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Cost Analysis and Working Methods for Balcony Railings in Multi-Storey Buildings

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Abstract: This article discusses cost analysis and methods for working on balcony railings in multi-storey buildings. Balcony railings are an important element in the design and safety of high-rise buildings, as they protect occupants from falls and provide an attractive aesthetic appearance. Therefore, it is important to ensure that the installation of balcony railings complies with applicable planning standards. By exploring information about material costs, work costs, construction efficiency, and other factors that influence the choice of railing form, this research will provide construction professionals with more informed guidance in decision making. In addition, this analysis will also open a window to better understand how the choice of railing shape can affect the project timeframe and the final result of the building.

Keywords: cost analysis, balcony railing, work methods.

Introduction

In the construction industry, high-rise buildings have become an important characteristic of modern urban development. The existence of multi-storey buildings brings new challenges in terms of safety, aesthetics and construction efficiency. Based on Law no. 28 of 2002 concerning buildings in article 3 states that in order to create a building that is functional and in accordance with a building layout that is harmonious and in harmony with its environment, it must guarantee the reliability of the building in terms of safety, health, comfort and convenience.

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One important component that plays a role in security and aesthetics is the railing, or fence, which is installed on the floor and stairs. Railings not only play a role in ensuring the safety of residents and visitors, but also provide a significant visual impact on the overall appearance of the building.

According to Resse and Eidson (2006) quoted from Lucky and Tjia (2014), safety railings or safety fences are fences that are used to secure the sides, edges, roofs, open holes/voids in elevators or construction stairs of a building.

According to Krier in a book entitled Architectural Composition (2001), guardrails or railings are needed when there is a danger in the use of space. The guardrail is also a physical barrier that is used if there is a social agreement regarding the use of space.

According to the Republic of Indonesia Minister of Manpower Regulation No. PER.01/MEN/1980 Article 8, all equipment with open floor sides, holes in open floors, roofs or stages that can be entered, open sides of

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stairs, all excavations and holes Those considered dangerous must be provided with a strong safety fence or cover.

From the several definitions of railings or guardrails above, it can be concluded that railings are a safety medium in multi-storey residences that are installed on stairs and balconies. The shape can be in the form of a wall or fence equipped with handrails. The height of the protective fence is usually adjusted based on its function and must be able to create a safe atmosphere for residents. Ideally adapted to comfortably reach an arm when an adult is standing.

Balcony railings are an important element in the design and safety of high-rise buildings, as they protect occupants from falls and provide an attractive aesthetic appearance. Therefore, it is important to ensure that the installation of balcony railings complies with applicable planning standards. The use of balcony railings in multi-storey buildings is an important part of the security and aesthetic aspects of the building. The balcony railing functions as a guardrail on the balcony to prevent building occupants or visitors from falling from a height.

With the various types and shapes of railings available on the market today, construction professionals and planners must face the challenge of choosing a railing form that suits project needs, as well as considering cost factors and work methods. Currently, there are not many studies that comprehensively analyze the various types of railings used in multi-storey buildings, especially in relation to cost analysis and work methods.

Previous research tends to focus more on the design and structural aspects of building components, while cost analysis and work methods are often treated as less in-depth. Therefore, more in-depth research regarding cost analysis and construction methods for various forms of railings in multi-storey buildings will provide a valuable contribution to construction practice

By exploring information about material costs, work costs, construction efficiency, and other factors that influence the choice of railing form, this research will provide construction professionals with more informed guidance in decision making. In addition, this analysis will also open a window to better understand how the choice of railing shape can affect the project timeframe and the final result of the building.

Therefore, this research will focus on cost analysis and work methods for various forms of railings commonly used in multi-storey buildings. By investigating these aspects in depth, this research is expected to provide valuable insights for construction professionals, developers, and project planners in optimizing safety, aesthetics, and efficiency in selecting and implementing railings in high-rise buildings.

Method

The research method used in this research is field observation. Observations are carried out to observe, record and collect research data. Then, from the data taken, the costs and work methods are analyzed, including material requirements, production costs, work time, work system and any obstacles that exist in the field.

Result and Discussion

In this apartment building in Bekasi district, there are 33 floors in total, but of the 33 floors, floors 19 to 33 have new railings installed on the balconies, while the rest still undergoing fabrication/work. 1 floor of the apartment building consists of 25 balcony railings. Of the 25 existing balcony railings, they are further divided into 4 types of balcony railing categories, as follows.

