CONSTRUCTION ANALYSIS OF HOUSING'S ROOF IN GORONTALO CITY

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ABSTRAK

Sebuah penelitian dilakukan untuk menganalisa konstruksi atap-atap perumahan di kota Gorontalo, Indonesia. Pengamatan terhadap perumahan dilakukan menggunakan google maps dan streets. Sejumlah 12 tipe atap ditemukan setelah menyurvei 30 buah perumahan. Konstruksi ke 12 tipe atap ini diteliti menggunakan metode analisis deskriptif. Bentuk atap, denah, jumlah bidang atap, arah hadap atap, tinggi tiang kuda-kuda, dan keberadaan jurai luar dan jurai dalam merupakan faktor-faktor dalam menganalisa atap-atap perumahan. Hasilnya adalah atap pelana bersusun merupakan bentuk atap yang paling banyak ditemukan pada 27% dari total jumlah perumahan. Atap pelana bersusun memiliki jumlah bidang atap yang sedikit, jenis kuda-kuda rangka atap yang juga sedikit, dan tidak memiliki jurai luar dan jurai dalam, sehingga dipertimbangkan sebagai bentuk atap sederhana jika dibandingkan dengan bentuk-bentuk atap lainnya. Bentuk atap ini juga merupakan konstruksi yang lebih disukai oleh pengembang perumahan karena mudah dibangun, menghasilkan sedikit sampah sisa material, dan biaya konstruksi yang lebih rendah.

Kata kunci: Atap, Bentuk, Perumahan, Konstruksi, Gorontalo

ABSTRACT

An investigation of housing's roof in Gorontalo city, Indonesia, is conducted to analyze the construction. Observation of the housing is done utilizing google maps and streets. Twelve roof types are obtained from surveying 30 housings. The construction of 12 roof types is examined by employing descriptive analysis method. Roof shapes, floor plan shapes, the number of roof planes, surface orientations, truss post height, and the presence of hip and valley, are the factors in analyzing the housing roofs. It is found that stacked gable is the popular roof type found in 27% of the housings. Stacked gable roof has fewer roof planes, fewer truss types, and has no hip and valley, therefore it is considered a simple roof shape compared to the other housing roof types. The roof is also a construction prefered by the housing developers since it is easier to be assembled, produce less waste and low cost in its construction.

Keywords: Roof, Shape, Housing, Construction, Gorontalo

1. INTRODUCTION

Roof is a part of building envelope which act as the head of a building. Roof functions as to withstand the force of the wind, to block the heat from the sun and maintain room temperature, and to avoid of rain water entering the room. (Maulana, 2011).

The roof shape, inclination, and orientation, are the factors in contributing to the aesthetic value of the building façade. Building's characteristic is defined by the roof shape. For example, the difference between housing, shophouse, and offices can be distinguished by the roof shape. Roof has an urbanism aspect (Hossein Soltanzadeh, 2014) which able to differentiate between building in the rural and urban area.

In the context of a city, roof shape has an important influence to reduce noise of road traffic from a street canyon to an exposed façade of neighboring building (Van Renterghem & Botteldooren, 2010). The roof can influence the pollutant concentration in a city. The concentration increased as the roof height decreases. It also decreased on the roof constructed with slanted and trapezoid-shaped roofs, but increased on the flat-shaped roof. (Yassin, 2011). Shape, angle and height of the roof are the most importance factors to assess air quality in urban an environment (Ferrari et al., 2019; Liu et al., 2019; Yassin et al., 2022)

Roof shape contribute to the energy performance of a building. A domed roof is more energy efficient compared to pitched roofs, flat, and vaulted roofs. Its indoor temperature is also cooler. In case of the wind flow pattern, the flow around domed and pitched roofs is more complex where differences in the wind velocity and wind pressure are noticeable compared to the other roof types.(Mahdavinejad & Javanroodi, 2016). Among the pitched roofs, hip

shaped roof is better in providing more thermally comfortable condition in the residential building. (Rury, 2016)

In residential building construction, building envelopes make up the major proportion of the materials, with walls contributing 46% and roofs 16% (Tiwari & Parikh, 1995). Meanwhile roofs traditionally correspond to about 3-8% of total project cost (Ulubeyli et al., 2014). Gable roof shape is the most economical of all the pitched roof shape. (Rury, 2016).

An article claimed that common types of roofing for residential buildings in Indonesia are Reinforced Concrete flat-roof and clay roof tile (Setiawan et al., 2015). But, for some region such as Gorontalo in Sulawesi Island of Indonesia, most of the roof covering is metal roof such as zincalume or metal tile, since it is more affordable and also uses less roof structure in the construction process.

