Green structure and green technology in preserving traditional architecture of Rumoh Aceh

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Abstract. Rumoh Aceh is one of the traditional architectural house in Indonesia that has become a cultural heritage as well as the identity of Aceh region. Rumoh Aceh as a building has the value of sustainability and environmentally friendly, and also loaded with the values of local wisdom that exist in the lives of Acehnese people. Rumoh Aceh in its development has undergone various adjustment processes to the environment so that it can survive until now. But along with the development of modern era that demands efficiency and the fact of increasingly difficult to find good quality wood materials for the manufacture and maintenance of traditional architecture of Rumoh Aceh, then gradually fewer people build and maintain Rumoh Aceh. Although constrained in the difficulty of procurement of good quality wood materials and maintenance, the existence of Rumoh Aceh must be maintained. Therefore, this research needs to be done as an effort to understand the constraints of the availability of good quality wood materials for the manufacture and maintenance of traditional architecture of Rumoh Aceh and find alternative solutions that are environmentally friendly to support the preservation efforts of Rumoh Aceh. This qualitative descriptive research uses variety of primary and secondary data of traditional architecture of Rumoh Aceh. The results of this study revealed the use of green structures and technologies as well as environmentally friendly engineering wood materials can be one of the alternative solutions in preserving the traditional architecture of Rumoh Aceh.

1. Introduction
Indonesia is known as a rich country of cultures that has a variety of different regional cultures as a result of the process of environmental adaptation and the influence of social and cultural aspects that occur in people from different regions [1]. One form of the culture of the area is traditional architecture. Every traditional architecture in Indonesia has a distinctive character in accordance with the local culture. To be able to live in harmony with each of the occupied environments, the community in each area has made adjustments to the natural conditions around it. The process of adjusting the environment certainly affects the architecture built in the area [2].

In connection with the recent developments in the city, Banda Aceh as the capital of Aceh province also seeks to maintain the ecological existence of traditional villages that are adaptive to the development of the city that describes the history of the city [3]. This is manifested through the existence of Rumoh Aceh architecture as one of the traditional architecture in Indonesia and is a pride for the people of Aceh. In its development, Rumoh Aceh shows that there has been a process of
adjustment to the environment and the influence of social and cultural aspects so that it can survive until now. The reliability of Rumoh Aceh architecture is closely related to the values of local wisdom that exist in the lives of acehnese people [4]. The values of local wisdom in Rumoh Aceh is what makes the architecture built by Acehnese people has traditionally become a cultural heritage as well as cultural identity of Aceh region [5].

The value of local wisdom in Rumoh Aceh which is responsive to the sustainable environment, also found in the form of a rowdy stilt house so that the main room of the building that is far above ground level becomes safe from the risk of flooding and disturbance of wild animals. Similarly, the construction structure of buildings with uncut wood materials allows the building to survive and respond to earthquake shake. The value of environmentally friendly local wisdom in the use of materials in Rumoh Aceh shows one of the expressions of excellence of traditional architecture that is reliable and in accordance with the natural environment in the Aceh region [6].

The building principle of Rumoh Aceh is adaptive to the environment and has sustainability value in line with the principle and concept of green architecture or green buildings that are environmentally friendly, it can be seen from the activities of residents, building construction, building materials, and energy efficiency used. Referring to one of the categories of green architecture assessment by Green Building Council Indonesia (GBCI) namely in the category of eco-friendly houses, Rumoh Aceh can be classified as a wise house in using land, paying attention to the conservation of natural resources materials also healthy and safe for homeowners [7].

Although it has a number of advantages in terms of sustainability and environmentally friendly, but the reality shows the existence and people’s interest about Rumoh Aceh is decreasing. Today, the number of Rumoh Aceh as residential building is getting less, replaced by new building with a dominant modern style of concrete construction. Many owners of Rumoh Aceh have dismantled the old house and refurbished it by following modern architectural style that is considered more efficient and in accordance with today's lifestyle, so this condition makes the craftsman who is expert in building Rumoh Aceh which called utoeh become increasingly difficult to find [8].

