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Overview of High Rise Development in Surabaya City in Several Periods of Years

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Abstract

Surabaya as a metropolitan city, in this era is facing high business activities, economy, education, entertainment and residential needs. The presence of high rise supported by construction technology such as materials or structures, is a solution and opportunity for architecture to answer problems in urban areas by creating buildings that are comfortable and safe for residents and the environment. Starting with the establishment of Wisma BII in 1992 as the first high rise milestone, Surabaya continues to experience rapid development in high rise development. In this research there are 83 high rise buildings in Surabaya that will be analyzed by comparing the main parameters such as function, form, and material. It was found that most of the high rises developed into a mixed use with a setback form and the main structural material is concrete. The analysis was conducted using data from journals and the Council on Tall Building and Urban Habitat (CTBUH) and produced relevant findings. This research is expected to be useful for architects and urban developers in supporting sustainable development in Surabaya.

Keywords: high rise, building function, building form, building materials, typology

1. Introduction

Surabaya as the second metropolitan city in Indonesia after Jakarta continues to develop following interesting trends such as competing to build high rise buildings to serve as a transformation of identity for the progress of a country or city in all fields (Praditya, 2024). Currently, Indonesia is the 9th country in the world that has quite a lot of high-rise buildings because it is driven by the rapid advancement of science or technology that allows the creation of more modern, efficient, and functional building designs and constructions (Aulia Putra, 2018). The city's economic growth and rapid urbanization can be one of the driving factors in terms of the need for more space. According to UN data, urbanization will continue to increase by 70% especially in urban areas by 2050 and the population in Asian cities will grow to 2.5 billion (United Nations, 2019). The emergence of high rise development can be one of the interactive solutions to meet residential and commercial needs while supporting the development of technological innovation trends in construction to create more efficient and sustainable buildings (Al-Kodmany et al., 2022). Not only serves as a spatial solution, the construction of high-rise buildings also reflects the successful achievement of SDGs for point 9 regarding innovation and point 11 regarding sustainable infrastructure development and procurement (Al-Kodmany, 2022). In some previous studies, high-rise buildings only focus on the collaboration between structural and technological aspects, so research related to the analysis of high-rise building development in Surabaya is carried out by identifying and classifying to provide an architectural overview through functions, forms, and facades starting from the initial period before 2000 to 2024, with several architectural elements that will be used as the main parameters.

2. Literature Review

2.1. Typology in Architecture

Typology is a word derived from the word "typos" which means to study types or differences based on certain interpretations (Santi, 2023). The concept is rooted in the grouping of objects based on certain characteristics, which allow for similarities and differences (Craighead, 2009). In architecture, typology refers to the grouping of buildings based on certain features or characteristics which is in line with the idea that typology is a systematic classification process (Grover et al., 2019). Thus, typology is not only a grouping study but also an analytical tool to understand the evolutionary patterns of basic building elements, especially in the context of architecture (Dharmatanna, 2024).

2.2. High Rise Typology Based on Material

The development of high-rise buildings is significantly influenced by the advancement of construction materials from steel as the main construction material due to its strength and durability, to concrete which continues to develop so that its use is in great demand to more efficient composite structures. This can be seen as much as 54% of high-rise buildings around the world use reinforced concrete and 43% composite structures that combine steel and concrete such as (Szolomicki & Szolomicka, 2019). In fact, according to CTBUH, the majority of the world's 100 tallest buildings use composite materials or reinforced concrete, signaling the high interest in these materials as a more efficient construction solution. Some novelties in materials can make tall buildings not only structurally strong, but also more efficient in all respects including occupant comfort (H. Ilgın & Aslantamer, 2024).

2.3. High Rise Typology Based on Building Function

Functionally, tall buildings have several typologies of functions, the first is commercial, such as office buildings or shopping centers that are designed to support economic activities (Dzuri & Zakariya, 2024). The second is residential, such as apartments or condominiums, which are designed with the comfort and privacy of the occupants in mind, and Mix Use, which combines various functions into one building such as commercial, residential and public facilities such as restaurants. This typology is often found especially in city centers, where land use is limited, and public facilities such as hospitals, universities, banks, etc., are designed with attention to public service functions and accessibility to all users (Santoso, 2013).

