that has been adjusted and is not equipped with a soil cooling system or sub ground passive cooling is simulated with 4 different day variables throughout the year, with the following results:
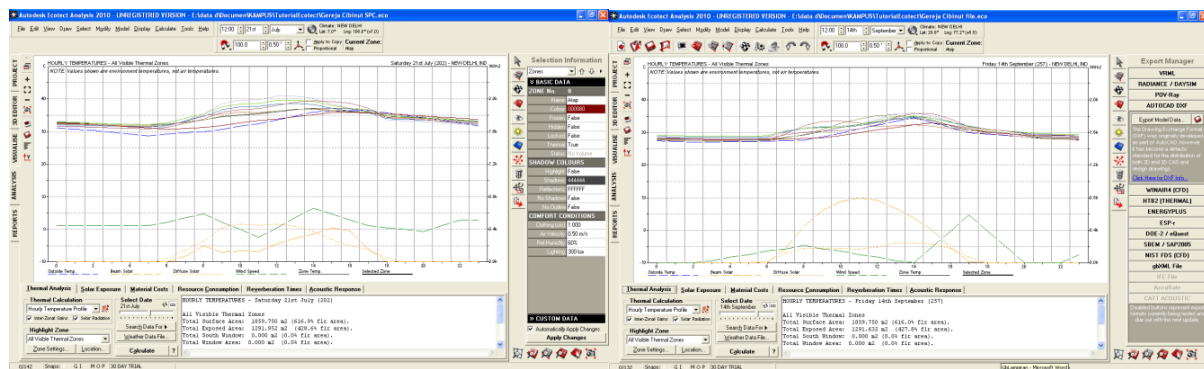
Figure 11. Hourly thermal simulation results on July 21 and September 14 without sub ground passive cooling system.
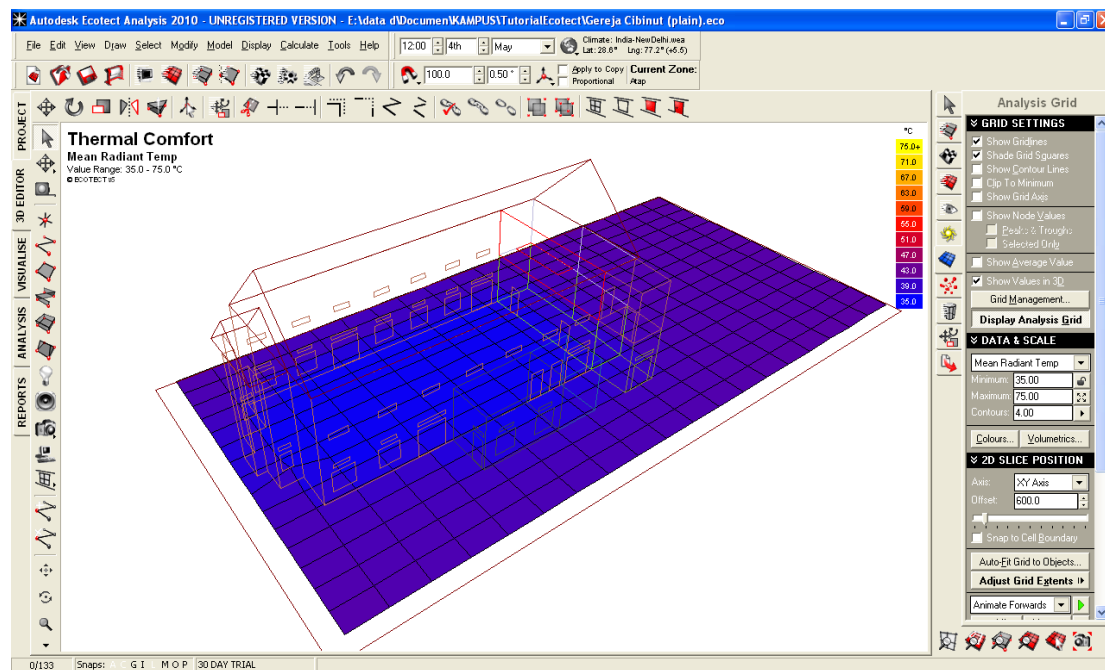
From the simulation results (*figure 11*) on July 21, it can be seen that the highest temperature occurred at 14.00 with a temperature of 40.5º, the lowest temperature was at 05.00 with a temperature of 28º. In the simulation results on September 14, the highest temperature reached 36º at 12.00 to 14.00 and the lowest temperature was 27.5º occurred at 0.00 - 04.30 and around 22.00.
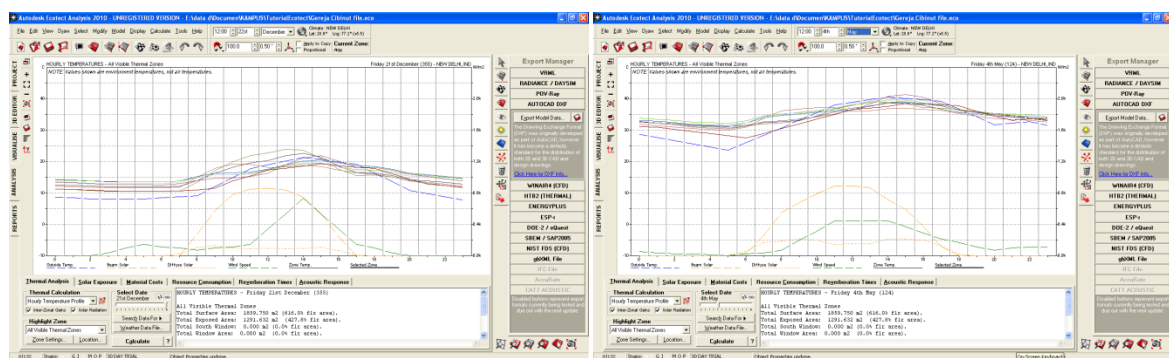
Figure 12. Hourly thermal simulation results on December 22 (*left*) and May 4 (*right*) without sub ground passive cooling system.

