QUANTIFICATION OF REINFORCED CONCRETE BUILDING FRAME

NOR ASMA BINTI MAMAT

QUANTIFICATION OF REINFORCED CONCRETE BUILDING FRAME

NOR ASMA BINTI MAMAT

Diterbitkan dan diedarkan oleh:

Nor Asma Binti Mamat
Politeknik Kota Bharu
KM. 24, Kok Lanas,
16450 Ketereh, Kelantan.

QUANTIFICATION OF REINFORCED CONCRETE BUILDING FRAME

Cetakan Pertama 2023

Nor Asma Binti Mamat

QUANTIFICATION OF REINFORCED CONCRETE BUILDING FRAME
/ Nor Asma Binti Mamat

QUANTIFICATION OF REINFORCED CONCRETE BUILDING FRAME

e ISBN 978-629-98438-0-1

NOR ASMA BINTI MAMAT

(online)

AUTHOR'S BIO

NOR ASMA BINTI MAMAT is a lecturer in Diploma in Quantity Surveying at the Department of Civil Engineering, Politeknik Kota Bharu. She has 14 years of teaching experience in several Malaysian Polytechnics. Started working in polytechnics from 2009 until now.

During her duty as a lecturer, she served as the Head of Programme in Quantity Surveying at Politeknik Kota Bharu for a year. She has experience teaching in Building Measurement, Construction of Law, Cost Estimating, and related courses in Quantity Surveying field. She also has registered as Provisional Quantity Surveyor (PVQS) with the Board of Quantity Surveyor Malaysian (BQSM) and graduated members with the Royal Institute of Surveyors Malaysia (RISM). Obtained a Diploma in Quantity Surveying (2003) and a Bachelor of Quantity Surveying (2005) at Universiti Teknologi Mara (UiTM).

She then pursued her master's degree in Construction Contract Management at Universiti Teknologi Malaysia (UTM) in 2017. She has produced a book entitled "Measurement for Superstructure Works" in 2019 for polytechnic malaysia purposes. In addition, she also has produced e-book in Principles of Law together with her colleagues.

THE EDITOR

NOR ASMANI BINTI MAMAT is an Assistant Director at the Department of Sewerage Services (JPP), Ministry of Natural Resources, Environment and Climate Change, Putrajaya, Malaysia. She has also served as a Quantity Surveyor at WAW Associates and SBJ Binajaya Development Sdn. Bhd., Kelantan.

Obtained a Diploma in Quantity Surveying (2012) and a Bachelor of Quantity Surveying (2017) at Universiti Teknologi Malaysia (UTM). And now serve in the JPP until now.

Acknowledgement

Alhamdulillah, thanks to Allah s.w.t. I able to complete this e-book in time specified. His blessing and guidance gave me strength to overcome obstacle while completing this e-book.

I would like to express a million thanks to my family. Without their support, guidance and encouragement, I might not able to complete this e-book.

Finally, I would like to express my appreciation to family, management of the Politeknik Kota Bharu, head of department, head of program and colleagues.

Preface

This e-book was prepared as reference for those whose are studying in Quantity Surveying and others who an attached to construction field.

This book contains element for building frame and an example of measurement and bill of quantity which is practiced in the industry.

Nor Asma Binti Mamat

TABLE OF CONTENT

LIST OF FIGURE

REFERENCES

1. Malaysian Standard Method of Measurement of Building Works Second Edition. The Institution of Surveyors, Malaysia (2000)

2. Ahmad Abdullah & Khairuddin Abdul Rashid. Pengukuran Kuantiti Bangunan Edisi Kedua. Prentice Hall (2009)

3. Nor Asma Binti Mamat. Measurement for Superstructure Works. Politeknik Sultan Azlan Shah (2019)

CHAPTER 1:

INTRODUCTION TO FRAMEWORK

INTRODUCTION

In the context of building construction, a framework typically refers to the structural frame of a building, which provides the basic framework for the entire structure. The framework is typically made up of a series of interconnected elements, such as columns, beams, and trusses, that work together to support the weight of the building and transfer loads to the foundation.

The framework of a building is designed to withstand a wide range of loads and stresses, including the weight of the building itself, as well as loads from wind, snow, seismic activity, and other environmental factors. The size, shape, and spacing of the framework elements will depend on the specific requirements of the building, including its size, height, and intended use.

The framework elements in a building are typically made from materials such as steel, concrete, or timber, and are often pre-fabricated off-site before being assembled on-site. This allows for faster construction times and greater precision in the manufacturing process.