Table 1 Balcony Railing Shape Data

Railing Shape	Amount
Straight Shape	18
L Shape	2
U Shape	2
Handrailing	3
TOTAL	**25**

The forms of balcony railings in the apartment under study

Figure 1 Straight Balcony Railing.

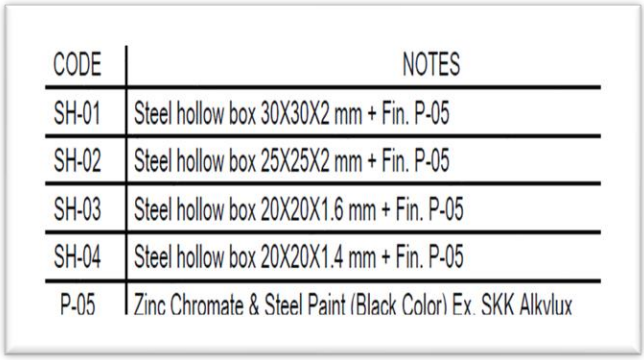
Figure 2 U Shape Balcony Railing

Figure 3 L Shape Balcony Railing

Figure 4 *Handrailing*

Table 2 Railing Code Data and Their Shapes

Railing Code	Railing Shape
RL-AB1	Straight Shape
RL-AB2	Straight Shape
RL – AC	Straight Shape
RL – AD2	Straight Shape
RL – AE1	Straight Shape
RL – AE2	Straight Shape
RL – AF	Straight Shape
RL – AH1	Straight Shape
RL – AH2	Straight Shape
RLB – E	Straight Shape
RLB – F	Straight Shape
RLB – G	Straight Shape
RLB – H1	Straight Shape
RLB – H2	Straight Shape
RLB – I	Straight Shape
RLB – L	Straight Shape
RLB – N	Straight Shape
RLB – O	Straight Shape
RL – AD1	L Shape
RL – AG	L Shape
RLB – J	U Shape
RLB – K	U Shape
RL – AA	*Handrailing*
RLB – A	*Handrailing*
RLB – Q	*Handrailing*



CODE	NOTES
SH-01	Steel hollow box 30X30X2 mm + Fin. P-05
SH-02	Steel hollow box 25X25X2 mm + Fin. P-05
SH-03	Steel hollow box 20X20X1.6 mm + Fin. P-05
SH-04	Steel hollow box 20X20X1.4 mm + Fin. P-05
P-05	Zinc Chromate & Steel Paint (Black Color) Ex. SKK Alkvlux

Figure 4 Material Specifications Obtained from the Implementing Contractor

Regarding balcony railing material requirements, each form requires different materials according to its shape and dimensions. The following is a list of materials used in each form of balcony railing :

1. *Hollow Iron*
   There are 4 different thicknesses of hollow iron used in this apartment balcony railing, namely 3x3cm hollow iron 2mm thick, 2.5x2.5cm hollow iron 2mm thick, 2cmx2cm hollow iron 1.6mm thick, 2x2cm hollow iron 1.4mm thick.

2. *Dynabolt* m8 x 65mm
   Dynabolt m8 x 65mm is used on each side of the upper right and left ends of the railing to unite the wall and the railing itself. The system is to weld the ends of the railing with dynabolt.
3. Iron Cuttings ⌀10 x 200mm
   M10 iron with a length of 200mm or 20cm is useful for joining the bottom end/legs of the railing with the floor base. The system is almost the same as using a dynabolt, namely by welding the end of the railing with the end of an M10 iron cutting which is stuck into the floor.
4. Hollow Iron Cover
   The hollow cover functions to cover the ends of the railing, both the upper right and left sides as well as the lower side/railing legs which have been welded using dynabolts and iron cuttings. The hollow cover adjusts the size of the existing hollow.
5. Paint
   The paint itself is divided into 2 stages, namely the base paint process then the finishing paint in matte black.

