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CLIMATE RESPONSIVE DESIGN IN HERITAGE STRUCTURE: AN ANALYSIS ON THE DECORATIVE ARCHITECTURAL COMPONENTS DESIGN OF RUMAH LIMAS BUMBUNG PERAK (RLBP)

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Abstract

The absence of readily available energy in the past such as electricity has contributed to the indigenous formation of a climate-responsive dwelling structure that harnesses the provided energy from nature. The decorative architectural component is one of the heritage values in traditional Malay house that is not only functional but also symbolic and aesthetic towards the house's heritage architectural character. The aim of this research is to explore the climatic responsive function of the decorative architectural components of *Rumah Limas Bumbung Perak* (RLBP). Qualitative research was used as the research approach via case studies. This encompassed field works of site observation conducted on the decorative architectural components observed from the 9 samples of *Rumah Limas Bumbung Perak* (RLBP) chosen. The analysis was conducted by analysing the design attributes of the decorative architectural components that lead to the research findings. The findings of the research found that the design attributes of the decorative architectural components of RLBP correspond to multiple climatic functions – as a shading and filtering device, ventilation device, and climate protection device that contributes to the climate responsive design of the components. The output from this research not only strengthened the existing findings but also can contribute to the formation of the planning guideline for future housing planning in Malaysia, particularly on the spatial and sustainable quality of modern house design.

Keywords: Climatic Responsive, Decorative Architectural Components, Design Attributes, Heritage Structure, *Rumah Limas Bumbung Perak*

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INTRODUCTION

More and more energy are used day by day. In recent years, the residential sector's energy requirements in Malaysia have surged significantly due to an increase in demand and enhancements in people's quality of life (Daud et al., 2023), causing the policymakers to express their concerns about this growing need for energy. It is projected that Malaysia's household electricity usage will rise due to an increase in possession of appliances, improved economic conditions, and shifts in lifestyle. The latest objective in household energy management is to enhance users' energy habits, lower electricity expenses, and encourage the optimal utilization of new energy devices. Prioritizing energy efficiency holds significant importance in curbing Malaysia's energy demand, attaining sustainability targets, and fostering environmental improvements (Daud et al., 2023). As stated by Ahmed et al. (2019) the use of sustainable building design practices is essential for cutting energy consumption. In achieving low energy consumption that includes energy and water consumption and the environmental impact, sustainable building design takes into account variables including culture, community, and particular site circumstances (Wu et al., 2018). Ideally, future designers or architects should come out with a residential design typology that is not only reasonable in term of its cost but also comprised of optimized design solutions that helps to reduce domestic energy consumption that is commonly due to thermal comfort. Optimum design solutions and strategies can be learned from the past precedent of vernacular structure design where in the Malaysian context, the traditional Malay house design. The ancestors from the past designed their dwellings thoughtfully by considering all aspects that affect their life. One of the very important aspects that affect their dwelling designs is the climatic aspect. The absence of readily available energy in the past such as electricity has contributed to the indigenous formation of a climate-responsive dwelling structure that harnesses the provided energy from nature.

Traditional Malay houses prioritize environmental and socio-cultural factors in their design, creating homes that are natural, flexible, and adaptable to various conditions and the lives of their occupants. Factors such as house design, size, space flexibility, arrangement, allocation, lighting, and ventilation are considered to enhance comfort and satisfaction for occupants (Ahmad et al., 2022). Its architecture has been known for its climate responsive and sustainable design. This has been proven in a lot of previous research conducted in studying the environmental influence and factors in the design and physical features of the traditional Malay house architecture. This includes the study on the architectural features of the house such as the elevated floor design, roof design, the usage of material, availability of opening, building orientation etc. Nasir (1986), Yuan (1987), Hanafi (2007), and Surat (2018) claimed that the carvings adorning the traditional Malay house that comprised of the decorative architectural

components of the house is one of the features that contribute to the sustainability of the house. The decorative carving components does not only function to contribute to the aesthetical appearance of the house, but also to function as a climatic device. The variety and exquisite design of the carvings functioned to encourage the air circulation inside the house, shade and filter the occupants from the heat and glare produced by the scorching sun as well as it also protects and shield the house from damage that can be caused by the humid, tropical weather (Hanafi, 2007). In the study of decorative architectural components as part of the features that contribute to the sustainability of the Malay house, previous research conducted by Denan et al. (2015); Othman and Abdul Majid (2017), and Mohd Nawayai et al. (2020) established the decorative architectural components as the shading, filtering, and ventilation devices in the traditional Malay house architecture. Extending from this research, therefore this research will be focusing on analysing the climatic role of decorative architectural components of *Rumah Limas Bumbung Perak* not only as the shading, filtering and ventilating purposes but also includes as a weather protection.