GENERAL RULES OF MEASUREMENT

The main purpose of the measurement work is to prepare a bill of quantities (BQ). The contents of the BQ are based on the elements in the building. As for the frame element, items measured are columns and beams (floor beam and roof beam). Therefore, roof trusses will be measured in roof element. The method of measurement is based on the Standard Method of Measurement 2 issued by Royal Institution of Surveyor Malaysia (RISM).

The Standard Method of Measurement 2 (SMM2) is a set of rules and guidelines used to quantify and describe the work required to complete a construction project. It is a standard system of measurement that provides a common language for the construction industry to measure and estimate the cost of construction works accurately and consistently.

ITEMS INVOLVED IN THE ELEMENT FRAMEWORK

Therefore, to measure work for frame elements, the works involved are concrete work, formwork and reinforcement works.

CONCRETE

Concrete is a composite material made up of a mixture of cement, water, aggregates (such as sand, gravel, or crushed stone), and often other materials such as fly ash or slag.

Figure 1.1: Concrete
Source: https://www.concrete-info.com/concrete-material/

Cement and water form a paste that binds the aggregates together, creating a solid and durable material that is used in a wide range of construction applications. Generally, reinforced concrete will be used to build the column and beam.

Reinforced concrete is a composite material made from a combination of concrete and reinforcement materials, typically steel reinforcement bars (rebar) or steel fibers. The reinforcement materials are added to the concrete mixture to improve its strength, durability, and resistance to cracking and other types of damage.

The process of making reinforced concrete involves pouring concrete into a formwork or mold, and then adding the reinforcement material before the concrete sets. The steel reinforcement is placed in a grid pattern throughout the concrete, with the spacing and size of the bars or fibers determined by the specific requirements of the project.

FORMWORK

Formwork is a temporary structure or mold that is used to shape and support concrete until it sets and hardens.

Figure 1.2: Timber formwork

Source: https://www.thecoreengineers.com/2019/07/formwork.html

It is an important component of concrete construction, allowing for the creation of complex shapes and structures, and ensuring that the concrete sets correctly and maintains its intended shape and size.

Formwork is typically made from variety of materials, including wood, steel, aluminium, or plastic, and is designed to withstand the weight and pressure of the wet concrete. The formwork is placed in position before the concrete is poured and is then removed after the concrete has hardened.

REINFORCEMENT

Bar reinforcement, also known as rebar, refers to the use of steel bars or rods in concrete construction to provide additional strength and support to the structure. When concrete is poured around rebar, the two materials work together to resist forces that could cause the concrete to crack or fail.

Rebar is typically made from carbon steel or stainless steel and is available in a range of sizes and shapes to accommodate different types of construction projects. The bars are typically placed in a grid pattern throughout the concrete structure, with the spacing and size of the bars determined by the specific requirements of the project.

The primary function of rebar in concrete is to resist tensile forces. Concrete is very strong in compression but is much weaker in tension. By adding rebar to the concrete, the tensile forces are distributed across the entire structure, helping to prevent cracking and failure.

