Building material engineering for Coronavirus (COVID-19) prevention with thermal ambient in a 2-storey residential

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Abstract. The Corona Virus Disease 2019 pandemic is an event of the spread of the corona virus around the world. LIPI researchers stated that air temperature and humidity can affect the spread of the corona virus. Coronavirus resistance decreases in hot air temperatures and high humidity. Based on the problem of hot air temperature and high humidity that can retard the spread of the corona virus, a study was carried out on the effect of the material on the thermal conditions of buildings to reduce the spread of the corona virus. Thermal measurements are carried out on a 2-storey residential house. The research objective was to determine the thermal condition of the 2-storey residential material which can reduce the spread of the corona virus. The research method is quantitative research method with experimental approach. The quantitative research method with an experimental approach is to measure air temperature and humidity on several materials of a 2-storey residential house using ecotect software. The results of the research are ceramic floor materials, brick walls, glass openings, gypsum ceilings and ceramic tile roofs have thermal conditions that can reduce the spread of the corona virus in a 2-storey residential house.

1. Introduction
The corona virus pandemic is an event of the spread of the 2019 corona virus disease around the world. The corona virus pandemic was caused by the COVID-19 virus, which is the new type of corona virus SARS-CoV-2. The COVID-19 epidemic was first detected in Wuhan China in December 2019, and was designated a pandemic by the WHO in March 2020 [1].

There is no vaccine or cure for this disease. Prevention is done by washing hands, wearing masks, keeping a distance, and isolating if infected [2]. Climate factors with high temperatures and high humidity also help reduce the spread of the coronavirus Covid-19. Several studies have indicated that high temperatures and high humidity can reduce transmission of the coronavirus [3]. The resistance of the coronavirus Covid-19 decreases in hot temperatures and high humidity. Coronavirus does not last long in tropical areas with hot temperatures and high humidity [4].

In preventing the spread of coronavirus, the Indonesian government has implemented a stay at home policy. By staying at home, the house must be protected from the spread of the corona virus. So the house air temperature and humidity should be able to reduce the spread of coronavirus. Building material is one of the factors that affect air temperature and humidity. Several studies have concluded that the material for floors, walls, openings, ceilings and roofs can affect the thermal conditions of a residence house [5,6].

So research was carried out to make thermal homes that can reduce the spread of coronavirus. Thermal conditions with high temperature and humidity can reduce the spread of coronavirus. Thermal
conditions are measured based on residential materials, because material is one of the factors that affect
the temperature and humidity of the building. This study uses a 2-storey residential house, the type of
house that is mostly in housing and settlements. Measurement of temperature and humidity in building
materials using the ecotect software.

2. Thermal comfort
Factors affecting comfort and mental and physical abilities of building users [7]:

- Solar radiation.
- Reflection and absorption.
- Temperature and temperature changes.
- Air humidity.
- Air movement.

Thermal comfort standard for airspeed [8]:

- Lippsmeir states that the standard wind speed is [9]:
  1. 0.25 m / s comfortable, without feeling any air movement.
  2. 0.25 - 0.5 m / s comfortable, air movement is felt.
  3. - 1.5 m / s slight to unpleasant airflow.
  4. Above 1.5 m / s is not pleasant.
- Lechner states a comfortable range for wind speeds ranging from 20 to 60 feet/minute (fpm)
  approximately 0.6 mph - 2 mph [10].
- According to MENKES NO.261 / MENKES / SK / 11/1998, the room wind speed is 0.15 to
  0.25 m / s.
- Thermal comfort standards for air temperature [11]:
  1. Cool comfortable, between effective temperatures of 20.8 ° C-22.8 ° C.
  2. Optimal comfort, between 22.8 ° C-25.8 ° C effective temperature.
  3. Warm comfortable, between effective temperatures of 25.8 ° C-27.1 ° C.
- Basaria states that comfortable temperatures according to the technical planning procedures for
  energy conservation in buildings [12]:
  1. Cool comfortable, i.e. 20.5 ° C-22.8 ° C.
  2. Optimal comfort, i.e. 25.8 ° C-25.8 ° C.
  3. Warm comfortable, i.e. 25.8 ° C-27.1 ° C.
- MENKES NO.261 / MENKES / SK / II / 1998 states that room temperature is: 18 ° C-26 ° C
  [13].
- Lechner states that air temperature will determine the speed of heat that will be lost mostly by
  convection above 98 ° F, the airflow is reversed and will get heat from the air, the comfort range
  for most people 89% can reach up to 68 ° F (20 ° C) in winter and 78 ° F (25.5 ° C) in summer
  [10].