This article review some of the roof shapes in the housings of Gorontalo city. The research aims to analyze the roof construction. The result is expected to disclose the common housing roof construction and more information regarding the assembly.

2. METHODOLOGY

To achieve the aim of the research, some measures are taken. The first is field observation of housings in Gorontalo city. Survey is conducted through online surveillance, employing google maps. By inputing the keyword "housing", 30 housings location in Gorontalo city is obtained.

Regarding the floor area, housing is categorized into several types ranging from the 36 m^2 which has 2 bedrooms, 48 m^2 which has 3 bedrooms and so on. Since the data is taken through online observation, there is no confirmation on the observed housing's area. This research focuses more on the roof shape and assumes all the housing area are the same.

The roof shape is explored further through google street view. Then, the roof is drawn and modeled in 3D program. The roof shape is then analyzed and classified. The research employs descriptive analysis method. Floorplan analysis of the housing is conducted to learn the relation between the floorplan and the roof shape since the roof perimeter is defined by the floorplan. Construction analysis of the roof breakdown the roof into variables such as the roof shapes, the number of roof surfaces, roof orientations, variety of truss post height, and the presence of hip and valley.

Common roof shapes found globally are gable, hip, shed/skillion, mansard, gambrel, dutch, curved, dome, and flat roof. Roof perimeter follows the floorplane perimeter. Therefore, a complex shaped floorplane will also has a complex shaped roof. The combination of roof shapes can be found on the complex shaped floorplane. Gable and hip are the common roof shapes found in Indonesia. They are both usually combined together to form a complex roof shape. The difficulty of constructing a complex roof shape is higher than a simple shape, since there are more planes, difference of roof post heights, and the presence of hip and valley.

Simple gable roof has 2 planes, hip has 4 planes. The combination of both of them will develop more than 4 planes. More surfaces on roof means more work in the construction process thus raising the difficulty level in assembling the building.

Combination of roof shape will result in the emergence of intersections between the shapes. The intersection forms a valley, where the rain water falling from 2 roof planes meet. See figure 1 for more details of the valley and roof parts. The presence of valley requires the installation of rain gutter below the valley, hence making the roof construction more complicated. A hip roof has a hip or the edge where 2 roof planes meet and should be covered as to prevent rain water leak into the building. The presence of hip and valley adding more difficulty to the roof construction.

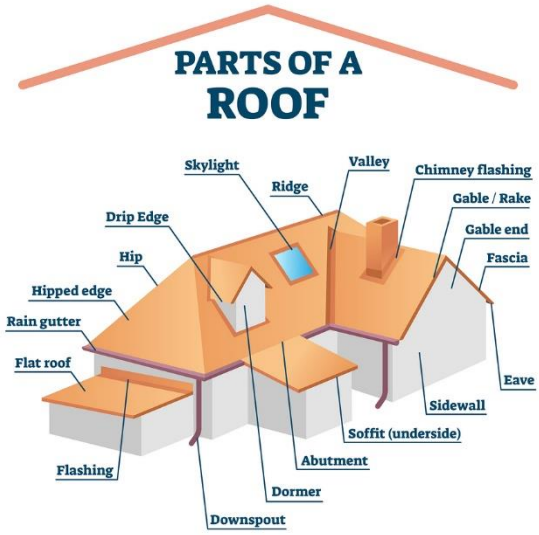


Figure 1. Roof parts (bigstockphoto.com)

The height of a roof's ridge depends on the roof's slope and the building span. Larger inclination angle and building span result in higher ridge. The ridge defines the truss posts' height. A complex shaped floorplan tends to have variety of building width, consequently the roof's height also varies on each of the spans.

These variables formulating the complexity of the roof construction. The more complex roof is the one which is more difficult to be built. The more the number of roof's surfaces, planes, orientations, truss post height, and the hip and valley, the more complex the roof shape is. Finally, the level of complex roof construction is determined as simple, moderate, and complex roof, based on the variables above.

3. RESULT AND DISCUSSION

3.1. Observation Result

Observation on 30 housings in Gorontalo city resulting in the finding of 12 typical roof shapes. All of the roof shapes are presented in table 1 along with the number of surfaces, orientations, truss post height, and the presence of hip and valley.

Some of the roof shape can be found in most of the housings which mean there are popular roof shapes among the other found shapes. The most popular roof shapes are stacked gable (number 2) which can be found in 8 housings. Following stacked gable are gable (number 1) and gable with terraces (number 5 and 6). Both of them found in 4 housing respectively. Figure 2, 3, and 4, present the housing employing the simple, moderate, and complex roof shapes. Metal tile roofing are utilized as the roof covering.

