Wood and steel as a material alternative of concrete replacement in house structures in Merauke city

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Abstract. Concrete is a building material that is generally widely used as a house structure material in Indonesia. This is very possible considering that the concrete forming material consisting of sand, cement, and gravel is a material that is available in nature and is relatively easy to find. But in certain areas such as in Merauke, there are no materials such as gravel and sand so wood and steel are alternative substitutes for concrete. This study aims to analyze and compare two types of semi-permanent houses that use different materials on the main structure, namely wood material, and steel material. This research is qualitative research with the following stages of research, namely determining the home mouse sample, interviewing people who are considered to have competence in the field of architecture and direct field observation. The results showed that in terms of costs, semi-permanent wood houses were relatively cheaper compared to semi-permanent steel houses. In terms of the appearance of the building, steel material has more advantages, namely not shrinking so that cracks that occur on the wall due to shrinkage of the material as happened in semi-permanent homes of wood can be minimized.

1. Introduction
Concrete is a building material that is generally widely used as a house structure material in Indonesia. This is very possible considering that the concrete-forming material consisting of sand, cement, and gravel is a material that is available in nature and is relatively easy to find in several regions in Indonesia. In addition to its easy availability, concrete also has other advantages, namely ease of use and the ability of the concrete to adapt so that monolithic concrete does not require a connection like steel [1].

Merauke is one of the districts with a fairly rapid rate of economic growth in Indonesia, this is indicated by the increasing number of people from other regions who come to Merauke to invest and work and open businesses. With the economic growth also caused the population growth, the need for housing as one of the basic human needs in addition to food and clothing has also increased. The increasing demand for housing is inversely proportional to the availability of the material in the city of Merauke. As it is known that to get sand and gravel with good quality, the material must be imported from outside the area such as Palu, Makassar, and Surabaya. This causes the price of sand and gravel to be very expensive. Based on the AHSP Dinas Pekerjaan Umum dan Penataan Ruang Merauke Regency, The cost of 1 m3 concrete of f’c 19.3 or equal to K 225 (standard quality of concrete most used to house construction) is IDR 2,930,895.00 [2]. The high price of concrete has
triggered the community to look for alternative concrete replacement materials for simple house structures.

Research on the quality of concrete using local sand has been carried out before and resulted in compressive strength and tensile strength of concrete using local aggregates of lower strength, this can occur because local aggregates have a greater absorption capacity, so cement water must be distributed evenly in the mold and strengthen cement paste is absorbed into the aggregate granule, so that the strength of the concrete is not evenly distributed [3].

Kancingan house is a house that uses wood as the main structure but uses brick as a wall material. In addition to using wood as a concrete substitute material, now some houses try to use steel as a commonly used concrete column replacement concrete material.

2. Methods
This research is a qualitative research with the following research stages determining the sample of the rumah kancingan, interviews with people who are deemed to have competence in the field of architecture and direct field observation.

2.1. Research sites
This research was carried out in the city of Merauke by taking several samples of semi-permanent houses that use wood and semi-permanent houses that use steel as the main structure.

2.2. Research samples
This study uses several samples of semi-permanent houses of wood scattered in Merauke City and semi-permanent houses that use steel located in the housing of PT. Simpati is on Jalan Blorep, Merauke

2.3. Research purposes
This study aims to analyze and compare two types of semi-permanent houses that use different materials on the main structure, namely wood material and steel material.

3. Result

3.1. Semi-permanent houses use wood as the main structure

![Figure 1. Picture of semi-permanent house’s section that uses wood as a structural material](image)
Figure 1 shows a picture of semi-permanent sections of the wood house which shows that wood is the main structure that carries the burden of the building. The wood column used is a wooden block measuring 8/8 cm usually made of meranti wood which is wood with a quality class II wood category. Generally, semi-permanent wooden houses or commonly called Kancingan houses do not have sloof, although there are some houses that still use sloof to tie the foundation and hold the load of the wall. The connection between wood columns and foundations is anchor which is planted on foundation or sloof.

Figure 2 shows the wall material used, namely brick, but because the wood column whose dimensions are only 8/8 cm thick is a brick wall that is 5 cm thick with 1.5 cm thick plaster on two sides of the wall. To strengthen the walls so that the walls are more sturdy, stable and not fractured, the walls are reinforced with a 4/8 cm regel beam. this regel beam functions the same as a practical column on a concrete permanent house.

Figure 3 shows the process of installing mirplat beams. Mirplat beam is a beam that serves as a ring bALK of wood 4/8 cm, which is the place to support the roof frame and channel the load of the roof to
the building column. The frame of the truss commonly used in semi-permanent houses (wooden Kancingan) is the framework of wooden truss 5/10. Like most frame truss in residential construction, the roof truss in this building is also in the form of construction consisting of transverse beams (which receive tensile forces), beams as supports or poles (which receive compressive forces) to support and line and rafters and roof coating [4].

3.2. Semi-permanent houses use steel as the main structure

The steel structure is a structure made of steel components that are interconnected to distribute loads and provide rigidity. Because steel has a large tensile strength compared to concrete, steel is often used as a building material for industrial buildings, bridges and other high-rise buildings. Because steel has high ductility, the steel material is combined with concrete to get high tensile strength in the building structure.