2.4. High Rise Typology Based on Building Form

Typology in the form of buildings, especially tall buildings, plays an important role, especially in determining the aesthetics, stability and efficiency of the building. Supported by the development of technology, the shape of the building will continue to be explored from the initial geometric shape to be more dynamic, so that the building is not only visually appealing but also able to withstand wind or earthquake loads (Moon, 2016).

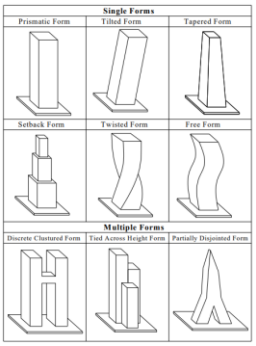

Figure 1. Classification of tower shapes for tall buildings
Sumber : *(Ozsahin, 2022)*

The variety of building forms classified into several forms as in (Figure 1) above, greatly reflects innovation in the fields of structure and architecture (Ozsahin, 2022).

2.5. High Rise Typology Based on Facade Material

Facade materials are one of the most important architectural elements and are often a key element in determining the building aesthetics, energy efficiency, and sustainability of high-rise buildings. In general, they are classified into three main categories, namely mono-material, mixed-material, and adaptive or responsive facades. Mono-material facades usually offer ease of maintenance and a minimalist appearance, but tend to be less flexible in design or thermal performance. In contrast, mixed-material facades usually combine two or more materials, allowing for a more dynamic and energy-efficient design by optimizing natural lighting and ventilation (Gasparri et al., 2022).

3. Methods

This study was conducted using qualitative and descriptive methods by collecting 83 samples of high-rise buildings in Surabaya to be analyzed based on their architectural characteristics. This method

was chosen because the focus of this study lies in in-depth interpretation through the study of the relationship between architectural parameters such as function, form, structural material, and exterior facade material. With the aim of providing initial design direction for architects and engineers, as well as answering the main issue of the extent of development experienced by the City of Surabaya, especially in the field of construction. With the help of several journals, articles, books, dissertations, and several other internet sources, researchers can find further information related to building data that cannot be found on websites such as CTBUH (https://www.ctbuh.org/) because the information contained only certain information about tall buildings such as location, height, function, and structural material only as *Figure 2.*

Figure 2. Data collection method and generation of results in diagrams (*Author, 2024)*

The data obtained will be processed into a table to be classified based on the period of the year of establishment, namely period I (before 2000), period II (2000 - 2010), period III (2011 - 2020) and period IV (2021 - 2024) which is based on height, number of floors, function, shape, structural material and exterior facade material. Then processed with calculations in the form of bar charts, pie charts, and to find out more about the development of tall buildings in Surabaya, a relationship is made from the results of the comparison into a bar chart in the form of grouping based on the relationship between height and function, grouping based on the relationship between height and shape, grouping based on the relationship between height and structural material, and grouping based on the relationship between height and exterior facade material. The buildings that will be the objects of analysis in this study have a height of between 70 m - 300 m and the number of floors between 20 floors - 55 floors. With the number of buildings with a height of 75 m - 100 m there are 18 buildings, the number of buildings with a height of 101 m - 150 m there are 36 buildings, the number of buildings with a height of 151 m - 200 m there are 16 buildings, the number of buildings with a height of 201 m - 250 m there are 7 buildings, and the number of buildings with a height of 251 m - 300 m there are 6 buildings.

4. Analysis and Interpretation

During several periods in Indonesia in the 1990s, many high-rise building projects were delayed or canceled. As in the period 2001 - 2010, Surabaya City is still not developing too rapidly due to limited market demand for its space needs. The development of the trend of mass high rise development occurred in period III, namely 2011 - 2020, namely after 2010, because Surabaya began to experience development, especially in improving the city's main road access which automatically supported connectivity and vertical property development which created a more attractive area for investors, thus making the city of Surabaya an investment magnet, especially in the fields of business and development (Febrinastri, 2020).In addition, there is support from the city government to overcome the increasing population and limited land supported by the concept of mix use development that combines residential, commercial, and office functions (Petriella, 2021). Since 2010 until now, almost 70% percent of people in Surabaya have begun to adopt an urban lifestyle which has an impact in the form of opportunities for the development of large projects either from the base or extension of existing ones so that several large companies or investors have grown rapidly to answer the urgent market needs through the development of high-rise buildings that surround them (Fadhil et al., 2024).

