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Innovative Use of Wood and Steel in Concrete

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ABSTRACT
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. In this paper we will discuss Innovative Use of Wood and Steel in Concrete.

Keywords*: Wood, Steel, Concrete, Materials, Innovative, Cement, Sand, Building material, Structural engineers, Construction, Ceramic composites, Brick*

Introduction
Concrete is a building material that is commonly utilised in Indonesia as a house structural material. This is quite likely given that the concrete-forming ingredient of sand, cement, and gravel is a natural substance that is relatively easy to find in numerous locations of Indonesia. Concrete, in addition to its simplicity of availability, has additional advantages, such as convenience of use and the flexibility of the concrete to adapt such that monolithic concrete does not require a connection like steel [1].

Wood is an essential component in construction. It is a versatile building material because it can be found almost anywhere. Because it was more efficient than hauling other materials all the way from Europe, early immigrants in North America utilised wood to create log homes. Wood as a construction material did not necessitate the use of complex tools. Wood was the most dependable building material available at the time. Because wood is so dependable, structures erected over 800 years ago are still standing today. Looking back in time, wood is still the primary method for building houses today. However, a fresh material became accessible after some time. Concrete was employed in various ancient civilizations, including Rome and Egypt, where resources were rare and wood was unavailable. Concrete is commonly utilised today in basements, bridges, and huge industrial structures since it is one of the most impermeable and cost-effective materials available.

Looking around, one could argue that concrete and steel are the most often utilised building materials in construction today. Concrete, unlike wood, is produced using unsustainable methods. Concrete cannot be retrieved and is left where it is demolished, whereas wood can be broken down and reused. Steel is the most recently developed of the three materials. Steel became a popular building material during the industrial revolution due to its durability. During this time, most people began switching from building with wood to steel. With society's current knowledge, we know that wood is the best option in terms of sustainability. The progression of concrete and steel may not lead down the most sustainable path. [2]

Review of Literature:
The embodied energy content of each building material varies greatly, particularly concrete, because cement manufacture is extremely energy and fossil fuel intensive, making it a leading contributor to global warming (Shams et al, 2011). [3]

These findings are important for architects, structural engineers, constructors, and building owners who want to forecast environmental implications during the life of a facility. The life cycles of building materials must be better understood before their environmental impact can be decreased, and have proven to be an effective tool in resolving crucial issues about contemporary public concerns, such as greenhouse gas emissions (Hsu, 2010). [4]

Wood is a material that may easily be utilised for building and requires minimal energy to reclaim. If the wood has not rotted away, reclaimed wood, the term used for removed timber from historic constructions, can be extracted underwater. [BJ1] One advantage of using recycled wood instead of fresh new wood is that we may utilise larger pieces of lumber when new wood cannot grow as tall owing to time constraints. When new wood begins to dry out, it also needs time to shrink into its size. Reclaimed wood, on the other hand, can be significantly more reliable than new wood (Erhlich, 2011). [5]

When discussing elements that focus on sustainability, professionals frequently take the manufacture of a building material into account. This factor is evaluated using the LCA. Some building materials, such as steel, are more difficult to produce and contribute more to overall material consumption because they are fundamentally nonrenewable resources (Kim et al, 1998). [6]

Objectives:

- It is an environmentally friendly building material.
- It is a concrete substitute that is stronger than traditional Portland cement.
- Concrete is used in the construction of structures to give strength, durability, and versatility.

Research Methodology:

This study's overall design was exploratory. Concrete is offered as a locally available material for building a low-cost housing suitable for persons of various economic backgrounds. It is an Argonne material similar to shotcrete or ceramicrete, which is a ceramic-concrete blend used in spray-foaming concrete. Grancrete's ceramic composites and biodegradable components give strength to produce a very sturdy house structure. It is a spray that can be used with any aggregate, transforming a simple wooden panel sprayed with grancrete into a highly robust concrete panel. [7]

Result and Discussion:

Wood & Timber:

Wood has been utilised as a building material in its natural state for thousands of years. Engineered wood is becoming increasingly popular in developed countries.

Wood is a byproduct of trees and other fibrous plants that is utilised in building when it is chopped or pressed into wood and timber such as boards, planks and similar materials. It is a generic building material that may be used to construct almost any sort of structure in most climates. Wood is extremely strong when compressed vertically and may be exceedingly flexible under pressures, retaining strength while bending. Even within the same tree species, different varieties of wood have a wide range of properties. This means that some species are more suited to certain uses than others. Quality is also determined by growing circumstances.