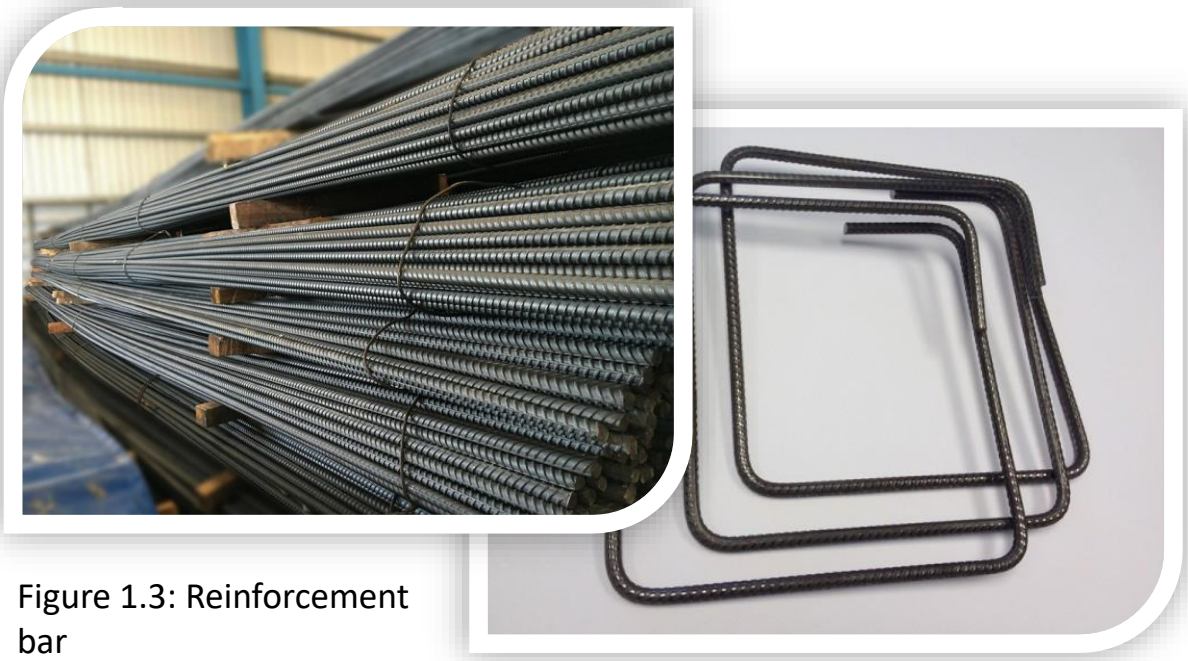


Figure 1.3: Reinforcement bar

Source:https://www.thestructuralworld.com/2018/03/16/development-length-in-reinforcing-bars/
http://www.lemon-gs.co.uk/shop/reinforcement/bar-reinforcement/reinforcing-steel-square-links.html

MEASUREMENT PAPER

All measurement work should be done on the measurement paper and the two commonly used types of measurement paper are traditional measurement paper and segregation measurement paper (normally known as slip sort paper). However, segregation measurement paper is widely used among Quantity Surveying practitioners in Malaysia. Therefore, it is also practiced at higher education institutions.

To fill in the slip sort paper, is according to the annotations specified in the form. In addition, for Column **[1]** is a column of numbers, column **[2]** is a dimension and **[3]** is the total of calculation. Column **[4]** is a space for preliminary calculations and annotations (also known as side cast).

<table>
<tr><td colspan="2">Job:</td><td>Bill No.:</td><td>Element No.:</td><td>Slip No.</td></tr>
<tr><td colspan="5">Heading:</td></tr>
<tr><td colspan="3" rowspan="2">Description:</td><td>Unit:</td></tr>
<tr><td>Quantity:</td></tr>
<tr><td>[1]</td><td>[2]</td><td>[3]</td><td colspan="2">[4]</td></tr>
</table>

Figure 1.4: Typical Slip Sort Paper

CHAPTER 2:

MEASUREMENT FOR COLUMN

COLUMN

In architecture and structural engineering, a column is a vertical structural element that is used to support loads from above and transfer them to a foundation or other support structure below.

Columns are typically cylindrical or rectangular in shape, and can be made from a variety of materials, including stone, brick, concrete, steel and wood. Columns can be used to support a wide range of structures, including buildings, bridges, and monuments.

They are often used in combination with other structural elements, such as beams and trusses, to form a complete structural system. The size, shape and spacing of columns will depend on the specific requirements of the structure including its size, height and intended use.

CONCRETE TO COLUMN

Concrete works can be divided into two types which are reinforced concrete and mass concrete. However, reinforced concrete will be used for the frameworks due to its strength to support the load.

According to Section F.1.2 of SMM2, reinforced concrete works shall be described and measured separately from other concrete.

According to Section F.1.8, Concrete shall be measured as carried out but no deduction shall be made for the following:

a. Volume of any steel embedded in the concrete

b. Voids due to boxed or tubular steelwork not exceeding 0.05m2 sectional area

c. Voids not exceeding 0.05m3 other than voids in soffits of troughed or coffered slabs.

According to section F.3.1, concrete in columns shall be measured in cubic metres. The volume of concrete is obtained by calculating the cross-sectional area multiplied by the height of the column (*Length x Width x Height*). The column height is taken entirely from the top of the ground beam and penetrates the upper floor level up to the top level of the upper beam as in the following illustration (figure 2.1).

The measurements for columns and beams will depend on the specific requirements of the structure including its size, height and intended use.

For columns, the key measurements include the diameter or width and height or length. The diameter or width will depend on the load that the column is intended to support, while the height or length will depend on the height of the building or structure.