4.1. Development Analysis Based on Building Function Aspects

A high-rise building is categorized as single-functional if more than 85% of the total floor area is used for one type of function only, and multifunctional when it has multiple functions (Xie et al., 2022). As in (Figure 3) which classifies high rise into 3 single functional categories, namely hotels, apartments or condominiums, and offices, and multi-functional categories, and it is found that the 83 high rise buildings in Surabaya are mostly designed for mixed use, although there are some buildings that still have one dominant function, namely residential apartments or condominiums.

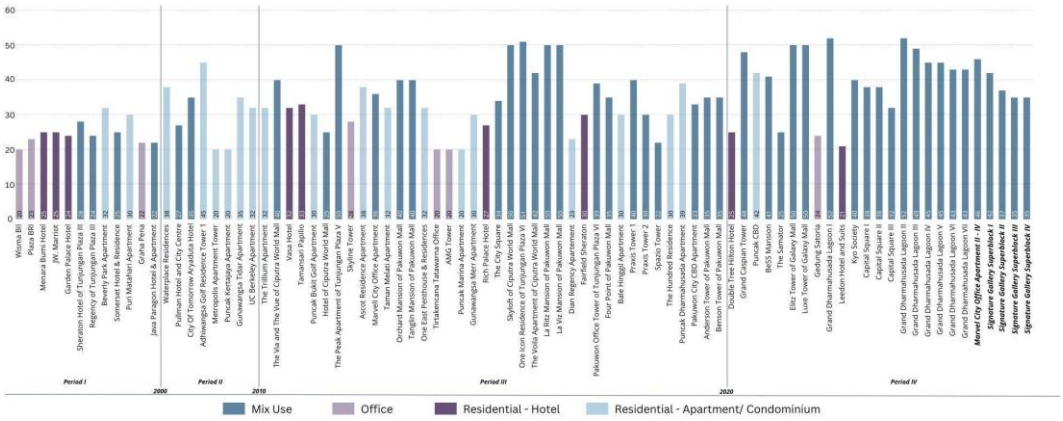

Figure 3. Diagram of High-rise Building Development Results Based on Function Aspects (*Author, 2024)*

The comparative diagram analysis *(Figure 4)* shows a significant increase in mixed use buildings from 28.6% before 2010 to 66.1% in period III. This trend shows a shift in high-rise building design towards more efficient integration of multiple functions in one building. Although single functions are declining, some functions such as apartments still dominate more than hotels or offices. The adoption of multifunctional design reflects that some high-rise buildings are implementing sustainable solutions to future land constraints and the increasing urban population.

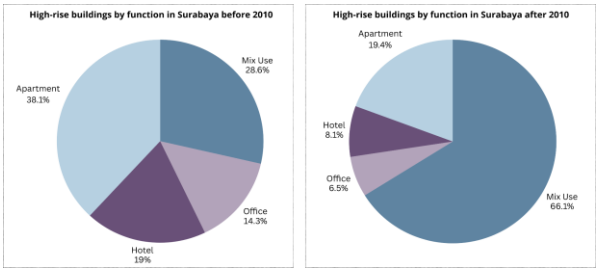

Figure 4. Comparative Results of High-rise Building Development Based on Function Aspects Before and After 2010 (*Author, 2024)*

But when viewed *(Figure 5)* from period I to period IV, the most dominant function remains mixed use with 56.6%, while the dominant single function in the city is apartment with 24.1%.