In addition to efficiency and lifestyle changes, there are considerations on the availability of quality wood materials that are increasingly difficult to obtain also affect the community to be difficult to care for and rebuild Rumoh Aceh. Similarly, the natural properties of wood materials which can be damaged and broken, becoming the weak side of Rumoh Aceh material. Although, it is known some traditional techniques in the way of selection and preservation of wood as an effort to overcome it’s weakness, but it is considered less optimal.

The decreasing trend at this time, efforts to maintain the existence of Rumoh Aceh on some new building designs also seemed forced. Similarly, the lack of availability of good quality wood materials causes the community to try to find solutions for wood replacement materials such as iron, mild steel and concrete, so that the form of the building will change not as Rumoh Aceh in the original form. Meanwhile, the development of the condition until now is quite alarming because Acehnese people slowly have the potential to lose their traditional architectural identity of Rumoh Aceh.

Based on the description above, the problem formulation in this study is how to find environmentally friendly solutions in terms of the availability of good quality wood materials for the manufacture and maintenance of traditional architecture of Rumoh Aceh. The purpose of this research is to get an alternative solution that is environmentally friendly in terms of the availability of good quality wood materials for the manufacture and maintenance of traditional architecture of Rumoh Aceh which also supporting the preservation efforts of Rumoh Aceh.
2. Materials and methods

2.1. Rumoh Aceh
Traditional architecture is one of the artifacts of community culture in an area that appears in line with the development of a ethnic group, where there are social, religious, and cultural values that cause traditional architecture can be considered as the identity of a ethnic or regional. Aceh as a ethnic group in Indonesia, has its own cultural artifacts, one of which is Rumoh Aceh or traditional house of Aceh. Acehnese people call their house as Rumoh Aceh. The two words are derived from the choice of the word rumoh which means house and Aceh indicates the geographical location of an area. Thus, Rumoh Aceh is a traditional house of Aceh region that represents Aceh culture so as to show the identity, character and philosophy of the people of Aceh region, as shown in figure 1.

![Figure 1. Traditional architecture of Rumoh Aceh.](image)

2.2. Method
This study used descriptive qualitative approach in conducting literature studies related to the application of green technology in the concept of green buildings and makes it a reference to obtain alternative environmentally friendly solutions in terms of the availability of wood materials for the manufacture and maintenance of traditional architecture of Rumoh Aceh while supporting the preservation efforts of Rumoh Aceh. The stages carried out in this study include data collection, data analysis, and discussion based on research problems. Data collection methods are conducted in the form of searching and collecting sources of literature in the form of books and scientific journals as well as publications of scientific seminars published online. In addition, literature study data is obtained from official government document sources, articles, research reports, and other relevant and reliable sources. Qualitative analysis of data on literature data, conducted by identifying data, compiling data, and organizing and interpreting data in accordance with research objectives, so as to draw conclusion.

3. Results and discussion

3.1. Development of green building concept that is environmentally friendly
The concept of green architecture or green buildings that are environmentally friendly began to develop since the United Nations Commission for Environment and Development issued a popular declaration under the name Brundtland Report in 1987. This declaration initially relates to the
importance of maintaining environmental sustainability, then extends to involve environmental problems in the scope of urban areas, city parts, and buildings, which are required in line with the carrying capacity of the natural environment in order to minimize the decline in environmental quality. In line with the concept, architects are required to design architectural works that consume minimal natural resources, consume minimal energy, water and minerals, and have minimal negative impacts on nature and the environment without having to decrease the quality of life and comfort of human beings in carrying out their daily lives. Standardization and green-level assessment of a building began in the UK in 1990 when the government-owned building research institute, Building Research and Establishment (BRE) formulated a standard called the Building Research and Establishment's Environmental Assessment Method (BREEAM). BREEAM is a reference for a complete green level assessment, covering 10 aspects of buildings, namely management, health and quality of life, energy, transportation, water, materials, waste, land use and ecology, pollution, and innovation.