Thermal comfort standards for humidity [8]:

- Lippsmeir states that relative humidity is 20-50% [14].
- MENKE states that healthy air humidity is 40% - 60% [13].
- SNI states the area of thermal comfort in conditioned buildings for Indonesians is 40% -70%
  [15].

Temperature and humidity can affect the spread of the SARS-CoV-2 coronavirus. The resistance of the
Covid-19 virus decreases in hot temperatures and high humidity. Covid-19 cases are concentrated in
the northern hemisphere which is experiencing winter with temperatures <18 ° C and humidity <9g / m3.
So that the coronavirus will not last long in tropical areas with high heat and humidity. Decreased virus
resistance due to high temperature and humidity will slow down the spread. Confined spaces with poor air circulation can exacerbate the spread of the Covid-19 virus [4].

The coronavirus will die if heated at 56 °C for 30 minutes. The temperature of solar radiation cannot reach 56 °C. Even ultraviolet rays cannot match the intensity of ultraviolet lights. So that the coronavirus cannot be killed by sunlight. But the Corona Covid-19 virus will begin to weaken when it is between 26-27 °C and when exposed to sunlight [16].

3. Research methodology
This research uses quantitative research methods with experimental approaches. Quantitative research methods use alternative materials for floors, walls, openings, ceilings, and roofs in a 2-story residential house [17]. The experimental approach is carried out by measuring the air temperature and humidity of the house using ecotect simulation. The measurement results of the ecotect software are to find out the engineering of 2-storey residential building materials against air temperature and humidity which can reduce the spread of the coronavirus Covid-19 [18,19].

The 2-storey residential model uses the Chrysant type residence in Green Serpong Bintaro Housing (figure 1 and 2). Green Serpong Bintaro Housing represents the type of cluster housing favored by suburban communities in this era. The Chrysant type residence in Green Bintaro Serpong housing has material specifications:

- Floor: Interior ceramic ikad 50 x 50.
- Walls: Plaster masonry, polished and painted.
- Opening: Glass with wooden frames.
- Ceiling: Furring metal frame gypsum board.
- Roof: Cengkareng Indah flat concrete tile cover.

![Figure 1. Plan of Chrysant type residential in Green Bintaro Serpong Housing.](image-url)
Alternative building materials using the method of Purposive Sampling Inclusion, is a sampling method that researchers want based on research objectives. The research objective is to find out building materials that have thermal conditions that can reduce the spread of the coronavirus Covid-19. Alternative building materials, are the most widely used building materials:

- Floor (ceramic and parquet).
- Walls (brick and brick Hebel).
- Openings (glass and glass with louvers).
- Ceiling (gypsum and GRC).
- Roof (ceramic tile and concrete tile).

4. Results and discussion
Simulation of thermal condition measurement using Autodesk Ecotect Analysis 2011 software. The direction of the building in the Chrysant type residential simulation at Green Serpong Bintaro Housing is 37.5 ° from the north, as the best orientation throughout the year for the Jakarta location.

The thermal condition of a 2-story residential house with ceramic floor material, brick walls, glass openings, gypsum ceiling and ceramic tile roof is measured using the ecotect simulation. The 2-storey Chrysant Type residence at Green Bintaro Serpong Housing has an average daily temperature of 33.6°C (Figure 3).
Figure 3. Simulation of the thermal condition of residential Chrysant type Green Bintaro Serpong Housing Using Ecotect 2011.