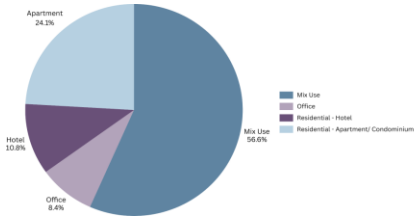

Figure 5. Percentage Results of Tall Building Development Based on Function Aspects (*Author, 2024)*

4.2. Development Analysis Based on Building Form Aspect

The shape of tall buildings is generally divided into 3 main parts, namely the head (top), main body (tower), and base (base) with various shapes such as single shapes which include prismatic shapes,

tapered shapes, oblique shapes, setback shapes, twisted shapes, and free shapes and compound shapes which include separate grouped shapes, transversely bound shapes, and partially separated shapes (Yadav & Roy, 2024). Based on the analysis (Figure 6), the majority of the setback and tied across height shapes are effective in overcoming wind pressure and lateral loads and are able to support maximum daylighting due to their slender shape, as well as the presence of green space at the base. Meanwhile, the tied across height form enables multifunctional design with a structure that is more efficient and stable against problems in the surrounding urban environment (Ali & Moon,2018).

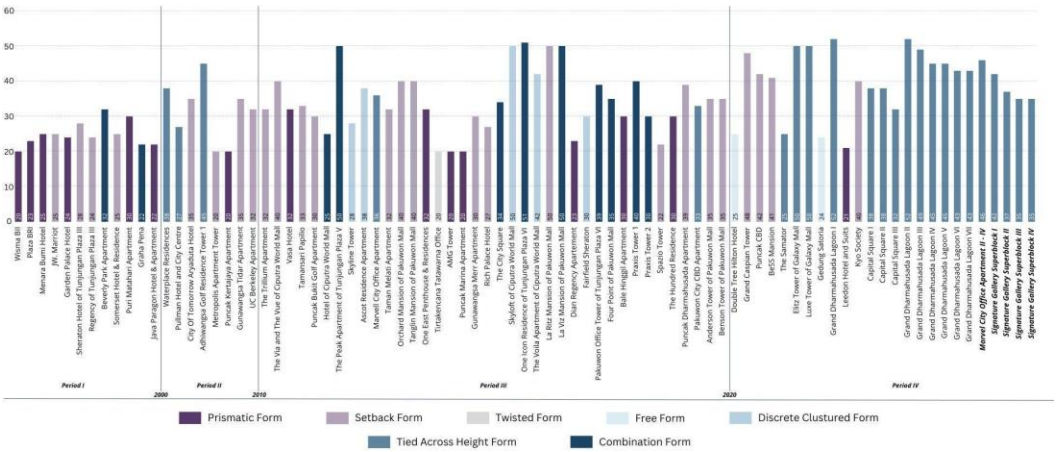

Figure 6. Diagram of Tall Building Development Results Based on Shape Aspects (*Author, 2024)*

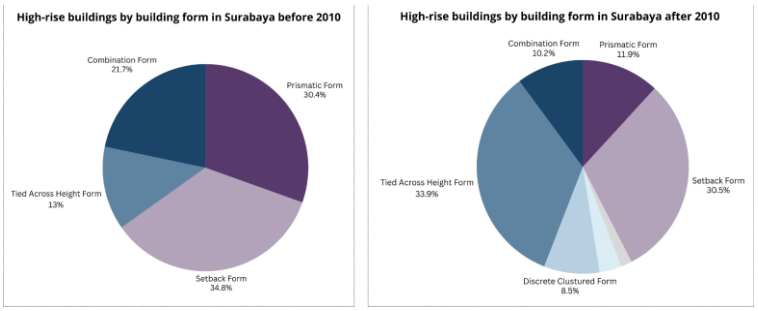

Figure 7. Comparative Results of Tall Building Development Based on Form Aspects Before and After 2010 (*Author, 2024)*

Based on the analysis on the comparison diagram *(Figure 7)*, it can be seen that the development of high-rise building forms in Surabaya shows the dominance of the use of setback forms from the early period until now. In addition, prismatic forms are also still widely used, especially from period I to period II with a percentage of around 30.4% but has decreased to 11.9% because it has begun to be replaced by tied across height forms which reached 33.9% due to its efficiency in distributing lateral loads and design flexibility. In addition, several innovative forms such as twisted forms, free forms and discrete clustered forms began to appear in period III or after 2010 along with the demand for more aesthetic

designs. Some buildings in Surabaya also take the form of a mixture of several existing single forms to create unique and creative design solutions for the evolving urban needs.