Another green standard is Leadership in Energy and Environmental Design (LEED) which was initiated by the United States Green Building Council (USGBC) in 1994 by adopting and developing the BREEAM concept for more practical applications. Similarly, other green standards, such as the National Australian Building and Environment Rating System (NABERS) issued by the Australian government, then Green Stars initiated by the Australia Green Building Council, and Green Marks issued by the Singapore Green Building Council. Some of these standards certainly try to more specifically present green standards that are more practical and easy to apply with the conditions of their respective countries.

3.2. Sustainability concept in tradistional architecture of Rumoh Aceh

Traditional architecture of Rumoh Aceh in the development process shows the value of local wisdom in the form of community concern in realizing and thinking the value of natural sustainability. Before construction began, the availability of materials had been planned in advance such as the method of planting a number of types of trees that would later be needed and used as the main wood material for poles, beams, walls, floors and roof frames, as shown in figure 2. This principle is also in line with Frick [9] which mentions it as a pattern of ecological architectural planning which includes the existence of connectedness with the overall system, tradition in development and cooperation between humans and the surrounding nature for the safety of both parties.

![Figure 2. Wood material in Rumoh Aceh.](image)

Acehnese people have long known the use of wood materials. The use of wood material is considered as Indonesian vernacular tradition and is believed to have similar origins from ancient development traditions. Rumoh Aceh as traditional houses in Indonesia generally use wood raw materials mainly as its main building materials, which are in the form of stage buildings and wooden construction. Almost all Indonesian traditional houses which are vernacular architectural heritage have similar shapes, both from the shape of the building as well as from the morphological form of its basic structure.
The selection of good quality wood materials such as Damar (*Agathis dammara*) and Merbau (*Intsia bijuga*) for Rumoh Aceh is also associated with the decent period of buildings which is the period of time the building can still meet the function and reliability of the building in accordance with the requirements that have been set. In general, for new buildings, building components can be taken into account for 50 years, while for components in house buildings can be taken into account for 20 years. To improve the decent life and durability of wood materials, some traditional preservation methods such as soaking or immersion (as shown in figure 3) and smoking have been common in the construction of Rumoh Aceh, but not optimal so that there are still parts of the building that risk damage and must be replaced periodically.

![Figure 3. Traditional wood preservation through immersion.](image)

The ecological approach to traditional architecture of Rumoh Aceh can be seen in the concept of buildings that emphasizes on awareness that appreciates the importance of sustainability or sustainability of ecosystems in nature. The ecological approach and sustainability concept in Rumoh Aceh as traditional architecture has protected nature and its ecosystems from more severe damage, and can also create comfort for its residents physically, socially and economically. The ecological approach to sustainable architectural design does not determine what should happen in architecture, as there is no distinctive nature that binds as standard or standard size, but includes harmony between man and nature.

Rumoh Aceh as sustainable traditional architecture also contains dimensions of nature, space, socio-cultural, time, and construction techniques. As for example, natural materials dominated by wood contain a relatively low energy consumption value that among others affects Rumoh Aceh to a low balance of room temperature. Another thing in energy saving can be obtained through the utilization of natural resources to allow the recycling of waste that can decompose itself with the cycle that exists in nature [10].

### 3.3. Engineering wood as construction material for Rumoh Aceh

Wood is building material which is sourced from nature and has sustainable and environmentally friendly value. However, nowadays wood materials have begun to be less popularly used as the main material of the building. This is partly due to the increasing difficulty of obtaining good quality wood materials, especially the high price of such materials. Many wood with any type on the market is generally only used as a supporting element or as scaffolding wood. Meanwhile, the use of materials from industries such as cement and steel, with relatively stable price conditions and availability in the market makes it the main choice in the construction of modern buildings.