Perak is one of the Peninsula regions that has a unique traditional Malay house of its own. There are two types of traditional Malay house in Perak which is *Rumah Kutai* (RK) and *Rumah Limas Bumbung Perak* (RLBP) (Rashid et al., 2019; Rashid, 2017). RK is the oldest type, meanwhile RLBP is the later type of Perak traditional Malay house. RK architecture and characteristic is simpler than RLBP which is more decorative with exquisite decorative features. From the review of previous research conducted, it can be understood that there has been a lot of research conducted on RK architecture. However, there has been a gap of study conducted on studying RLBP, particularly on its architecture and decorative features. Based on these gaps of studies, therefore the aim of this research is to explore the design attributes of the decorative architectural components as a climatic responsive design in the architecture of RLBP. This study is hoped to strengthen and add up to the existing study in establishing the traditional Malay house architecture and its features as a sustainable and green design building.

LITERATURE REVIEW

Decorative Architectural Components of RLBP

Decorative architectural components commonly function as additional elements that enhance the architectural character of the house. In Malay traditional architecture, decorative architectural components are also known as carved components, aesthetic elements, ornaments, carving panels and *kerawang* several past research. The term decorative element represents the non-structural element that is used as decorative and adds aesthetic value in a particular traditional Malay house architecture, besides its basic house structure and component. It refers to a

non-structural feature utilised as a decorative element in a traditional Malay home to enhance the aesthetic value. The decorative architectural component is commonly composed of wood carving. According to Hanafi (2007) and Othman and Abdul Majid (2017), decorative architectural components function to add aesthetic value and it function as climatic devices to the traditional Malay house. In a *Rumah Limas Bumbung Perak,* there is an overall of 14 decorative architectural components in RLBP that is comprised of; *Tunjuk Langit, Kepala Cicak Type L, Kepala Cicak Type i, Papan Cantik, Lubang Angin Luar, Lubang Angin Dalam, Gerbang Luar, Gerbang Dalam, Papan Manis, Pagar Musang Serambi, Kepala Tingkap, Pagar Musang Tingkap, Kepala Pintu Luar* and *Kepala Pintu Dalam* (Rashid et al., 2018). As stated by Rashid et al. (2018), Denan et al. (2015), and Kamarudin and Said (2011), carved components in a traditional Malay house not only functions to add aesthetic value to the house, but also functional in term of its use. Besides functioning as a filtering device, the carved components also function as a ventilation panel that allow the air to pass through and ventilate the interior of the house. This natural ventilation system helps to maintain a comfortable indoor environment and reduces the reliance on mechanical cooling systems, thus reducing energy consumption of the house (Nik Hassin & Misni, 2019). In addition, Hanafi (2007) added that there are several decorative architectural components that commonly comprised of *kerawangs* (carving) functions to protect the structural members of the Malay house from weather – seepage of rain water that might damage and rot the timber members thus jeopardizing the structural integrity of the house. This can be seen through the function of the *Papan Manis* and *Papan Cantik* (that is also commonly known as *Papan Pator* or *Kening)* that functioned to protect the end of the timber rafters from rainwater seepage.

Design Attributes

The carvings that adorned the traditional Malay house follow a specific order. The elemental characteristic of the traditional Malay woodcarving is very much influenced by the traditional Malay people's lifestyle, including the cultural and belief system, the climate, topography, and their surrounding natural environment. These carvings serve as a form of artistic expression and cultural representation, preserving and showcasing the rich cultural heritage of the Malay people (Choo, 2022; Hussain et al., 2020). The attributes of the Malay woodcarving in the traditional building throughout the Peninsula Malaysia based on the types of woodcarving element, carving category, carving element, pattern, motif, placement, carving technique and function (Hanafi, 2007). Choo (2022) stated that the motifs used in the carving of the decorative components of RLBP is commonly comprised of flora and geometrical motif where these motifs can be commonly found adorning the *Kepala Tingkap, Kepala Pintu* and *Lubang Angin*

panel. This panel is commonly placed at the top of the house components such as the wall, window, and door as a decorative panel as well as a ventilation panel that allow passage of air to pass through in and out of the house. The selections of the flora motif selected to adorn this carved panel have been selected from the type of floral species that commonly available from the surrounding area of the house that contains either medicinal benefits or fragrant properties.