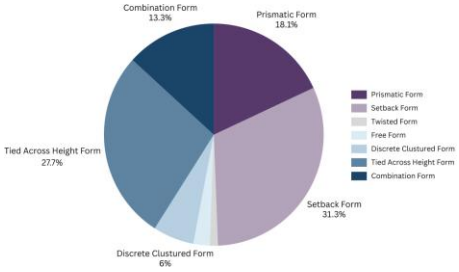

Figure 8. Percentage Results of Tall Building Development Based on Building Form Aspect (*Author, 2024)*

When viewed from *(Figure 8)*, period I to period IV, the most dominant building form used is the setback form with a percentage reaching 31.3%, tied across height forms at 27.7%. Some other forms that are still often used but not too dominating are prismatic form at 18.1% and combination form at 13.3%.

4.3. Development Analysis Based on Material Aspects of Building Structures

Materials commonly used as ordinary lateral and vertical structural elements include reinforced concrete, composite and steel. Composite structures can be formed through a combination of steel and concrete components. In Surabaya based on (Figure 9), structural materials for high-rise buildings are dominated by concrete, although there are still some that use composite materials. For steel materials, it is rarely used because in terms of construction costs which are quite expensive compared to concrete, besides that it also requires more complex technical expertise in installation especially for high rise buildings, also limited infrastructure for fabrication and transportation of steel elements is a major obstacle, while concrete can be cast directly at the construction site so as to reduce logistical complexity (Anwar, 2018).

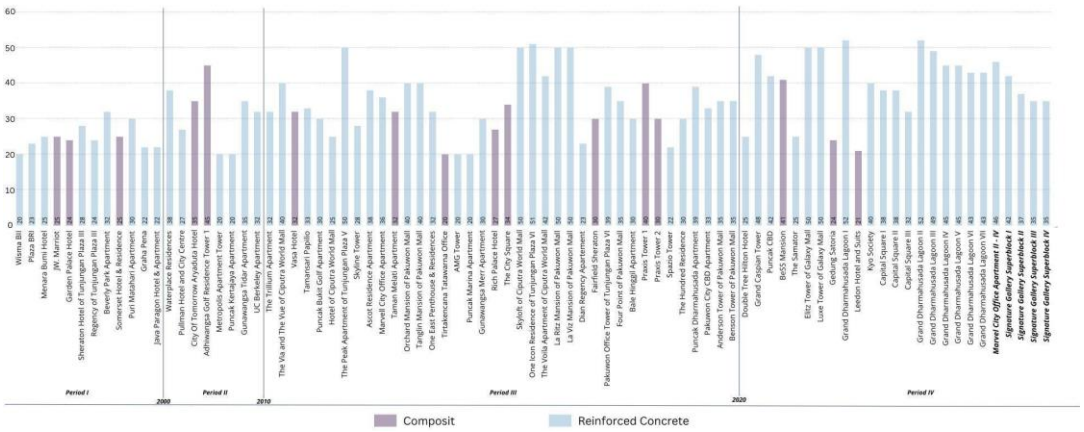

Figure 9. Diagram of High-rise Building Development Results Based on Building Structure Material Aspects (*Author, 2024)*

As in Surabaya alone, 80.7% of existing high-rise buildings use concrete materials for their structures, and only 19.3% use composite materials. The data in *(Figure 10)* is consistent with the material classification in the CTBUH database for tall buildings in Surabaya City, which shows a preference for structural efficiency and more economical construction.