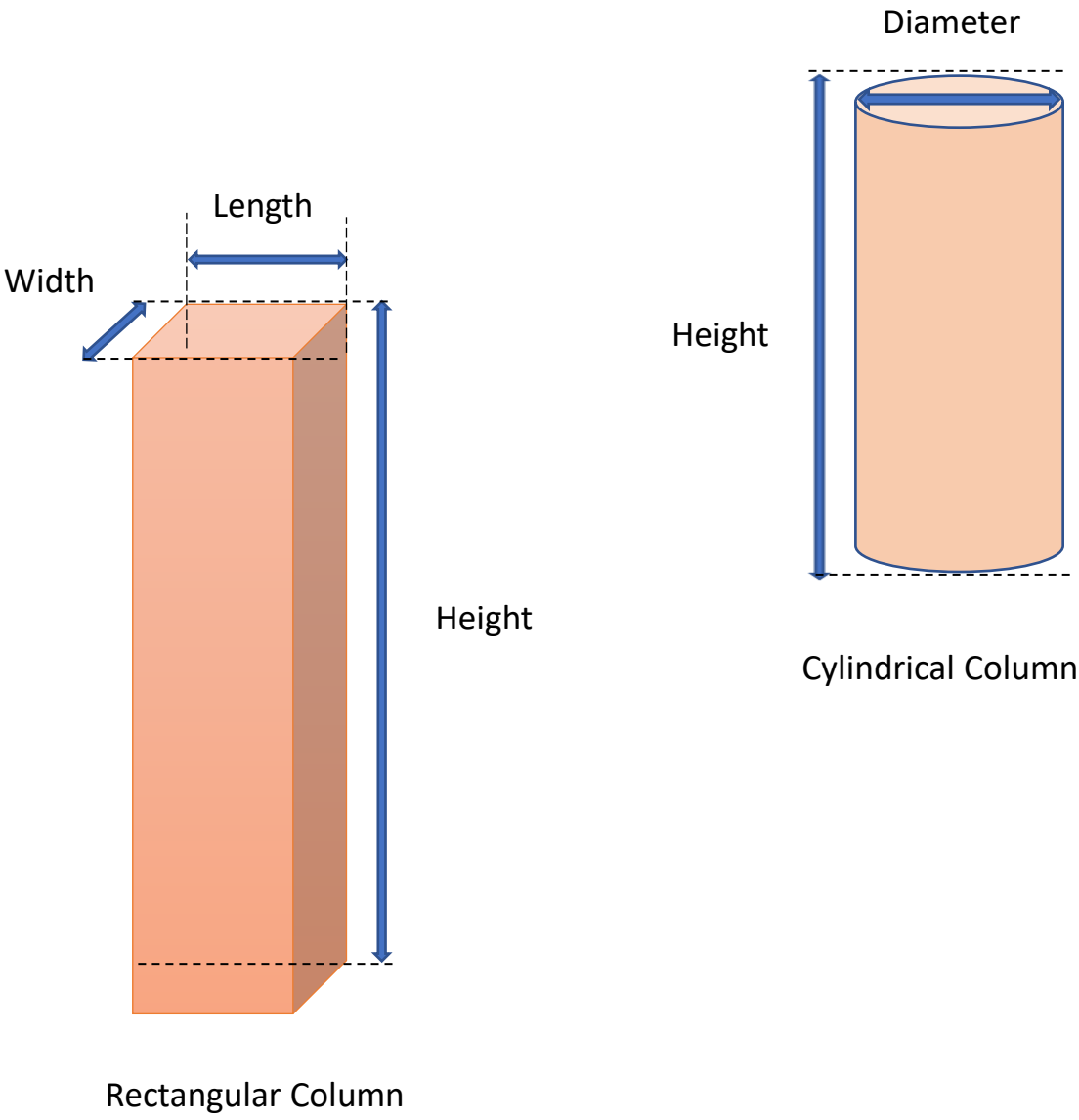
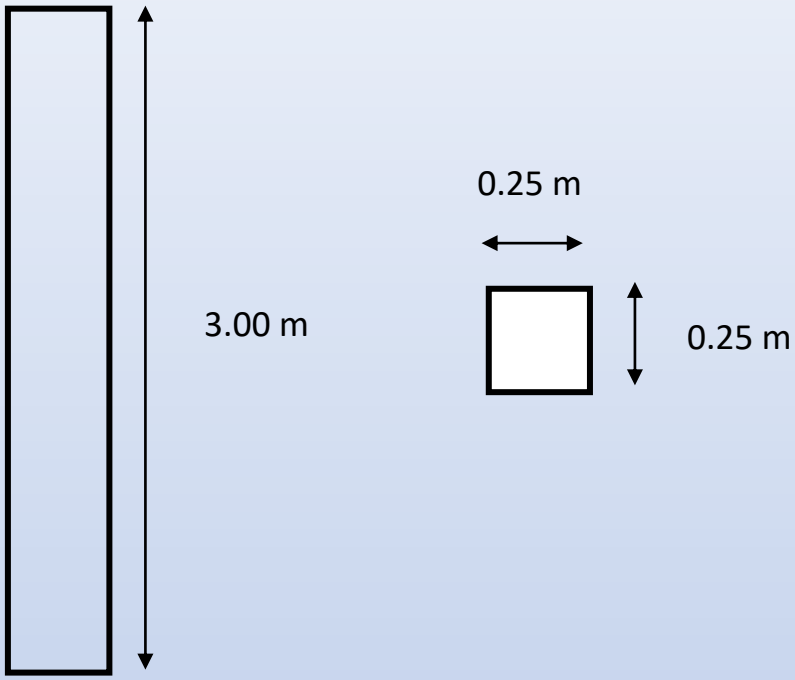