The simulation results (*figure 12*) on December 22, the highest temperature was 24º at 10.00 until 14.00. Low temperature of 20º from 00.00 to 07.00. Meanwhile, in the simulation results on May 4, the highest temperature was 42º at 13.30 to 15.00 and low temperature was 28º from 02.30 to 4.30.

Figure 13. The simulation results of the average temperature in the form of a gird.

From the simulation results graphically, Ecotect is also able to provide simulation results in a grid The following (figure 13) are the results of a grid simulation where this simulation does not include the application of sub ground passive cooling system and the results are the average temperature in the church building space of 35º and the temperature around the building is 43º.

When compared with the 4 previous samples, the highest average temperature $(40.5 + 36 + 42 + 24)$ / 4 is 35.6 ° in the form of a church building that is not equipped with sub ground passive cooling system. It can be said that the simulation results from Ecotect are quite close to its accuracy.

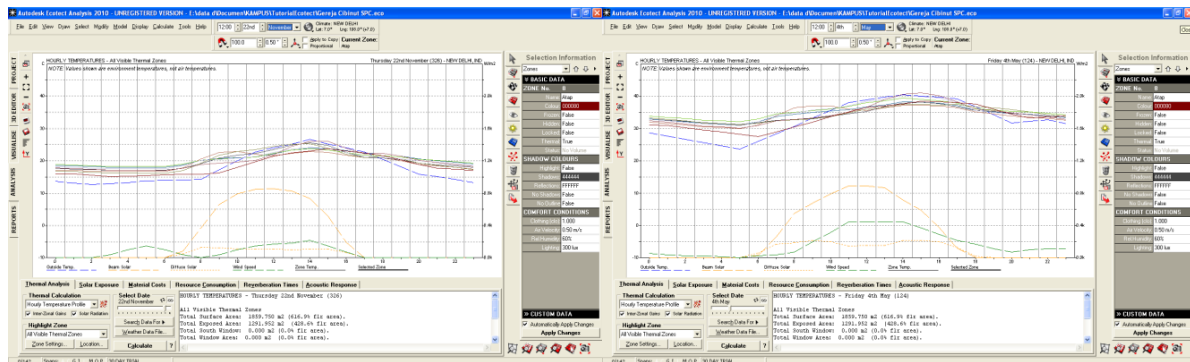## 4.2. Thermal simulation without sub ground passive cooling system

The building object with material that has been adjusted and has been equipped with sub ground passive cooling system is simulated with 4 different day variables throughout the year, with the following results:
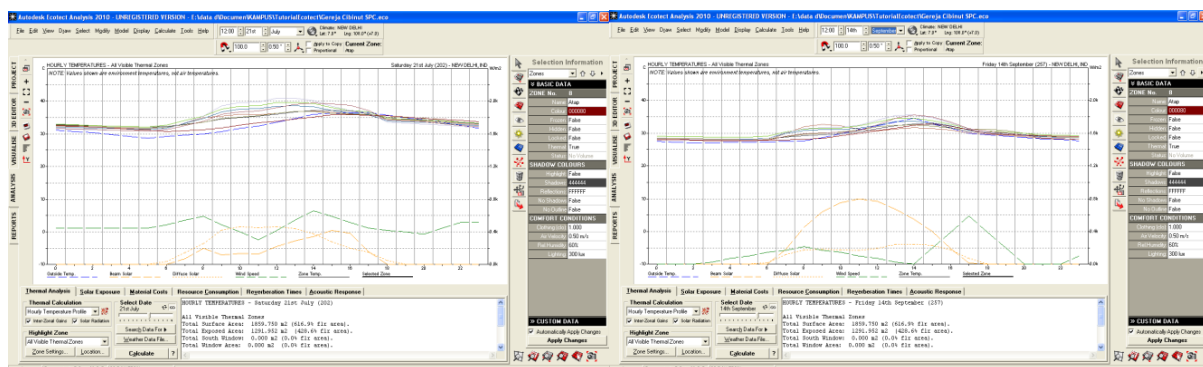
Figure 14. Hourly thermal simulation results on July 21 and September 14 with sub ground passive cooling system.