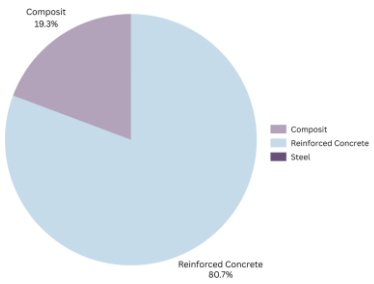

Figure 10. Percentage of High-rise Building Development Results Based on Structural Material Aspects (A*uthor, 2024)*

4.4. Development Analysis Based on Material Aspects of the Building Façade

Facade materials play an important role in aesthetics and sustainability. As in Figure 11, commonly used materials include curtain walls (glass), composite panels, wood panels, metal panels, ceramics, and even original concrete walls with a layer of paint. The selection of these materials is usually adjusted to the design concept, such as reflective materials for a modern style that gives a futuristic impression or high-albedo materials that support energy efficiency. Facade materials can be distinguished into single materials or the use of 1 type such as curtain walls only or concrete walls only to be cleaner and easier to maintain, or mixed materials that combine 2 or more materials to be more aesthetic and functional that supports building sustainability (Goyal, 2023).

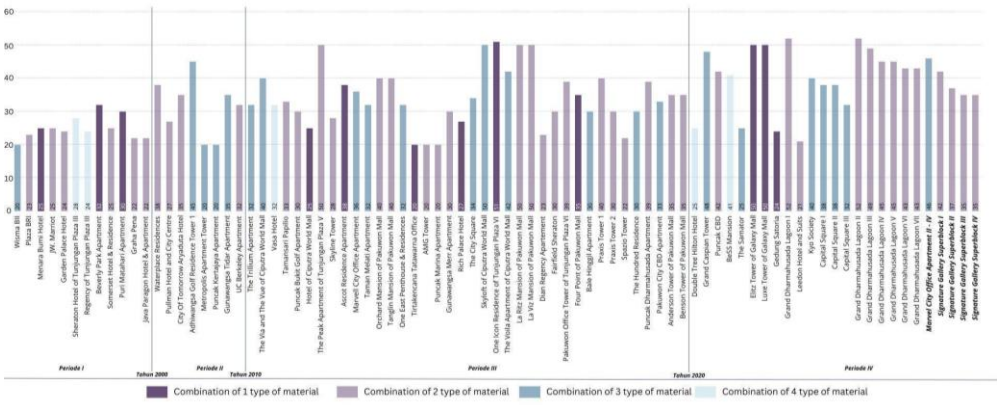

Figure 11. Diagram of High-rise Building Development Results Based on Material Aspects of the Outer Facade (*Author, 2024)*

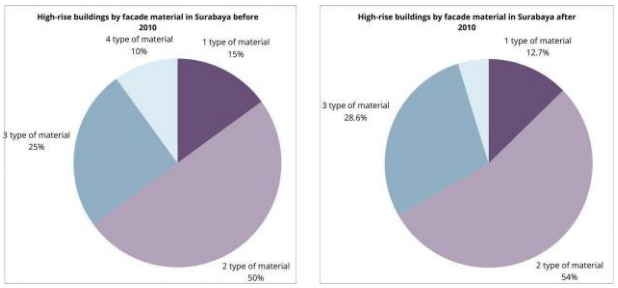

Figure 12. Comparative Results of High-rise Building Development Based on Material Aspects of the Outer Facade Before and After 2010 (*Author, 2024)*

Based on the analysis of the comparison diagram in Figure 12, it can be seen that high-rise buildings in Surabaya predominantly use compound materials with a combination of 2 materials for their facades from 50% to 54%. In contrast, the combination of 1 type of material has decreased which reflects the change in design preferences along with the development of the city. So in Figure 13, overall from period I to period IV, high-rise buildings in Surabaya almost mostly use compound materials with a combination of 2 types of materials, amounting to 51.8%.

