Comparison structure and construction of Husein Sastranegara International Airport terminal and Kertajati International Kertajati terminal in West Java

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Abstract. The need for air transportation increases every year. Indonesian government is on a never-ending construction of airport infrastructure across new regional points to create equitable development. Airport is an infrastructure to connect between modes of transportation. One of the most important parts of airport is the passenger terminal. Passenger terminal requires a wide-span structural system in order to accommodate arrival and departure procedures without disturbing circulation. Large wide-span structure requires an effective construction system. This paper aims to describe wide-span structures in airport terminal buildings. The method used in this study is qualitative with comparative strategy, primary data are obtained by open interviews related to airport terminal data and the secondary data related to structure obtained by a variety of literature. Data are analysed by comparing structures and construction systems at two international airports that have different structure sizes and systems, namely Husein Sastranegara Airport and Kertajati Airport. The results of this study show that alternative choices of wide span structure systems are adjusted to the form concept and airport location.

1. Introduction

West Java is one of the widest provinces in Indonesia with an area of about 3537.78 ha the second widest in Java after East Java province. West Java's economic growth of 2019 was the highest in the last five years [1]. To support economic growth, West Java has two international airports namely Husein Sastranegara International Airport and Kertajati International Airport.

Airport, which is an area that offers air transportation activities, is required to have a terminal that can accommodate all the activities of all potential passengers. The activities in the terminal range from operational, administrative, and commercial activities. To fulfill the activities on the terminal building a wide span of structure is required. Wide-span structure is selected to allow the use of column-free space for passenger circulation upon arrival and departure t is not interrupted. According to the journal “Study of the concept of cable structures and structural behavior in wide span system” written by Saman Siavashi and Mahsa Rostami, Wide span structures can be loosely defined as building enclose large areas without any intermediate support [2].

The selection wide span structure in every airport should be precise according to its function and capacity so as not to cause problems of excessive space. Wide-span structure has varied shapes and sizes that is appealing to compare. For example, Husein Sastranegara International Airport uses a reinforced
concrete structural system that is installed tilted following the form of a triangular roof while Kertajati International Airport uses an iron frame structure system that is arranged forming the roof.

1.1. Research objectives
This research aims to obtain information regarding structure and construction systems that is suitable for airport terminals in terms of size, location, and construction system impacts on the surrounding environment which is beneficial for other airports construction by comparing structural and construction.

1.2. Research benefits
The Benefit of the research is to provide knowledge about the selection of structural and construction systems for of airport terminals use.

2. Literature study

2.1. Definition of comparison
The meaning of comparison according to Indonesian dictionary is several case studies to compare. Comparison research is a kind of descriptive research that seeks a fundamental answer to causation, by analyzing the factors causing the occurrence or emergence of a particular phenomenon [3]. Comparing between two or more groups of as given variable. Comparison is a descriptive investigation that seeks to find solutions through causal relationships i.e., choosing certain factors related to the situation or phenomenon being investigated and comparing from factor one to another [4]. Based on the comparison of some of the researchers’ opinions, a comparison is a form of research comparing one object to another using variables related to the object being researched to gain similarities or differences.

2.2. Definition of structure
In principle, the structure of a building is the load-dispensing system from the very top of the building into the ground [5]. Simply consists of three parts namely roof, walls, and foundations. The function of structure system is to withstand stress force, pressure force, and rotation. Depending on the needs, the structure system adapts to the functions and activities that will be addressed therein. Wide-span structures are created due to the need for activities that require space flexibility. Here are the types of wide-span structures.

2.2.1. Truss structure. The form of structures consisting of straight stems that are connected forming a basic pattern of triangles (triangulation). The fundamental main principle on the triangular frame as a stable bearer element. The basic shape of the triangle can form a combination of shapes as shown below (Figure 1).

![Figure 1. The basic shape of the triangle [5].](image)

The combination of space truss makes space frame (a). Combination of pyramid shape with rectangular octahedron base (b) and pyramid with a triangular base forming tetrahedron (c).

2.2.2. Cable structure. Structures system that works based on the principle of attraction force. Here are the forms of cable structures (Figure 2).

![Figure 2. Forms of cable structures [5].](image)
2.2.3. *Column and beam structure.* Beams are horizontal structures while columns form vertical structures. A combination of beam and column structures to withstand stress force, pressure force, and rotation. Materials that can be used for beam and column systems are reinforced concrete, wood, and iron. Here is a simple form of beam and column structures (Figure 3).

![Figure 3. Beam and column structure [5].](image)

2.2.4. *Fold structure.* A rigid planar structure that is typically made of monolith materials that are small in height compared to other dimensions. The development of the plate structure is by folding it to increase the stiffness of the plate. Here is a picture of the fold structure (Figure 4).

![Figure 4. Fold structure [5].](image)

2.2.5. *Membrane structure.* Membrane structure is a thin and flexible structure form that is pulled to form a space. In membrane structure there are two types of structures, namely tent and Pneumatics. Below is the type of membrane structure (Figure 5).

![Figure 5. Membrane structure [5].](image)

2.2.6. *Shell structure.* A three-dimensional structural shape that has a rigid, thin curved surface. The base shape comes from a curve rotated against one axis for example is the surface of a ball. Shell structure can be seen in Figure 6.