In the simulation results (figure 14) on July 21, the highest temperature data was found at 11:30 am to 01:30 pm. And the lowest temperature is 24º at 03.30 until 05.30 am. While the simulation results on September 14th, the highest temperature was 36º at 01.30 to 14.30 pm and the lowest temperature was 26.5º at 00.30 to 07.30 am.
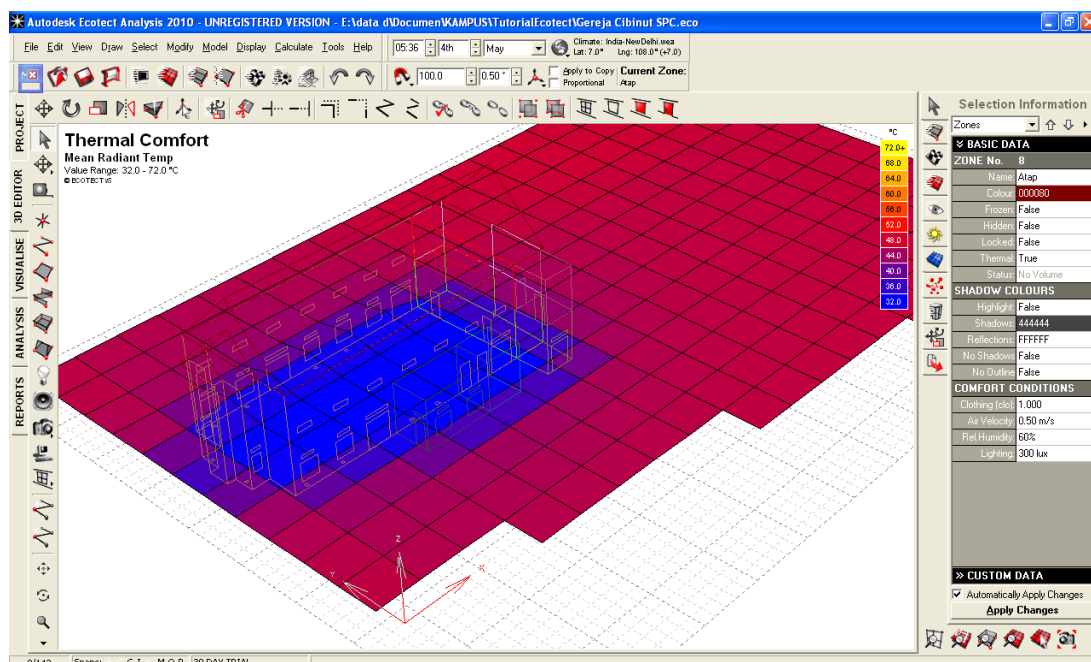
In the simulation results (figure 15) on December 22, the highest temperature data was found at 27º at 02.00 pm. And the lowest temperature is 15º between 00.30 and 03.30 am. Meanwhile, the simulation results on May 4 showed the highest temperature was 42º from 12.30 pm to 03.30 pm and the lowest temperature was 26.5º from 04.30 to 05.30 am.

Figure 15. Hourly thermal simulation results on December 22 and May 4 September with sub ground passive cooling system.

After simulating with the graphic output, it is followed by a simulation using the form of grid analysis. The results of the grid analysis (*figure15*) which included the ground cooling system were the average temperature in the church building of 32º and the temperature around the building was 44º.

When compared with the results of the grid analysis before applying the soil cooling system, the indoor temperature was 35º. So it can be seen that there was a decrease in the temperature in the church building by 3º after implementing a sub ground passive cooling system (*figure 16*).

Figure 16. The simulation results of the average temperature in the form of a gird.

5. Conclusion

Simulations that have been carried out by making a model which are then analyzed using the Ecotect 2010 software, based on the thermal comfort formulated by SNI, namely thermal comfort in tropical areas is divided into three criteria, namely; cool comfort with operative temperature (To) 20.50 ° C ~ 22.80 ° C, optimal comfort with to 22.80 ° C ~ 25.80 ° C and warm comfortably with to 25.80 ° C ~ 27.10 ° C.

So it can be concluded that the comfortable temperature is only obtained at the end of December because the temperature range in that period falls into the warm comfort criteria, namely 24º to 27.5º. This research still has many problems. One of them is that the Ecotect 2010 simulator does not include weather data for Indonesia, so the closest one to the location of the research object is Bangkok +7. Climate data for the Indonesian region is not yet available. So the accuracy of the simulation results is reduced.

References

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