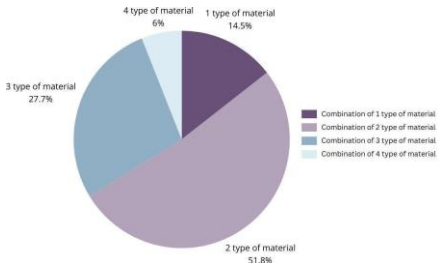

Figure 13 Percentage of High-rise Building Development Results Based on Material Aspects of the Outer Facade (*Author, 2024)*

4.5. Analysis of High Rise Architecture Development in Surabaya Based on Relationship Between Building Height and Building Function

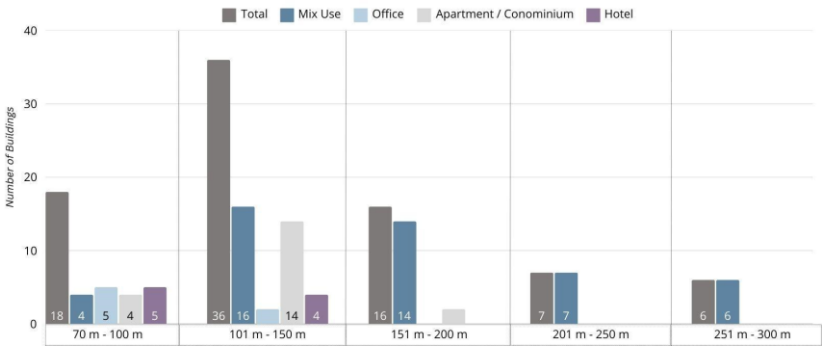

Figure 14. Diagram of Relationship Results Between Building Height and Function (*Author, 2024)*

In *Figure 14* explains that the high rise in Surabaya is dominantly tall between 101m - 150m with a mix use function of 44.4%, office only 5.6%. While the apartment function is quite a lot around 38.9%, and hotels around 11.1%. In the height range between 70m - 100m, 22.2% functioned as mix use,

27.8% functioned as offices, 22.2% functioned as apartments / condominiums and the remaining 27.8% functioned as hotels. In the 151m - 200m range, almost 90% also function as mix use and the rest function as apartments. In the height range of 201m - 250m and 251m - 300m range, 100% of buildings in Surabaya function as mixed use.

4.6. Analysis of the Development of High Rise Architecture in Surabaya Based on the Relationship Between Building Height and Building Forms

In *Figure 15* states that the height range of 101m - 150m the most building form is setback form by 50%, then prismatic form only reaches 13.9%. While the tied across height form is also quite a lot which is around 16.7%, while for some other forms it is still rarely found in Surabaya. In the height range between 70m - 100m, 55.6% are in prismatic form, 22.2% are still in setback form, 11.1% are in combination form and 11.2% are in twisted and free form. In the height range between 151m - 200m prismatic form is rarely found, some forms that are still dominant are 21.1% setback form, 10.5% discrete clustered form, 42.1% tied across height form and the remaining 26.3% is combination form. In the height range of 201m - 250m only tied across height form is around 100%. In the range of 251m - 300m also only 2 kinds of forms were found, namely 80% tied across height form and 20% still combination form.

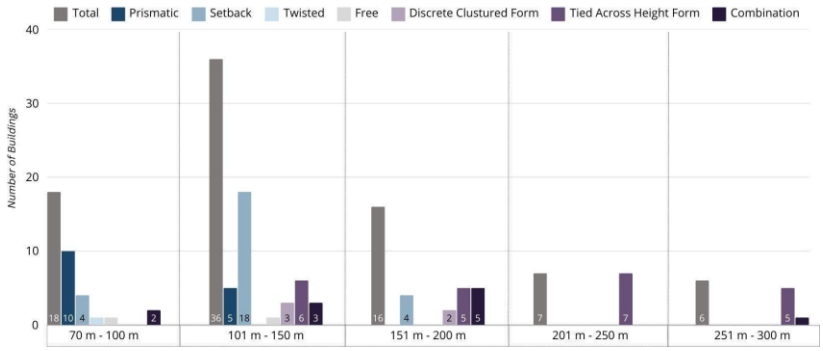

Figure 15. Diagram of the Relationship between Building Height and Shape (*Author, 2024)*

4.7. Analysis of High Rise Architecture Development in Surabaya Based on Relationship Between Building Height and Building Structure Material

Figure 16 illustrates the variation of building structural materials according to building height. The gray colored bars represent the total number of high rise buildings. It can be seen that high rises in Surabaya dominantly have a height range between 101m - 150m with the most material is concrete around 77.8% and 22.2% composite material. In the range of 70m - 100m 72.2% use concrete and 27.8% composite. In the 151m - 200m range, 84.2% use concrete and 15.8% use composite. While in the range 201m - 250m and 251m - 300m, 100% uses concrete material.

