

Roofs as Sustainable Design Elements in Vernacular Architecture of Southeast Asia

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Abstract: Sustainability emerges as one of the most crucial challenges in the modern day architecture and planning. It is based on the understanding that our resources are limited and we have a great responsibility to future generations. The knowledge that can be gained from wisdom of older generations through the lessons of vernacular architecture serves as a strong tool for application to buildings of the future. In view of the dimensions of sustainability i.e. social, economic etc., many vernacular elements can be adapted if not altogether adopted for providing sustainable solutions.

Southeast Asian countries and archipelagos have a treasure of such sustainable traditional and vernacular architecture. The traditional people of Southeast Asia have adopted various techniques and strategies in vernacular architecture that are sustainable by unknowingly adhering to basic architectural principles of energy efficiency and utilizing locally available materials and resources. Their built forms are unique, significantly the roof forms that are derivative of the historical, environmental and geographical context in which they exist. The structures so made not only adapt to the climate but also expresses the socio-cultural and economical aspects of the society. Traditionally, these roofs have given advantage to this built environment which is an intelligent response of the people to their knowledge rooted in the vernacular architecture.

Thus the main objective of the study is to give an overview of traditional and vernacular architecture of Southeast Asia in the perspective of sustainability and outline the significance of Roof as an element of sustainability in the dwellings of Southeast Asia. The paper aims to study how the vernacular architecture of Southeast Asia has survived the tests of time in the form of traditional residential settlements with typical roof forms which are significant elements that characterise their style and act as a guide for the future generations in providing concepts for sustainable solutions.

Keywords: Traditional & Vernacular Architecture, Sustainability, Roofs, Climate Responsive Design.

1. Introduction

Vernacular Architecture refers to the technology adopted for constructing buildings and shelters which are locally available, environment-oriented, community- based; it is a reflection of the technology and the indigenous culture of the society and its environment. Vernacular architecture does not acknowledge an architect or a treaty, but is an age old reflection of the historical, environmental and cultural context to which it belongs. Each element of a vernacular building contributes in a unique way through its form and shape to vernacular architectural style specific to a place. Amongst all these components that constitute a building envelope, the role of a roof is to meet man's need to protect him from the natural elements and are subject to the greatest changes in temperature. They reflect the social and cultural traditions and beliefs of a community as well as contribute in modifying the indoor temperature adapting to the varying climatic conditions. In addition their characteristics primarily depend upon the purpose of the building that it covered, the local traditions of construction, the available roofing materials, all adhering to the concepts of sustainable vernacular architecture. Within Southeast Asia, roofs play a particularly important role in defining the character of their buildings and the architectural character of the region as a whole. Their role is identified vividly in different regions, adapting to the varying climatic conditions. Sometimes, within the same region, roofs are a symbol of a particular geographic location, a particular building typology, a community or a group with its typical shape and character. Like in Japan although the basic roof form is a sweepingly pitched roof, there is wide diversity and variation of these pitched roofs from the Northern areas of Japan to the South of Japan.

2. Discussion

2.1 Diversity in Roof Forms of Southeast Asia

Southeast Asia lies in the warm, humid tropics experiencing monsoonal climate type. The roofs for built forms are therefore high pitched roof with a distinctive character and are found with different features in varied regions. The pitched roofs of the Southeast Asian houses define the architectural character of the built forms and define the first visual impression. They occupy the largest visual surface area as compared to the base and body of the building and are thus the most eye-catching features. With an exceptional suitability to climate the wide variety of sweepingly pitched roof forms contribute towards giving a significant visual character to the

built forms. They are the exemplary elements responsible for shaping the character of the buildings with their elaborate structure and decoration.

The roofs vary from saddle shape to boat shaped inspired from the boat forms used for fishing. The saddle backed roof forms also have variation like the Karo Batak of North Sumatra topped by a pyramid of multiple gables. In Karo the proportion of pile: wall: roof is 1:1:9 thus making the walls less significant in proportion to the roof. The soaring heights of these roof forms of about 14m to 18m makes them unquestionably the most expressive element in Southeast Asian built form.

Another underlying fact is that the roof forms add to the grandness of the built form with an impressive and huge exterior whereas the interiors are proportionately small. They can be visualised from far because of their upward sweeping eaves or gables or finials on the gables yet the interior may consist of two to three small rooms only. In Indonesia the Saddle backed roof strike an unfamiliar note aesthetically since these built up units often lacked walls and windows, and are dominated by roof. Among the Minangkabau of West Sumatra, roofs ascend up like the buffalo horns with extended ridge lines, sloping gable ends and embellished eave points.