***Rumah Limas Bumbung Perak* (RLBP)**

Nasir and Teh (1996) in the book: The Traditional Malay House, discussed that the roof of *Bumbung Limas Perak* had emerged from an early and simplistic variant of the *limas* roof, known as the *"Perabung Lima"* roof shape. It consists of 1 primary ridge in the centre of the roof accompanied by a little crest falling to the roof eaves. This roof is distinctive for its 3-dimensional appearance. Colonization period played an important role in developing *limas* roof development (Nasir & Aziz, 1985; Rasdi et al., 2005). This had given birth to several other kinds of *bumbung limas* that are more interesting and luxurious in terms of their looks (Harun, 2005). From the view of the environmental aspect, according to Hanafi (1996), the evolution of *Bumbung Limas Perak* happened due to the improvement of the roof design by the carpenter where the roof design without the gable end traps the heat and the hot air in the internal spaces, making the internal air environment hot and uncomfortable, especially on hot days where this gives birth to the addition of gable end to the *limas* roof. *Rumah Limas Bumbung Perak* is commonly popular in the western regions where it has a distinctive feature of a smaller triangular shape space located at its gable end (Nasir & Teh, 1996). In term of the spatial characteristic, RLBP is comprises of several component of spaces such as *Rumah Ibu* (the main living room), *Serambi* (entrance porch), *Anjung* (guest area), *Selang* (intermediate space) and *Dapur* (kitchen) (Rashid et al., 2019).

METHODOLOGY

The research is approached using the qualitative research approach by using case studies. There were nine case studies conducted in this research using the fieldwork approach of site observation. Photos, field notes and sketches were taken during the site observation process. Photos were taken both by using Canon DSLR Digital camera for the accessible area and mini–Mavic DGI Drone was used to take photos of the decorative architectural components that is located at the highly inaccessible area such as the roof. This was conducted on the decorative architectural components observed from the samples of houses chosen on RLBP.

Sampling Selection

A total of nine RLBP samples have been chosen from the inventory list reported in Choo et al. (2020). The RLBP houses were selected from four main area of Perak – Northern, Central, Coastal and Southern area of Perak. The selection of the RLBP sample houses were subjected under a criteria which is; the architectural age of the house – aged more than 80 years old, the house is decorated with decorative architectural components, the roof of the house contains prominent RLBP architectural character – *Bumbung Limas Potong Perak* roof, the house is located within the studied area - Perak state, the physical condition of the house - the form and the structure of the house is still intact and fit for study and the accessibility of the house – ease of accessibility allows the researcher to conduct study. As suggested by Choo et al. (2020), central area of Perak comprised of the finest collection of RLBP. Therefore, six RLBP houses that meet the criteria outlined were chosen from the central area. Whilst, for the remaining three areas, the best one house of the area that full fill the criteria listed was chosen to represent the RLBP of the area. Therefore, for this research, there is an overall of nine samples of houses were identified and chosen to be used as case studies samples. Six houses are from the central area, while for the remaining three area, one house was chosen to represent each of the area.