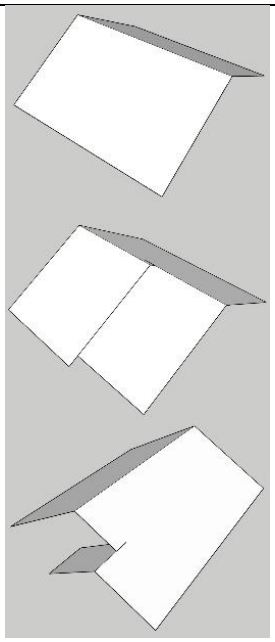
Figure 2. Stacked gable roof (source: author)

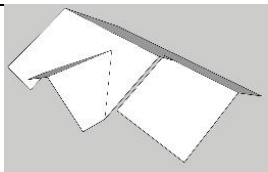
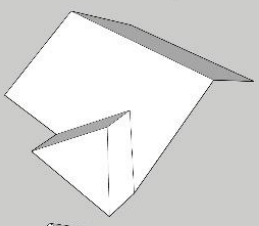
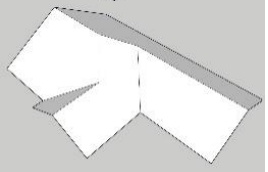
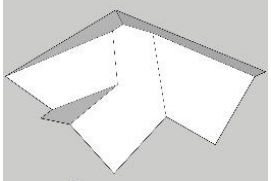
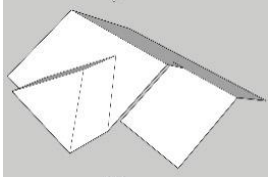
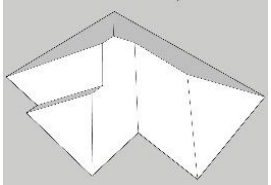
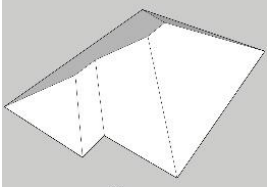
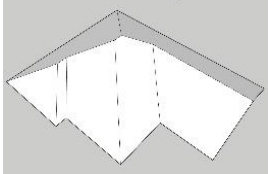
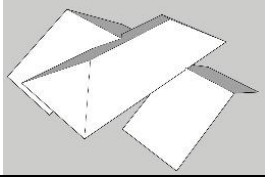
Figure 3. Stacked gable roof with terrace (source: author)

Figure 4. Hip roof with terrace (source: author)

All of the roof shapes are pitch roof. Some housing has small flat concrete roof to cover the terrace. Gorontalo is located in Indonesia, a tropical climatic region. Pitch roof is employed to deal with the heavy precipitation rate. Rain water should be shed quickly to the ground as to prevent build up of water on roof which would promote leakage into the building.

Tabel 1. Comparison of housing roof shapes.

No	Roof Shape	Drawing	Floorplan Shape	Surfaces	Orientations	Truss post height	Hip/ valley	Category
1	Gable		N	2 planes	2 ways	1 type	Not found	Simple
2	Stacked gable		N	3 planes	2 ways	2 types	Not found	Simple
3	Gable with terrace		N	3 planes	2 ways	2 types	Not found	Simple

No	Roof Shape	Drawing	Floorplan Shape	Surfaces	Orientations	Truss post height	Hip/ valley	Category
4	Stacked gable with terrace		L	5 planes	4 ways	3 types	Valley only	Moderate
5	Gable with terrace		N	5 planes	4 ways	2 types	Hip and valley	Moderate
6	Gable with terrace		L	5 planes	4 ways	3 types	Hip and valley	Moderate
7	Hip with terrace		L	6 planes	4 ways	3 types	Hip and valley	Complex
8	Gable with terrace		L	5 planes	4 ways	3 types	Hip and valley	Moderate
9	Hip with terrace		L	8 planes	4 ways	3 types	Hip and valley	Complex
10	Hip with terrace		N	6 planes	4 ways	2 types	Hip and valley	Moderate
11	Hip with terrace		L	7 planes	4 ways	3 types	Hip and valley	Complex
12	Hip and gable		L	8 planes	4 ways	3 types	Hip only	Complex

3.2. Typical Floorplan

The roof shapes are made and influenced by the floorplan shape. Analysis of the roof shapes found in the field observation shows that the roof is covering some typical floorplan shape. They are N-shaped floorplan type and L-shaped floorplan type as

can be seen in figure 5, and 6. The N-shaped floorplan arranged the rooms more in a slender shape, while the L-shaped floorplan is wider. Housing applying the N-shaped floorplan usually has more available area at the side of the house in a housing lot. While the L-shaped floorplan has more available area in its front.