Calculation Example

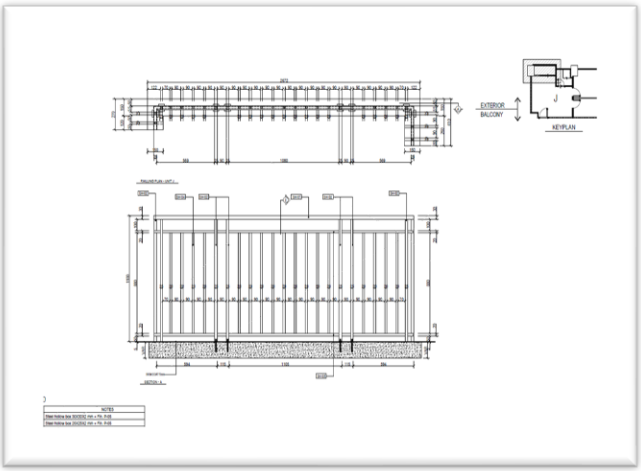


Figure 6 Balcony Railing Kode RL-AB1

a. Iron Hollow Calculations
   Hollow 3x3cm 2mm thick
   Railing lenght = 1.61 m
   The length of 1 hollow iron rod = 6 m
   Total *hollow* iron = $\frac{Railing\ lenght}{lenght\ of\ 1\ hollow\ rod} = \frac{1.61\ m}{6\ m}$

   =0.27btg

   Hollow 2,5x2,5cm 2mm thick
   Total length of railing frame = 4.28 m
   The length of 1 hollow iron rod = 6 m
   Total *hollow* iron = $\frac{total\ lenght\ of\ railing\ frame}{lenght\ of\ 1\ hollow} = \frac{4.28\ m}{6\ m}$

   =0.71btg

   Hollow 2x2cm 1,6mm thick
   total length of the horizontal radius of the railing = 2.42 meter
   The length of 1 hollow iron rod = 6 meter
   Total *hollow* iron = $\frac{total\ lenght\ of\ railing\ frame}{lenght\ of\ 1\ hollow} = \frac{2.42\ m}{6\ m}$

   =0.40 btg

   Hollow 2x2cm 1,4mm thick
   total length of the vertical radius of the railing = 7.92 meter
   The length of 1 hollow iron rod = 6 meter
   Total *hollow* rod = $\frac{total\ lenght\ of\ railing\ frame}{lenght\ of\ 1\ hollow} = \frac{7.92\ m}{6\ m}$

   =1.32btg

b. *Dynabolt* m8 x 65mm
   Because the dynabolts are installed at the top right and top left ends of the railing, where 2 dynabolts are installed at each end, and there is an additional frame to the left of the railing, namely using a 2x2cm hollow to which only 1 dynabolt is installed, the railing with code RL - AB1 requires 6 dynabolts.
c. Iron Cuttings ⌀10 x 200mm
   Railings with a length of >1.5m according to orders from the project implementer require 2 iron cuttings to be installed per railing leg, so railings with code RL – AB1 require 8 iron cuttings.
d. *Cover Hollow*
   Cover for *hollow* 3x3cm = 2 pcs
   Cover for *hollow* 2,5x2,5cm = 4 pcs
   Cover for *hollow* 2x2cm = 2 pcs
e. Paint
   Railing surface area = lenght x height
   = 1.61 x 1.1
   = 1.77 m2

   formula
   Volume (liters) of paint required = $\frac{surface\ area\ x\ DFT}{VS\%\ x\ 10}$

   DFT = *Dry Film Thicknes* (the thickness of the paint or coating layer measured on the surface of the object). The recommended DFT for the type of paint used is 30 – 50 microns.

   VS% = *Persen volume solid* (the volume of paint remaining divided by the volume of paint along with all the thinner). VS% for the paint used is 58%.

   Volume (liters) of paint required
   $= \frac{1.61\ m2\ x\ 50}{58\%\ x\ 10}$

   = 0.13 liter

   *For base paint and finishing paint, use the same brand of paint.

From the data obtained in the form of planning drawings for balcony railings totaling 25 railings, the amount of material required and the costs were obtained. After obtaining the amount of material needed for all existing forms of balcony railing, the material costs can be determined. The cost for making the railing itself is not determined by the shape but is calculated from the cost per meter, therefore the cost calculated is the total cost of balcony railing materials on 1 floor of an apartment building. The following is the cost of making a balcony railing for 1 floor.

Table 3 Material Requirements and Costs for Making Balcony Railings on 1 Floor.