2.2 Social and cultural significance of Southeast Asian roofs

In Southeast Asia, the diversity of houses show how the internal planning and habitation styles reflect the social, cultural and religious beliefs along with the indigenous use of material and the available and known technology. "Roofs" play large roles in traditional Southeast Asian architecture and have significant social and cultural values. They represent the social status and thus the roof design, and many forms of ornamentation are used to intensify their visual effect.

The concept of animal metaphors and symbolic representation of a buffalo as a distinct element makes these roofs symbols of rich cultural values. As per their cultural beliefs buffaloes are considered as a form of wealth and its sacrifice was a ceremonial feature providing a link between earth and heaven. In traditional religion it was also believed that the dead used to ride to the upper world (afterlife) on a buffalo. Thus, some roof forms are made in the form of a buffalo horn, which are used as the chief weapons of offence and defence. Roofs are also adorned with buffalo horns and modelled buffalo heads at the eaves points of the house as they are believed to serve for protective function along with them being ornamental like the Batak Toba of Sumatra.

Some gable finials are richly decorative in the form of crossed horns and their names were derived from horns because of their connection to buffalo horns like the Naga of North Thailand. In Central Sulawesi, the horns are carved in the shape of birds or naga (The mythical water snake in the Southeast Asian cosmology) and in Silang Gunting of the Malay house they are like open scissors. The wealthier houses had more elaborate horns and served as decorative elements to serve as a sign of rank or status. The decorative metaphors also relate the roof to the social status of the inhabitant. The more elaborately the roof is decorated the higher the status of the habitant or the structure. For example the roofs of granaries are usually richly decorated they serve as stores for life giving rice which was dedicated to the Goddess Dewi Sri and was the most sacred area of the house.

Some roof forms are in the shape of a boat which are considered to be auspicious as they are sources of fishing which is the main source of livelihood thus contributing to the social significance of the roofs. The roof heights also symbolised social status and dignity so the parts of the house which were used for rituals or sacred purposes like the rice stores etc. had higher roofs than the rest of the house e.g The Limas house. The roof heights also classify spaces into public- private, male-female, sacred-profane.

2.3 The cosmic perception of the roof

Roofs had relation to cosmology and the beliefs and forces which governed the social and cultural values of the lives of Southeast Asians. Orienting of the ridge lines upstream or towards the holy mountains like in the Balinese house and the Limas House also signifies the relation of the roof to cosmic beliefs. The high roofs with sweeping eaves pointing towards the sky symbolize dignity, power, and that sky is the limit proving the cosmic belief of being close to God. The direct relation of the human body to the parts of the roof can be explained through three varied examples. The House of Minangkabau people (Rumah Gadang= big house), is the case where roof structure is separated from body, therefore it was stated that "roof sit on body". The House of Batak Toba (Jabu) is the case where roof has no truss, therefore can be used as space-roof-space. The House of Sa'dan Toraja (Tongkonan=roof sit on body): dramatically extended eaves are built out of by means of cantilevered frame.

2.4 Functional Performance of roofs

The high and extensive pitched roofs in Southeast Asia are intentionally made to adapt to the hot and humid climatic conditions that exist in the regions of Southeast Asia most of the time in the year. Unlike most vernacular forms where window openings were the key source of ventilation; roofs forms are so designed to minimize openings yet keep the interiors ventilated

Ventilation: A high roof, typical in Southeast Asian vernacular, shows an understanding of the stack effect. Hot air rises with buoyancy and is infiltrated out via ventilation roof joints. The projected roof gables with extended dormers with jallis allow for additional ventilation in the interior or via grills at each gable end. The roof has dual structure or is lifted in some cases to provide adequate means of ventilation. The floor and the walls aid in maximising the ventilation effect.

Shading: The long overhanging eaves provide shading to the structures and protect the walls from rain lashes. For example the Toraja Tongkonan has huge overhanging eaves.

Drainage: In a hot and humid climate like that in Southeast Asia, the roofing system plays a crucial role in keeping the rainwater from entering the house. The steeper the roof slope, the quicker the rainwater runs down through the slope. In general, the side roofpitch varies from 20 to 25 degrees while the middle pitch has a slope, which ranges from 50 to 55 degrees.