As a material sourced from plants in nature, renewable wood means its availability will remain as long as the preservation of its resources is maintained. Wood can be perfectly recycled and decomposed in nature, so that wood becomes one of the environmentally friendly building construction materials. What needs to be done is to develop industrial plantation forests in an effort to meet the needs of the national timber industry and no longer rely on natural forests.
Some types of fast-growing wood plants such as sengon wood, acacia, jabon, albasia, and others, have been developed in industrial forest plants to provide wood needs for building construction. Wood used as structural elements can be either solid wood or engineered wood. Engineered wood such as glulam, cross laminated timber (as shown in figure 4) and others are made to meet the demands of the needs of large wood strength and dimensions. These products of engineered wood can be used as both structural and non-structural elements. Currently engineering experts have added design for disassembly or repackible design, design for recycling or recyclable design, and design for environment or design that considers environmental aspects into the planning of a design.

**Figure 4.** Engineering wood such as glulam and cross laminated timber.

Engineering for the development of various innovation products, in the form of engineered wood by composite from wood waste with non-timber waste is an effort so that the life or lifetime of wood products will be longer can be utilized. Engineered wood has been highly advanced and widely used in countries such as New Zealand, Canada, USA, Australia, and many countries in Europe. Multi-storey buildings up to 10 floors which are widely used as apartments using engineered wood have become common in some of these countries.

3.4 **Green structure, green technology and preserving traditional architecture of Rumoh Aceh**

Green construction, closely related to green technology, which will produce green buildings. Green construction aims to restore and maintain a balance between natural and artificial environments [11] and seeks to minimize the negative impact of the construction process on the environment in order to strike a balance between environmental capabilities and human life needs for current and future generations [12].

Green structures and technologies can be applied to roofs that play a role in minimizing heat radiation (roof ventilation, roof insulation layer); avoid solar radiation (multilayer roof, roof color); natural lighting (sky light ceiling); reduction of water runoff (large volume roof, light material, steep slope). To minimize heat radiation from the ceiling, one solution is to be able to create roof ventilation [13]. Thus the heat does not propagate to the ceiling through the conduction process which ultimately heats the space underneath. Indirect solar radiation can also be used to illuminate the space in the building by utilizing sky light on the ceiling [14].

**Figure 5.** Engineering wood as building elements on traditional architecture of Rumoh Aceh.
Green structures and technologies can also be applied to column and beam elements. Glulam beams are one of the methods of overcoming the limitations of the dimensions of the wood base materials available. By preparing the lamina-lamina and arranging them and performing the gluing process between the surfaces of the lamina can produce the dimensions of the beam as needed. In addition to glulam beams, there are also composite bamboo beam products [15] made of bamboo that has been separated (zephyr) then mixed adhesive and pressed into blocks. The use of composite bamboo beam products can be used as an alternative to increasingly expensive wooden beams and difficult of its availability. The composite bamboo beam products are cheaper and the raw materials are abundant so as to make this product has a quality equivalent to grade 1 wood.

Green structure and technology can also be applied to walls, in the form of breathing walls, multi-layer walls and green walls [16]. Green technology on the wall serves to remove heat in the room (multi layer wall); give a cool sensation (breathing wall); radiation protection (green wall). Walls with light and porous materials allow heat dissipation and air exchange [17]. The use of green walls as a barrier inside and outside the building will provide freshness, cooling and air quality in the inner space for the better [18].

4. Conclusions
In line with local wisdom in the traditional architecture of Rumoh Aceh which is environmentally friendly, the use of the concept of green construction and green technology can be an alternative solution in building and maintaining (green maintenance) Rumoh Aceh. Green construction applications and green technology can include elements of the main structure, namely columns and beams as well as roofs, walls and floors of buildings. Engineering wood can be a substitute for solid wood and other building materials, so as to maintain the original form of Rumoh Aceh as a building with wood materials that remain environmentally friendly.

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