The thermal condition of a 2-story residential house using ceramic and parquet floor materials is measured using ecotect simulations. The 2-storey residential house with ceramic floor material has an average daily temperature of 33.6°C. The 2-storey residential house with parquet floor material has an average daily temperature of 31.5°C (Figure 4). Ecotect simulation results show that ceramic floors have a higher air temperature than parquet floors in a 2-story residential house. The 2-storey residential house with ceramic floors has good thermal conditions to reduce the spread of the coronavirus Covid-19.

Figure 4. Simulation of the thermal conditions of Residential House with Parquet Floors.

The thermal condition of a 2-story residential house using brick and hebel brick wall materials is measured using ecotect simulations. The 2-storey residential house with brick wall material has an average daily temperature of 33.6°C. The 2-storey residential house with hebel brick wall material has an average daily temperature of 33.5°C (Figure 5). Ecotect simulation results show that brick walls have a higher air temperature than hebel brick walls in a 2-story residential house. The 2-storey residential house with brick walls has good thermal conditions to reduce the spread of the coronavirus Covid-19.
Figure 5. Simulation of the thermal conditions of Residential House with Hebel Brick Walls.

The thermal condition of a 2-story residential house using glass and glass using louvers opening materials is measured using ecotect simulations. The 2-storey residential house with glass opening material has an average daily temperature of 33.6°C. The 2-storey residential house with glass using louvers opening material has an average daily temperature of 29.3°C (Figure 6). Ecotect simulation results show that glass openings have a higher air temperature than glass using louvers openings in a 2-story residential house. The 2-storey residential house with glass openings has good thermal conditions to reduce the spread of the coronavirus Covid-19.

Figure 6. Simulation of the thermal conditions of Residential House with Glass using louvres Openings.

The thermal condition of a 2-story residential house using gypsum and GRC ceiling materials is measured using ecotect simulations. The 2-storey residential house with gypsum ceiling material has an average daily temperature of 33.6°C. The 2-storey residential house with GRC ceiling material has an average daily temperature of 23.6°C (Figure 7). Ecotect simulation results show that the gypsum and GRC ceilings have the same air temperature in a 2-story residential house. The 2-storey residential house with gypsum and GRC ceilings has good thermal conditions to reduce the spread of the coronavirus Covid-19.
The thermal condition of a 2-story residential house using ceramic tile and concrete tile roof materials is measured using ecotect simulations. The 2-storey residential house with ceramic tile roof material has an average daily temperature of 33.6°C. The 2-storey residential house with concrete tile roof material has an average daily temperature of 23.6°C (Figure 8). Ecotect simulation results show that the ceramic tile and concrete tile roofs have the same air temperature in a 2-story residential house. The 2-storey residential house with ceramic tile and concrete tile roofs has good thermal conditions to reduce the spread of the coronavirus Covid-19.

The ecotect simulation results show that the floor, walls, openings, ceilings, and roofs material affect the air temperature of a 2-story residential house. The results of measuring air temperature using the ecotect simulation show floor, walls, openings, ceilings and roofs material of a 2-story residential house that can reduce the spread of the coronavirus Covid-19 (Figure 9). Building materials for ceramic floors, brick walls, glass openings, gypsum and GRC ceilings, as well as ceramic tile and concrete tile roofs can reduce the spread of the coronavirus Covid-19.
5. Conclusion
The results of the research on Building Material Engineering for Coronavirus (COVID-19) Prevention with Thermal Ambient in a 2-storey Residential, obtained the thermal conditions of a residential house with alternative building materials. Alternative building materials for floors, walls, openings, ceilings and roofs of residential houses have thermal conditions above the average tropical climate temperature of 20°C - 27°C which can reduce the spread of the coronavirus Covid-19.