![Figure 6. Shell structure [5].](image)

2.3. *Construction*
Construction in the Bahasa Indonesia dictionary, defined as the arrangement (model, layout) of a building or structure and connection of words in a group of words. Building construction is a combination of all structural and nonstructural components. The construction system consists of the arrangement of interrelated or interdependent parts of each other being unified for the same function. In those sections consist of several interconnected, coordinated, integrated systems and subsystems. There are the three systems in the construction of the building: structural system, casing system, and mechanical system.
The structural system is designed to make buildings resistant to gravity force and lateral loads. It consists of a roof structure, columns, beams, support walls, and foundations. The use of roofing materials ranging from natural materials such as rocks, wood, and the use of fabricated materials such as asphalt, concrete, aluminum, membrane etc. Choice of wall system material as a structural element or space separator element. Ranging from red brick wall arrangement, light brick arrangement, glass wall, and partition wall of the material. The foundation system Material is chosen depending on the load to be sustained. The wide-span construction system has a more elaborate structure system. The use of selected materials must sustain the load of the roof that has a very wide-span. The most common wide-landscape structure system is the skeletal system using iron or steel frame material.

Non-structural construction elements are activities at the time of development. In general, building construction works are carried on the site. Ranging from foundation work, wall, and the roof frame. In this industrialization era construction works were developed to be easy and efficient. Structural system parts are done outside the off-site. Structural system is done in the factory first made into a series of components that are ready to be compiled or assembled within the site so as to save the working time. This construction system is called a prefabricated system.

2.4. Airport

Airport is a specific area of land or water (including buildings, institutions, and equipment) which is intended either in whole or in part for arrivals, departures, and aircraft movements (Annex 14 of the International Civil Aviation Organization). According to PT (Persero) Angkasa Pura II, Airport is an airfield, including all buildings and equipment that is minimum requirements to ensure the availability of facilities for air transport for the community [6].

Airport is an area on land and/or water with certain boundaries used as a place for aircraft to land and takes off, boarding passengers, loading and unloading goods, and place intra- mode and inter-mode transportation, which is equipped with safety facilities and aviation security, as well as basic facilities and other supporting facilities [7].

3. Research methodology

Qualitative methods with a comparison strategy are used as a research method. This method was chosen because suits the writer’s idea that intends to compare the structure and construction of International Airport Terminal Building in Husein Sastranegara and the Kertajati airport in West Java. The method of collecting data on this writing is divided into primary data collection and secondary data collection.

- **Primary data**, obtained in the form of interviews with related parties as an airport user by doing a direct study of the space.
- **Secondary data**, Data obtained from the Internet, e-books, scientific journals, and other writings that source and reference are clear.

The Research analysis is done by comparing structure and construction system in two airports, especially related to structure system, structure shape, roofing material, wall material, foundation, and construction system based on studies that have been done previously. So it can be deduced from the results of the comparison structure and construction system effective in airport terminals according to the design/shape of buildings and the site environment.

4. Results and discussion

The location of both Kertajati Airport and Husein Sastranegara is in West Java. However, having very different site conditions, Husein Airport is located adjacent to the center of Bandung City, while Kertajati airport is far from urban area. Husein Sastranegara Airport with an area of 17,000 M2 terminals has a capacity of three million passengers per year while Kertajati Airport with an area of 83,700 m2 terminal in the first phase has a capacity of five million. Here is a comparison table of structural and construction systems in both airports.
Table 1. Structural and construction system comparison.

| Elements          | Husein Sastranegara International Airport Terminal | Kertajati International Airport Terminal |
|-------------------|--------------------------------------------------|-----------------------------------------|
| **Structure System** | Using composite column structure system (steel and concrete). | Using truss structure system is supported by a concrete column. |
| **Structure Form** | Triangular structure shape. | Wavy Structure. |
| **Roof Materials** | Roofing material using fiber base material. | Roofing Material using a membrane that is covered by seamless steel. |
| **Wall Materials** | Dominated by concrete walls. | Dominated by glass walls. |
| **Foundation System** | Using anchor reinforcement concrete system to support concrete-composite steel. | Using Bore-pile system to support concrete column. |
| **Construction System** | All structure systems are done within the site. | Column system is done in site while steel frame using prefab construction system. |

Findings from the six elements ranging from structural systems, structural shapes, roofing materials, wall materials, foundations, and construction systems. Husein Sastranegara Airport uses a composite steel-concrete structure system and Kertajati airport using a reinforced concrete structural system to support the series of Space Frame. The structure of the two buildings has a significant difference.
Kertajati Airport has structure form consisting of a series of steel forming a corrugated roof while the roof shape of Husein Airport is arranged forming triangular. The roofing materials and walls are chosen according to the needs of each airport. Husein Airport is dominated by concrete walls and only part of the window that uses glass material. Kertajati Airport is dominated by the glass walls surrounding the building, only private spaces that uses concrete walls. The foundation system of the building of Husein airport uses anchor reinforcement concrete to support concrete-steel composite. Kertajati Airport uses the Bore-pile system to support large concrete columns due to the wide expanse of roofs.

Construction system works on Husein Airport building carried out on the site from the work of the foundry to the installation of roof frame while Kertajati airport installation of the roof has been done in another place so at the time of installation they only need to assemble the rod frame into one (prefabricated).

5. Conclusions
Based on the results of the elements comparison of Husein Sastranegara Airport and Kertajati Airport the use or selection of structural and construction systems in the airport terminal building is adjusted to the function and capacity of the space to be used. The rod frame usage at Kertajati Airport was chosen because it could accommodate more passengers. While the Husein Sastranegara Airport simply uses a concrete-steel composite that has a relatively small span and capacity. Material selection is also adapted to the shape of the building, the airport area, and the surrounding location. The foundation system also adjusts the structural elements to be sustained. The construction system adjusts the complexity of the structural arrangements. The use of fabricated materials makes it easier to construction Implementation.

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