L-shaped floorplan will have more complicated roof shape since it has more variety in building span, and ultimately more complex roof construction. The N-shaped floorplan is more commonly found in housing since the stacked gable, gable, and gable with terraces are the popular roof shapes.

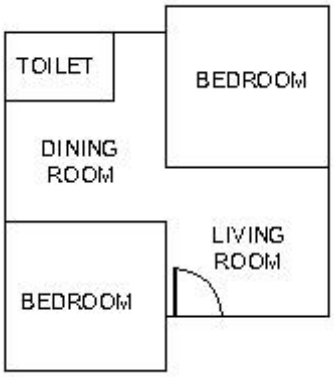


Figure 5. N-Shaped Floorpan

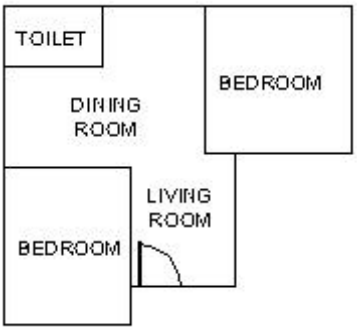


Figure 6. L-Shaped Floorpan

3.3. Dedicated Terrace Roof

Some housings have dedicated small terrace roof but still adjacent to the main roof. The terrace roof is small since the roof area is also small. In some of the simple roofs, the terrace is covered by the main roof. By enlarging the roof span or extending the roof length to the front, the main roof able to cover all of the terrace area. Roof shapes covering the L-shaped floorplan usually have this dedicated terrace roof.

3.4. Solar Heat Gain

The more directions the roof planes can face, olar heat gain on the roof will be more distributed. A simple gable roof facing both East and West is the worst example of solar heat gain on the roof. A simple hip roof faces 4 directions, therefore, the North and the South planes will be shaded when the Sun is leaning toward the South in December and toward the North in June. This is why the hip roof able to provide more comfortable condition in the building thermally.

3.5. Aesthetic Value

Compared to the simple roof, complex roof has more shapes and lines. This complexity turned the roof into a more interesting view than a boring simple roof shape. The complex shape can provide different sight when observed from different angle. There are some regular shapes such as square, triangle, parallelogram, and trapezium found on simple roofs. But in complex roof shape, the irregular shapes emerge. The irregular shape for example produced by the intersection between roof planes as can be seen in figure 7.

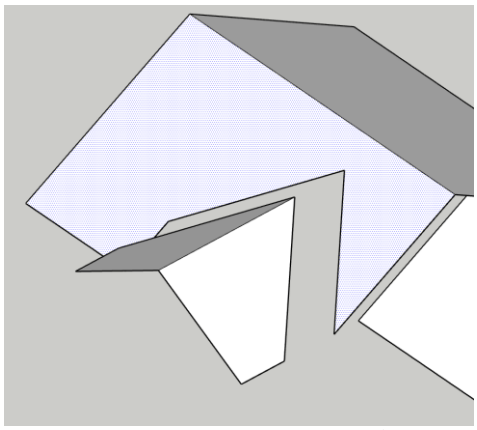


Figure 7. Rectangle plane cut by by gable roof

3.6. Material and Labor Cost

A simple gable roof has only 2 planes, 1 truss type, and no hip and valley. All the planes on the gable roof are rectangle. Considering metal roofing as the roof cover is rectangle shaped, less material is going to be trimmed. Metal roof on hip roof and at the intersection between 2 planes need to be trimmed to create the shape of triangle or trapezium. Ultimately the gable roof is producing less waste than the hip or the complex roof.

A moderate and complex roof has many truss types which vary in the height. The more truss type a construction have, the more time it takes to assembly the trusses. Not to mention to assembly the hip and valley. Consequently, the time-consuming process demand more labor cost. In conclusion, as what the said research above, gable roof is more economical than hip roof.

4. CONCLUSION

An observation of housing roofs in Gorontalo city is conducted to analyze the construction. Online survey using google maps and google street result in the finding of 12 roof shapes from 30 housings. The number of planes, surface directions, trusses post height, and presence of hip and valley become the variable to determine the construction difficulty. The roof shapes can be grouped into 3 types according to the difficulty of construction, namely simple, moderate, and complex construction.

Stacked gable is the popular roof shape found in 27% of housings in Gorontalo city. The roof is simpler to be constructed, and require less cost. Since simple gable shape is lacking in visual, the roof is modified into a stack to generate a more pleasing view. Therefore, this type of roof is preferable by housing developers.

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