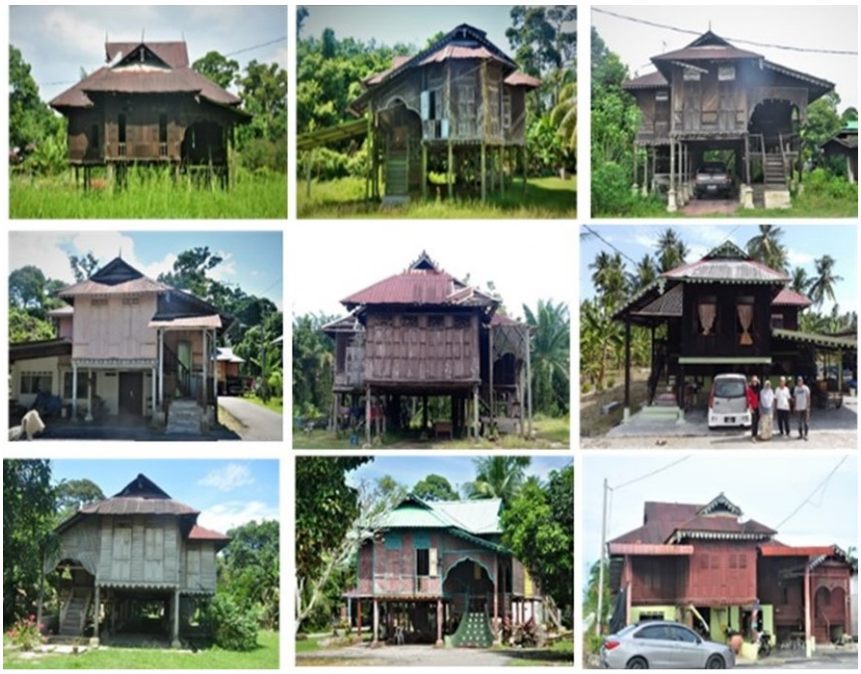

Figure 1: Nine Sample Houses of Rumah Limas Bumbung Perak.

ANALYSIS AND FINDINGS

As outlined earlier in the introduction of the research, the aim of this research is to explore the climatic function of the decorative architectural components of RLBP. This aim has been strategized to be achieved by analysing the design attributes of the decorative architectural components of RLBP that is relative to its function. The analysis was conducted on a total of 105 nos. of decorative architectural components gained from nine samples of RLBP house chosen. There are an overall of 14 nos. of decorative architectural components of RLBP analysed in this research, which is; *Tunjuk Langit (TL), Kepala Cicak Type i (KCi), Kepala Cicak Type L(KCi), Papan Cantik (PC), Lubang Angin Luar (LAe), Lubang Angin Dalam (LAi), Gerbang Luar (GBe), Gerbang Dalam (GBi), Pagar Musang Serambi (PGa), Papan Manis (PM), Kepala Tingkap (KT), Pagar Musang Tingkap (PGb), Kepala Pintu Luar (KPe)* and *Kepala Pintu Dalam (KPi).* The analysis was conducted on the climatic function of each of the decorative architectural component that comprised of the function of the decorative architectural components as sun shading and filtering device, natural air ventilation device and weather protection device.

Air Ventilation Device

From the analysis conducted on the climatic function of the decorative architectural components, it can be found that there is at least a total of 8 out of 14 decorative architectural components of RLBP functioned as the air ventilation device. This air ventilation device existed in the panel form. The panel is made up of the perforated panel where it is either comprised of the direct piercing carving panel or lattice panel or panel with louvers fin. The surface of these panel was found to be comprised of both solid and void surface quality. It can be observed that the void surface of the panel allows the passage of air passing into the houses. The location and placement of this air ventilation panel was found to be located at the wall - *Lubang Angin Luar, Lubang Angin Dalam, Gerbang Luar,Pagar Musang Serambi,* window - *Kepala Tingkap, Pagar Musang Tingkap and* door - *Kepala Pintu Luar, Kepala Pintu Dalam.* It can be identifiable from the data that the placement of most of these decorative architectural components were found at the spaces that mostly occupied by the occupants such as the *Anjung, Rumah Ibu* and *Selang* of the RLBP house sample studied. The placement of the panel can be relatable to the function of the decorative architectural components as air ventilation device that ventilate the spaces by allowing the exterior fresh air to the interior of the house.

Table 1: Climatic Function – Air Ventilation Device

RLBP House Sample	Decorative Architectural Components of RLBP													
	TL	KCL	KCi	PC	LAe	LAi	GBe	GBi	PGa	PM	KT	PGb	KPe	KPi
House 1					n/a	X	X		X		X	X	X	n/a
House 2					X	X	X		X		X	X	X	n/a
House 3					X	X	X		n/a		X	X	X	X
House 4					n/a	X	X		X		X	X	X	X
House 5					X	X	X		X		X	X	X	X
House 6					X	X	X		X		X	X	X	X
House 7					X	X	X		X		X	X	X	X
House 8					X	X	X		n/a		X	X	X	X
House 9					n/a	X	X		X		X	X	X	X

Legends: TL- Tunjuk Langit, KCL- Kepala Cicak Type i, KCL- Kepala Cicak Type L, PC-Papan Cantik, LAe- Lubang Angin Luar, LAi-Lubang Angin Dalam, GBe-Gerbang Luar, GBi-Gerbang Dalam,
PGA-Pagar Musang Serambi,PM-Papan Manis,KT-Kepala Tingkap, PGb-Pagar Musang Tingkap,
KPe-Kepala Pintu Luar, KPi-Kepala Pintu Dalam, n/a - decorative architectural component not available.