Profile C is a profile of cold-formed which has a large ratio of width and thickness (b / t). This profile is called a profile that is not compact and will be very easy to bend [5]. Profile C, which is commonly used as gording, has now been developed into the main structure of the building.

![Figure 4. Picture of a semi-permanent house that uses steel](image1.png)

Figure 4. Picture of a semi-permanent house that uses steel

![Figure 5. Picture of the process of making Sloof in a semi-permanent house using steel](image2.png)  ![Figure 6. Picture of the process of making brick walls in a semi-permanent house that](image3.png)

In figure 4, shows the semi-permanent buildings that use steel construction. The type of steel used in this house is CNP (LIP Chanel) steel 10.50.20.2.3 with a length of 6 m and weighing 24.4 kg each. The column is 3 m away considering that this house is a simple type 36 m² house so the building's grid is 3 m. As in the wooden house, brick walls are reinforced with dividing columns and practical beams to strengthen the walls and reduce cracks in the walls. The wall thickness of a semi-permanent
steel house is 15 cm (1/2 brick), just like a permanent house that uses concrete as its main structural material.

Unlike the case with semi-permanent houses with wooden structures, in semi-permanent steel houses, the foundation is reinforced with sloof which uses concrete material reinforced with the main reinforcement using iron Ø10 and begel Ø8-15 cm. (figure 5). The connection between CNP steel columns and Sloof uses anchor which is planted in Sloof.

In figure 6, a house ringbalk is made of CNP steel with the same specifications as the building column. Ringbalk is the one that binds each column and becomes the place where the horses meet. The horses are made of CNP (LIP Chanel) steel 10.50.20.2.3. For recording the roof uses mild steel 41.31.16 mm

4. Discussion

Table 1. Comparison of semipermanent wood and steel house structures

| Material type structure | Foundation | Column | Wall | Ringbalk | Roof |
|-------------------------|------------|--------|------|----------|------|
| Wood                    | Using Batubata without Sloof | Wood 8/8 | ¼ brick | Mirplat Beams 4/8 | 5/10 wooden frame truss and 5/10 wood gording |
| Profile C Steel         | Using batubata with concrete sloof which is reinforced with reinforcement | Profile C Steel 10.50.20.2.3 | ½ brick | Profile C steel truss 10.50.20.2.3 with light steel gording 41.31.16 |

From table 1 it can be seen for the type of both foundation of the semi-permanent house structure, both using the foundation of the pair of brick which are made in a shape like a trapezium as generally the shape of the continuous foundation of the building. The only difference lies in the Sloof, in semi-permanent houses that use wood, the column structure rests on the foundation by using the anchor as a binder of the foundation with the column. In semi-permanent steel houses, the structural column rests on the sloof using the anchor as a column binder with sloof. The use of anchor as a binder is needed considering that both semi-permanent structures of wood and semi-permanent steel are not monolithic structures such as concrete. The main structure of semi-permanent houses is wood using 8/8 size wood columns which are reinforced with a 4/8 regel beam so that the column can stand to become more rigid and stable. For ringbalk where the truss frame rest on, use wooden blocks with the same dimensions as the column structure. In general, construction of Kancingan houses is capable of bear the loads that works on buildings. The roof load distribution is carried out by ringbalk and columns fulfilling the predetermined requirements, this is possible because the wood used has resistance to loading due to the mechanical properties of wood which also has compressive strength and tensile strength [6].

The main structure of semi-permanent steel houses uses CNP steel columns 10.50.20.2.3 which are then reinforced with practical columns which are also made of steel. Unlike a practical column in a permanent house that uses concrete structures, the distance of columns and practical beams to the structure of semi-permanent houses is more tightly steel, which is around 1-1.5 m. a tight distance is needed so that there is no failure of stability such as steel that experiences bending and twisting.

In terms of the appearance of the building, semi-permanent houses of wood and semi-permanent steel have the appearance of a permanent house in general because the walls of the building use brick. But in semi-permanent houses, wood, wood and brick ties on the Kancingan house which are the main problems in terms of aesthetics, Because wood which is an organic material will experience shrinkage
and deformation and this is what greatly disrupts the appearance of building walls [7]. Whereas in semi-permanent steel houses, the cracks in the walls are less because the nature of steel is more homogeneous with cement and sand and also does not occur in steel shrinkage.

In terms of costs, semi-permanent wood houses is cheaper to develop compared to semi-permanent steel houses because semi-permanent houses use lesser brick and cement and sand because the walls are only as thick as ¼ brick with thinner plaster compared to the walls in semi-permanent houses steel with ½ brick thick walls and 2.5 cm plaster to cover CNP steel structures (profile C) to avoid corrosion which can damage the structure.

5. Conclusion

Based on research by comparing two types of concrete replacement materials in the structure of houses in Merauke, it can be concluded that each of the types of semi-permanent houses has advantages and disadvantages because wood and steel materials have advantages and disadvantage itself. These two types of structures are fairly cheap and easier to implement in the field compared to permanent houses of conventional concrete construction so that they can be used as alternative concrete replacement materials that are more environmentally friendly. For next research, it is necessary to compare the feasibility of the structure of these two types of semi-permanent structures.

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