Material	Volume	Satuan	Harga Satuan		Jumlah
Hollow 3x3 2mm	9	batang	Rp 178,000.00	Rp	1,602,000.00
Hollow 2,5x2,5 2mm	18	batang	Rp 113,000.00	Rp	2,034,000.00
Hollow 2x2 1,6mm	15	batang	Rp 84,000.00	Rp	1,260,000.00
Hollow 2x2 1,4mm	39	batang	Rp 76,000.00	Rp	2,964,000.00
Dynabolt m8x65	100	pcs	Rp 2,500.00	Rp	250,000.00
Stek besi m10x200	3	batang	Rp 98,000.00	Rp	294,000.00
Cover hollow 3x3	50	pcs	Rp 3,000.00	Rp	150,000.00
Cover Hollow 2,5x2,5	100	pcs	Rp 2,500.00	Rp	250,000.00
Cover Hollow 2x2	19	pcs	Rp 2,000.00	Rp	38,000.00
Cat dasar	5	liter	Rp 55,000.00	Rp	275,000.00
Cat hitam doff	5	liter	Rp 75,000.00	Rp	375,000.00
Thinner	15	liter	Rp 20,000.00	Rp	300,000.00
TOTAL				Rp	9,792,000.00

The 3x3cm 2mm thick hollow iron used for 1 floor is 9 rods with a total price of Rp. 1,602,000.-
Hollow iron 2.5x2.5cm thick 2mm used for 1 floor totaling 18 rods with a total price of Rp. 2,034,000.-
Hollow iron 2x2cm thick 1.6mm used for 1 floor totaling 15 rods with a total price of Rp. 1,260,000.-
Hollow iron 2x2cm thick 1.4mm used for 1 floor totaling 39 rods with a total price of Rp. 2,964,000.-
The number of m8x65 dynabolts used for 1 floor is 100 pcs at a price of Rp. 250,000.-
Cover hollow covers 3x3cm, 2.5x2.5cm and 2x2cm require 50, 100 and 19 pcs respectively with a total price of Rp. 438,000.-
Base paint and matte black paint each 5 liters at a price of Rp. 275,000.- and Rp. 375,000.-
Thinner costs 15 liters at a price of Rp. 300,000.-
The total cost for making 1 floor railing totaling 25 railings is Rp. 9,792,000.-

The easiest and fastest work system is handrailing, and the most difficult and time consuming is the U shape.
The easiest railing to install is a handrailing and the most difficult is a U-shaped railing

The costs are calculated as a whole by taking existing data on material requirements, the prices entered are the prices around the apartment building in Bekasi district. So there may be a price difference when compared to other areas. The total cost of 1 floor with 25 railings costs around Rp. 9,792,000.

Table 4 Data on how long it takes to make 1 form of railing

Railing Shape	Length/ Working time
Straight Shape	± 1hour
U Shape	± 2-3 hour
L Shape	± 1-2 hour
Handrailing	± 30 minutes

The workmanship system or what is usually called fabrication for making railings uses a welding and mall system. Based on the information from the informant, they first made 25 railings on one floor, then from the mall the railings were then made according to the code and floor required.

This data is data for just 1 form of railing, because the fabrication process takes place from 8 to 4 in the afternoon per day, so in 8 hours per day more than 10 railings in various shapes can be obtained, because according to the informant, the railing fabrication itself is not sequential. based on shape, but rather fabrication per predetermined railing code.

For a relatively fast work system, there is handrailing making, which only takes ±30 minutes, while for the U shape it takes 2-3 hours to make from the start of the assembly process until the painting process, because a lot of material is needed and there are elbows that have to be made. precisely.

Figure 7 balcony railing construction process

Table 5 Data on the Difficulty Level of Installing Balcony Railings

Railing Shape	Kategori
Straight Shape	Easy
U Shape	Difficult
L Shape	Currently
Handrailing	Very Easy

The level of difficulty of installing balcony railings is divided into 4 categories, namely very easy, easy, medium and difficult. This category was obtained through an interview process with the party who installed the railing in the building.

There are several obstacles in installing balcony railings, including the lack of appropriate dimensions in the planning and actual work in the field, so several modifications have to be made to the balcony railing. Then the balcony where the railing will be installed is not ready because the embankment has not been made at the bottom for the railing leg cuttings. This embankment is also usually made less neatly and just sticks, so the railing cuttings still have to penetrate the building structure, not just the embankment.

Conclusion

Based on the research carried out, namely by analyzing the costs and methods of working on balcony railings in apartment buildings in Bekasi Regency, the results of the cost analysis show that making railings in high-rise buildings requires a thorough cost estimate which includes the required material requirements that match the specifications given, accuracy time which will later affect labor wages and other things such as transport or mobilization. This analysis provides a clearer view of the financial commitment required in implementing projects, both small and large scale.

The work methods described in this research provide detailed guidance starting from the design or fabrication process to the process of installing balcony railings on site. Fluency in using work methods is very important to ensure that the project runs smoothly, safely and produces final results that meet quality standards.

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