This finding supports the statement by Hanafi (2007), Kamarudin (2015) and Mohd Nawayai et al. (2020), the carving panel that located at the wall and window of the exterior wall of the traditional Malay house helps to cool down the house by allowing the air to pass through the perforated panel as well as minimizing the penetration of sun light and glare from directly enter the house.

Sun Shading and Filtering Device

It appears from the analysis that there are at least four decorative architectural components of RLBP that function to shade and filter the heat and glare produced by the sun. This decorative architectural component is comprised of *Lubang Angin Luar, Gerbang Luar, Kepala Tingkap* and *Kepala Pintu Luar.* These components exist in the form of panel type where the panel is typically in the form of perforated panel. As suggested by Rashid et al. (2018), there are two types of perforation and incision in decorative elements of RLBP that comprised of carving type and lattice type of perforation. From the data collected, it can be confirmed that the perforation and incision type of the perforated panel of decorative architectural components of RLBP is comprised of either direct piercing carving panel or lattice panel. The characteristic of the perforation of the carving panel is comprised of both perforated (void) and solid, unperforated surface. The placement and location of these decorative architectural components can be found located at the exterior wall, window, and door. From the observation, it can be observed that the solid and void surface of the panel located at the exterior wall and window produced casted shadow during the day particularly when the sun light torch directly to the surface. As discussed by Denan et al. (2015), the function of the decorative architectural component is to shade and filter the heat and glare produced by the sun.

Table 2: Climatic Function – Sun Shading & Filtering Device

RLBP House Sample	Decorative Architectural Components of RLBP													
	TL	KCL	KCi	PC	LAe	LAi	GBe	GBi	PGa	PM	KT	PGb	KPe	KPi
House 1					n/a		X				X		X	
House 2					X		X				X		X	
House 3					X		X				X		X	
House 4					n/a		X				X		X	
House 5					X		X				X		X	
House 6					X		X				X		X	
House 7					X		X				X		X	
House 8					X		X				X		X	
House 9					n/a		X				X		X	

Legends: TL- Tunjuk Langit, KCL- Kepala Cicak Type i, KCL- Kepala Cicak Type L, PC-Papan Cantik, LAe- Lubang Angin Luar, LAi- Lubang Angin Dalam, GBe-Gerbang Luar, GBi-Gerbang Dalam,
PGA-Pagar Musang Serambi,PM-Papan Manis,KT-Kepala Tingkap, PGb-Pagar Musang Tingkap,
KPe-Kepala Pintu Luar, KPi-Kepala Pintu Dalam, n/a - decorative architectural component not available.

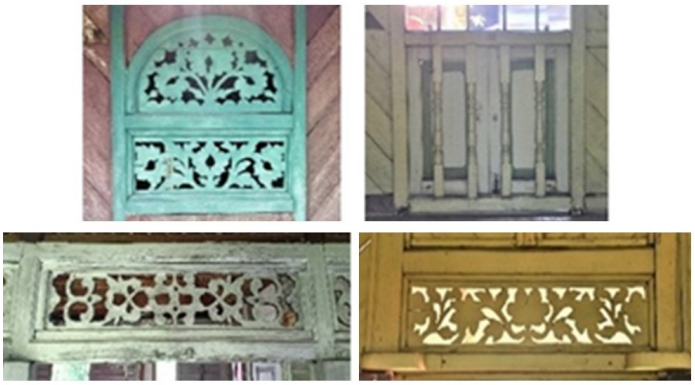

Figure 2: *Kepala Tingkap, Pagar Musang Tingkap, Kepala Pintu Luar* and *Kepala Pintu Dalam* (from left)

Figure 3: *Tunjuk Langit, Kepala Cicak i, Kepala Cicak L* and *Papan Manis* (from left)