Houses material with ceramic floors have a higher air temperature than parquet floors, because ceramic floors have a glossy surface so they reflect more heat than parquet surface. Houses material with brick walls have a higher air temperature than hebel brick walls, because brick walls have larger pores to absorb heat than hebel brick pores. Houses material with glass openings have a higher air temperature than glass with louvers openings, because glass openings absorb heat more easily than glass openings blocked by louvers. House material with gypsum and GRC ceiling has the same effect on air temperature, because the ceiling is located inside the building, so it is not exposed to direct sunlight. House material with a ceramic tile and a concrete tile roofs has the same effect on air temperature, because the sun's heat entering through the roof can be detained by the ceiling before it enters the building.

Building materials ceramic floor, brick walls, glass openings, gypsum and GRC ceilings, as well as ceramic tile and concrete tile roofs can reduce the spread of the corona virus in a 2-story residence house.

References
[1] Wikipedia 2020 Pandemi koronavirus 2019–2020 - Wikipedia bahasa Indonesia, ensiklopedia bebas Wikipedia
[2] Wikipedia 2020 Penyakit koronavirus 2019 - Wikipedia bahasa Indonesia, ensiklopedia bebas Wikipedia
[3] Liputan 6 2020 Penjelasan Mengenai Pengaruh Suhu Udara Terhadap Virus Corona Covid-19 - Bola Liputan6 Liputan 6
[4] Indoensia C 2020 Ahli Ungkap Pengaruh Suhu Panas Terhadap Virus Corona di RI CNN Indones.
[5] Jamaludin N, Mohammed N I, Khamidi M F and Wahab S N A 2015 Thermal Comfort of Residential Building in Malaysia at Different Micro-climates Procedia - Soc. Behav. Sci. 170 613–23
[6] Djamila H, Chu C-M and Kumaresan S 2014 A temperature humidity chart for the thermal comfort of seated persons J. Build. Constr. Plan. Res. 2 109–17
[7] Nabil T F 2012 Kenyamanan Thermal
[8] Nicol F 2004 Adaptive thermal comfort standards in the hot-humid tropics Energy Build. 36 628–37
[9] Lippsmeier G 1997 Bangunan Tropis Jakarta
[10] Lechner N 2014 Heating, cooling, lighting: Sustainable design methods for architects (John wiley & sons)
[11] Atrium Architecture 10 2011 Standar Kenyamanan Termal, Visual, dan Audial
[12] Talarosha B 2005 Menciptakan kenyamanan thermal dalam bangunan J. Sist. Tek. Ind. 6
[13] KEPUTUSAN MENTERI KESEHATAN REPUBLIK INDONESIA 1998 NOMOR: 261/MENKES/II/1998, TENTANG PERSYARATAN KESEHATAN LINGKUNGAN KERJA (MENTERI KESEHATAN REPUBLIK IDONESIA)
[14] Lippsmeier G 1994 Tropical Building Transl. by Syahmir Nasution, Erlangga, Jakarta
[15] Badan Standar Nasional Indonesia 1993 Tata Cara Perencanaan Teknis Konservasi Energi Pada Bangunan Gedung Jakarta BSNI
[16] Ika Ningtyas 2020 Benarkah Virus Corona Mati dalam Suhu 26-27 Derajat dan Saat Terkena Sinar Matahari? Tempo
[17] Hidayat A 2012 Pengertian dan Penjelasan Penelitian Kuantitatif - Lengkap - Uji Statistik
[18] Rury N, Pribadi I G O S and Santoso D 2015 Pengaruh Material Dan Bentuk Atap Rumah Tinggal Terhadap Suhu Di Dalam Ruang The Effect Of House Material And Roof Shape On Indoor Temperature AGORA 15 52–63
[19] Wahyudi E 2018 Pengaruh Bentuk Bukaan Atap Bangunan Terhadap Tingkat Kenyamanan Termal Pada Rumah Panjang Suku Dayak Brusu, Kecamatan Sekatak, Kalimantan Utara Borneo Eng. J. Tek. Sipil 2 94–104