Except in the United States, where the term "timber" is used, "timber" is the term used for building. When raw wood (a log, trunk, or bole) is "converted" (sawn, hewn, split) into minimally-processed logs stacked on top of each other, timber frame building, or light-frame construction, it becomes timber. The biggest issues with timber structures are fire hazards and moisture issues. [Citation required]

Softwood is now utilised as a lower-value bulk material, whereas hardwood is typically used for finishing and furniture.

Historically, oak was used to build timber frame structures in Western Europe; however, Douglas fir has recently become the most common wood for most forms of structural building.

In rural locations, many households or towns have a personal woodlot where they grow and harvest trees to build with or sell. These lots are cared after in the same way that a garden is. This was far more common in pre-industrial times, when there were laws limiting the quantity of wood one could chop at one time to secure a supply of lumber for the future, but it is still a viable method of agriculture. [8]

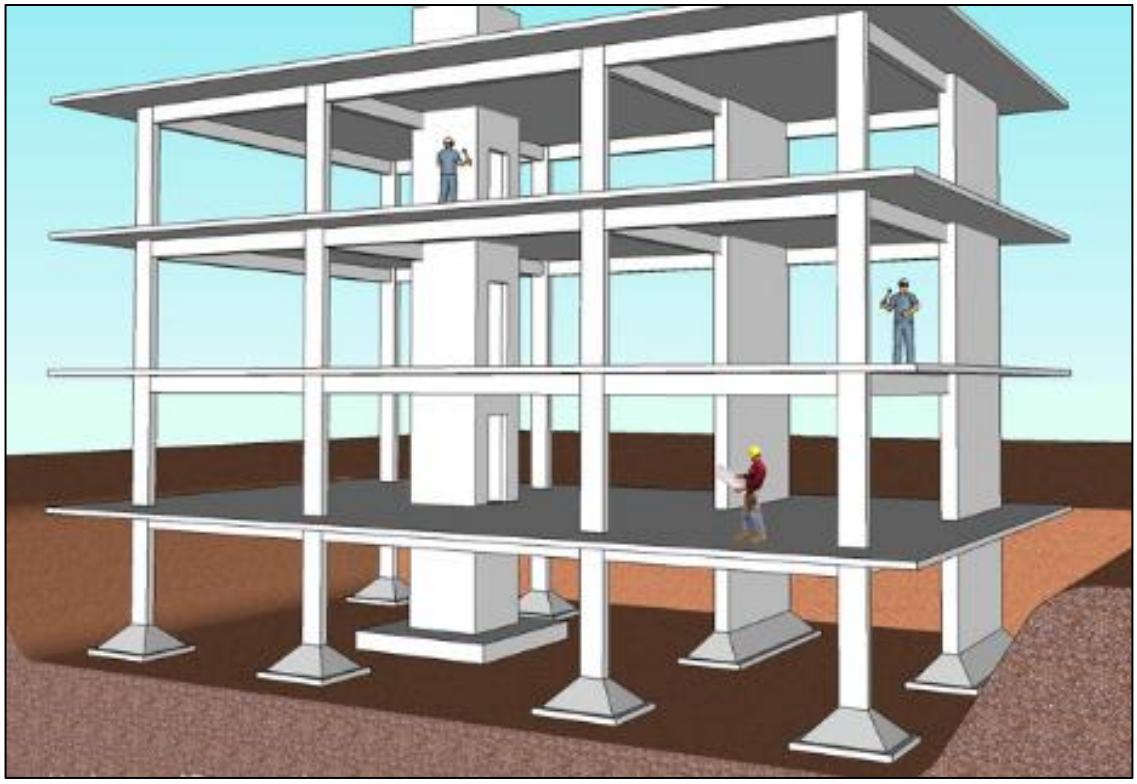
Figure 1: A Wood-Framed House

Concrete:

Concrete is a composite building material composed of aggregate and a binder such as cement. Portland cement concrete is the most popular type of concrete, consisting of mineral aggregate (usually gravel and sand), portland cement, and water.

After mixing, the cement hydrates and hardens into a stone-like substance. This is the substance alluded to by the term "concrete" in its broadest sense.