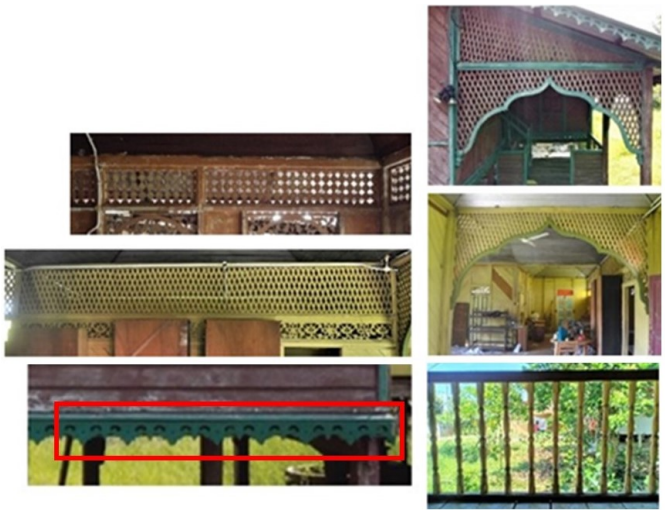

Figure 4: *Gerbang Luar, Gerbang Dalam, Pagar Musang Serambi, Papan Manis, Lubang Angin Luar,* and *Lubang Angin Dalam* (clockwise)

Weather Protection Device

The analysis of the research shows that there are three decorative architectural components that function as a weather protection device in RLBP house. These decorative architectural components are comprised of Kepala Cicak Type L (KCL), Kepala Cicak Type i (KCi), Papan Cantik (PC) and Papan Manis (PM). All of these decorative architectural components exist in the panel form where the form of the component is carved with simple direct piercing carving. From the placement of the decorative architectural components, it can be understood that KCL is located at the corner of the roof. This relates to the function of KCL – as a panel to cover the tip and corner of the roof rafter from water seepage produced by the rain. Meanwhile, KCi is located at the edge of the roof. It is placed at the centre of the roof apex where the panel functioned to cover the bare end of the roof ridge from direct exposure to the rain that might cause the edge of the ridge to get wet and rot over the time. PC and PM panel carry almost similar function to both KCL and KCi. PC panel function to cover the edge of the roof rafter ending at the roof eaves from water seepage caused by the rain. Whilst PM panel that is located at the bottom of the wall, at the edge of the floor rafter, function to cover the floor rafter from direct exposure to the rain and water seepage. Looking from the analysis, it can be understood that all of these decorative architectural components share almost the same function which to protect and shield the major structure of the house such as roof ridge, rafter and floor rafter from water seepage produced by the frequent tropical rain. These

decorative architectural components typically placed at the end of the structure that equal to the function of a cap. As explained by Hanafi (2007) and Yuan (1987), water seepage will encourage the exposed timber to rot, therefore panel such as *Papan Cantik, Papan Pator* or *Papan Manis* (PM) is commonly used as a weather board to shield the house structure from the rain.

Table 3: Climatic Function - Weather Protection Device

RLBP House Sample	Decorative Architectural Components of RLBP												
	TL	KCL	KCi	PC	LAe	LAi	GBe	GBi	PGa	PM	KT	PGb	KPe	KPi
House 1		X	X	X						X				
House 2		X	X	X						X				
House 3		X	X	X						X				
House 4		X	X	X						X				
House 5		X	X	X						X				
House 6		X	X	X						X				
House 7		X	X	X						X				
House 8		X	X	X						X				
House 9		X	X	X						X				

Legends: TL- Tunjuk Langit, KCL- Kepala Cicak Type i, KCL- Kepala Cicak Type L, PC-Papan Cantik, LAe- Lubang Angin Luar, LAi-Lubang Angin Dalam, GBe-Gerbang Luar, GBi-Gerbang Dalam,
PGA-Pagar Musang Serambi,PM-Papan Manis,KT-Kepala Tingkap, PGb-Pagar Musang Tingkap,
KPe-Kepala Pintu Luar, KPi-Kepala Pintu Dalam, n/a - decorative architectural component not available.

CONCLUSION

From the findings found in this research, it can be concluded that the decorative architectural components design of RLBP is comprised of a climate responsive design. The findings add up and strengthened the existing past research where the decorative architectural components, does not only add up to the aesthetic values of the house but also functioned as a climatic device that not only ventilate, and shade the house but also protect the structural members of the house from damage caused by the weather. This has been proven from the findings of the analysis on the design attributes of the decorative architectural components that have been analysed from its form type, form perforation and incision type and its placement that is relatable to the function of the decorative architectural components. Decorative architectural components of RLBP does not only function as air ventilation panel and sun shading and filtering panel, but also it functions as weather protection panel. This research finding is hoped not only to strengthen and add up to the existing literature in establishing the responsive design character of the traditional Malay house architecture, but the features can be adapted to the sustainable and green design building design features planning for a modern house. This will help the design of the modern house to become more sustainable and energy efficient so it can be part of the effort in helping to reduce

the energy consumption of the domestic residential sector for a better and greener future.

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