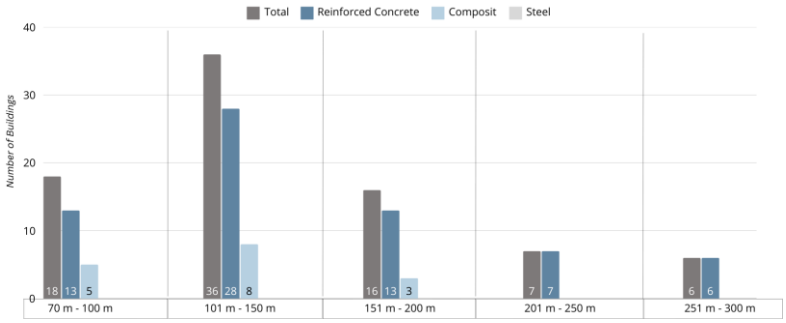

Figure 16. Diagram of Relationship Results Between Height and Building Structure Materials (*Author, 2024)*

4.8. Analysis of the Development of High Rise Architecture in Surabaya Based on the Relationship Between Building Height and Building Outer Facade Material

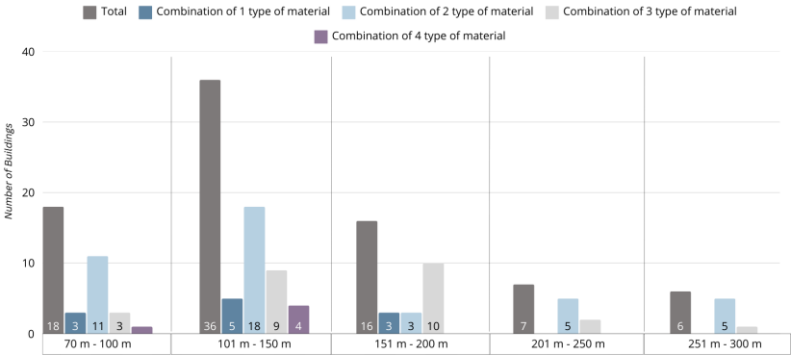

Figure 17. Diagram of Relationship Results Between Height and Materials of the Outermost Facade of the Building (*Author, 2024)*

In Figure 17 states that in the height range between 101m - 150m, the most facade material is a combination of 2 types of materials by 50%, 25% use a combination of 3 types of materials, 13.9% a combination of 1 type of material and 11.1% with a combination of 4 types of materials. In the range of 70m - 100m dominant as much as 61.1% still use a combination of 2 types of material, 16.7% use a combination of 1 type of material, 16.7% use a combination of 1 type of material and the rest use a combination of 4 types of material. In the range 151m - 200m dominant 52.6% began using a combination of 3 types of materials. In the 201m - 250m range as much as 60% with a combination of 2 types of materials and 40% already with a combination of 3 types of materials, while in the 251m - 300m range still 100% use a combination of 2 types of materials.

5. Conclusions

The increasing demand for high-rise buildings requires their design to pay attention to structural strength and visual appeal. This study provides insight into the condition of high-rise buildings in Surabaya and helps designers understand their architecture. Of the 83 buildings analyzed, it was found that the Grand Dharmahusada Lagoon is currently the tallest with a height of 271 meters equivalent to 52 floors. With its dominant function being mix use. The most dominant form is tied across height which has emerged since 2010, followed by setback and prismatic forms which have existed since 2000. Free form, split group, and combination forms are rarely found. Around 80% of the structure uses concrete and the rest uses composite materials. While the facade generally combines two materials such as curtain walls and composite panels or curtain walls and concrete walls. The design of high-rise buildings does require in-depth understanding because of the increasingly complex modern challenges and its role will be increasingly important in future developments.

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