Because concrete has a low tensile strength, it is often reinforced with steel rods or bars (known as rebars) for any size building. Reinforced concrete is the name given to this strengthened concrete. A vibrator is used to expel any air that has been entrained when the liquid concrete mix is poured around the ironwork in order to minimise any air bubbles that might undermine the structure. Because of its durability, formability, and ease of transport, concrete has become the most popular building material in the contemporary era. Recent innovations, such as insulating concrete forms, combine concrete forming and other construction phases (such as insulation installation). All materials must be taken in the proportions specified by standards. [9]



Semi-permanent houses use steel as the main structure:

A steel structure is a structure comprised of interconnected steel components that distribute loads and give rigidity. Steel is frequently utilised as a building material for industrial buildings, bridges, and other high-rise buildings due to its superior tensile strength compared to concrete. Because steel has a high ductility, it is mixed with concrete to achieve a high tensile strength in the building construction. Profile C is a cold-formed profile with a high width-to-thickness ratio (b / t). This profile is known as a non-compact profile, and it will be very easy to bend. Profile C, which is frequently employed as gording, has now been evolved into the building's main framework.

Figure 2: Picture of A Semi-Permanent House That Uses Steel

Figure 3: Picture of The Process of Making roof In A Semi-Permanent House Using Steel

Figure 2 depicts semi-permanent buildings constructed of steel. CNP (LIP Chanel) steel 10.50.20.2.3 with a length of 6 m and a weight of 24.4 kg was utilised in this house. Because this is a simple type 36 m2 house, the column is 3 m distant, and the building's grid is 3 m. Brick walls, like timber houses, are strengthened with dividing columns and useful beams to strengthen the walls and reduce fractures. Figure 2 depicts the wall thickness of a semi-permanent building that uses steel construction. CNP (LIP Chanel) steel 10.50.20.2.3 with a length of 6 m and a weight of 24.4 kg was utilised in this house. Because this is a simple type 36 m2 house, the column is 3 m distant, and the building's grid is 3 m. Brick walls, like timber houses, are strengthened with dividing columns and useful beams to strengthen the walls and reduce fractures. A semi-permanent's wall thickness. [10]

Table 1. Comparison of semipermanent wood and steel house structures

Material type structure	Foundation	Colomn	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 10.50.20.2,3	Profile C steel frame truss 10.50.20.2,3 with light steel gording 41.31.16

Table 1 shows that for the type of semi-permanent house structure, both use the foundation of a pair of bricks constructed in the shape of a trapezium as the overall shape of the continuous foundation of the building. The sole distinction is that in semipermanent dwellings made of wood, the column structure rests on the foundation by using the anchor as a foundation-to-column binder. The structural column of semi-permanent steel houses rests on the sloof, with the anchor acting as a column binder with the sloof. The use of anchor as a binder is required since both semi-permanent wood buildings and semi-permanent steel structures are not monolithic structures like concrete. The fundamental structure of semi-permanent houses is wood, with 8/8 size wood columns strengthened with a 4/8 regel beam to make the column stiffer and stable. Use wooden blocks with the same size as the column construction for ringbalk where the truss frame rests.

In general, the construction of Kancingan houses can withstand the loads that work on buildings. The roof load distribution is carried out by ring baulk and columns that meet the established requirements. This is feasible because the wood employed has load resistance due to its mechanical properties, which also have compressive and tensile strength.

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Conclusion:

Concrete construction is currently motivated by sustainability, durability, dependability, cost, human and environmental safety, and strength. Minimising micro cracks in concrete can be accomplished by using the appropriate binders and admixtures in the batching plant to improve concrete structure in an effective manner. Construction materials can account for up to 40% of the total cost of a project. 3D printing, 3D printed ceramics, pollution absorbing concrete, laminated timber, aluminium foam, bamboo reinforced concrete, bio-receptive concrete, bricks formed from pollutants, plaited microbial cellulose, super plasticizers, and other new construction materials are examples. The development of Super Ductile Rebars for usage during earthquakes is an

example of a construction material innovation. Success stories in the domain of converting garbage to wealth have been documented. Construction materials can account for up to 40% of the total cost of a project. More importantly, the use of innovative construction materials should be based on meeting some of these criteria, such as sustainability, durability, dependability, safety, economy, improved quality, enhanced mechanical and physical properties, flexibility in extreme conditions and locations, simple assembly, and environmental friendliness. This study provides the construction industry with the most recent information on a variety of new construction materials on the market. This will help to expand the construction materials database.

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