In tropical-humid architecture, pointed roofs also give an additional advantage of reducing the air velocity in building, but inside, air velocity conformed to air dynamic and opening area. The unknowing calculative roof angles of the roof are quite effective in solving climate problems.

2.5 Sustainable Roofing Materials

The Southeast Asians adopted the indigenous use of materials Traditional materials for roof cover are nypa (nipah: the needle – like trees) and rumbia (palm leaves). The roofs are built with natural materials like bamboo, timber, rattan, and wooden tree. The frames, posts, and beams usually are made of timber, wooden piles or bamboo piles. The floor consists of wooden boards laid over thin hardwood joists, between the floorboard and the hardwood joists a layer of split bamboo is laid to give extra rigidity to the floor. Its wall and partition are built from wooden board, wooden upright, or plaited bamboo. All of these components are prefabricated before in a shed called ‘pondok’ and are assembled with fitted wood joints, without the use of nails.

Southeast Asian roof traditionally is covered with bamboo layers and thatch. The bamboo layers constructed in panels; which are prefabricated before and tied to the roof structure with rattan string. The framework, the ridgepole, and the cross rafters were made of bamboo or timber. The Toraja people usually gained these materials from the forest and the nature surrounds them. The thatch materials are coconut and sugar palm leaves, grass and rice straw. Thick layers of thatch are put as the covering materials as they sufficiently provided for ventilation.

They also used simple and traditional carpenter tools and the wood carver to build the house and even though in traditional condition, they used bamboo scaffolding for finishing their jobs. There is no specific characteristic of the materials. The natural materials were used only because of the practical and economical reason. They tended to use material that was easy to get as long as it’s strong enough and the size was suitable.

2.6 Construction Technology of Roofs

The living houses of Southeast Asia adopted a construction technology specifically in the roof constructions, which was time tested, could endure the harsh weather conditions and also resist the seismic vibrations. The structure systems and methodology of prefabrication evolved from the basic knowledge of the materials and their properties. The pile and roof theory shows the simultaneous progression from a tee-shaped structure of poles set in the ground and overlapping at the top. Traditionally, the roof was constructed with layers of bamboo, and the wooden construction of the house assembled in tongue and groove system without nails. This honoured material, in combination with rattan, coconut leaf and variety of woods such as teak and ironwood, produce similar construction systems throughout the region.

Structure system and Construction- Structural elements of the roof were made from timber and bamboo as main frames. These materials were roped together using rattan rope and pin and hole joint system. Basically the structural elements that defined the roof shape were gable, ridge and bargeboard. Each of the three had distinct ways to be adopted for construction.

3. Reflections

In view of the three dimensions of sustainability i.e. social, economic and ecologic roofs are seen as vernacular elements that are adapted since ages for providing sustainable solutions. Untutored builders of the vernacular had an admirable talent for suiting buildings to their environment. An extensive knowledge of the climate and ability to modify their buildings meant various ventilation techniques for cooling and reducing solar gains were incorporated into their building designs. Traditional constructions system shows that these indigenous people were aware of the importance of the relationship between themselves and their environment. Settlements on wetland topography of Southeast Asia have influenced traditional construction techniques, which were closely related to the general design of the traditional house form. Socio-economic activities of indigenous

people in Southeast Asia were closely related to the surrounding environment. The environment has also dictated planning patterns and construction methods with unique forms of house-on-stilts architecture. Being located in wetland topography, these techniques and patterns have given them a unique and distinct culture compared to other tropical regions in the world.

Sanusi Hassan notes; "This relationship identifies that practice and belief of the Southeast Asian Communities in connection to ecological concern is not a new thing, as modern environmentalists have adopted. The distinction is that they had related the concern based on their belief to the surrounding superstitious nature while modern environmentalists were attempting to find solutions to a sustainable living environment relying on a scientific approach. Their belief shows that humans have a right to claim their place in nature."

4. Conclusion

The ethnic communities of Southeast Asia recognized sustainability as a way of life that was both practical and had a deep spiritual and social obligation. The study shows that in this society, people understood where the things they consumed came from. The people then, were not aware of the amount of energy required in transforming raw materials into building used. Yet, they adopted the most efficient techniques which consumed the least amount of energy and were eco friendly. An intimate social contact with the cycles of nature further ensured that the people were aware of how fragile their survival was, and the extent to which it depended upon a harmonious relationship with nature. Through the study it is evident that the roofs of Southeast Asia reflects the richness of sustainable vernacular architecture including their functional performance, shape and pitch, profile, and the qualities of its supporting structure, covering materials and associated features.

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