Figure 2.1: Column Elevation

Example 1: Concrete to Column (Cubic Metre)



0.25
0.25
3.00

0.19

Length
0.25

Width
0.25

Height
3.00

FORMWORK TO COLUMN

Formwork is a temporary structure used to support freshly poured concrete until it has cured and is able to support itself. The formwork is typically made of wood, steel or plastic and is designed to conform to the shape of the concrete structure being poured.

According to section F.10.3, formwork to concrete shall be measured to the surfaces of the finished structure. In section F.10.4, void that does not exceed 1.00 square meters should not be deducted because it is considered a small quantity. Section F.10.6 stated that the permanent formwork and left in formwork shall be described and measured separately because the formwork can only be used once and therefore its cost is higher than ordinary formwork. In section F.10.7, formwork to curved surfaces shall be described and measured separately by stating the geometrical nature and the radius or radii.

According to Clause F.15 (formwork to pilasters and columns), formwork to isolated columns shall be measured in square meters. Formwork to columns measured by the girth multiplied by the height of columns to acquire an area of concrete formwork required for columns. No deduction shall be made for the intersection of beams. In other words, the jointing between column and beam, there is no need to deduct the area of intersection.

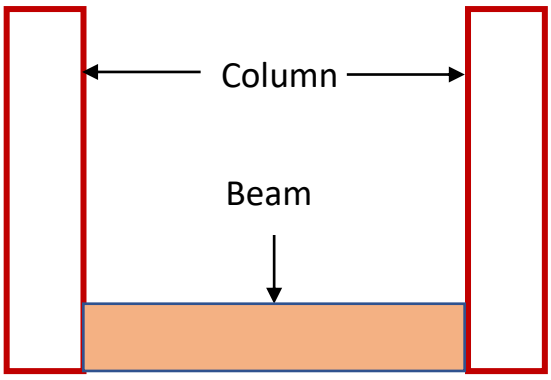
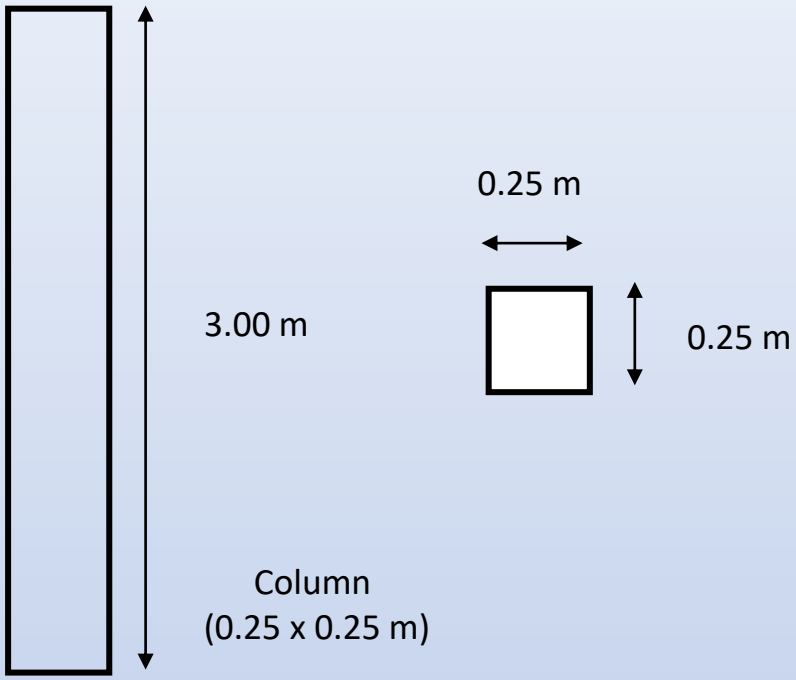
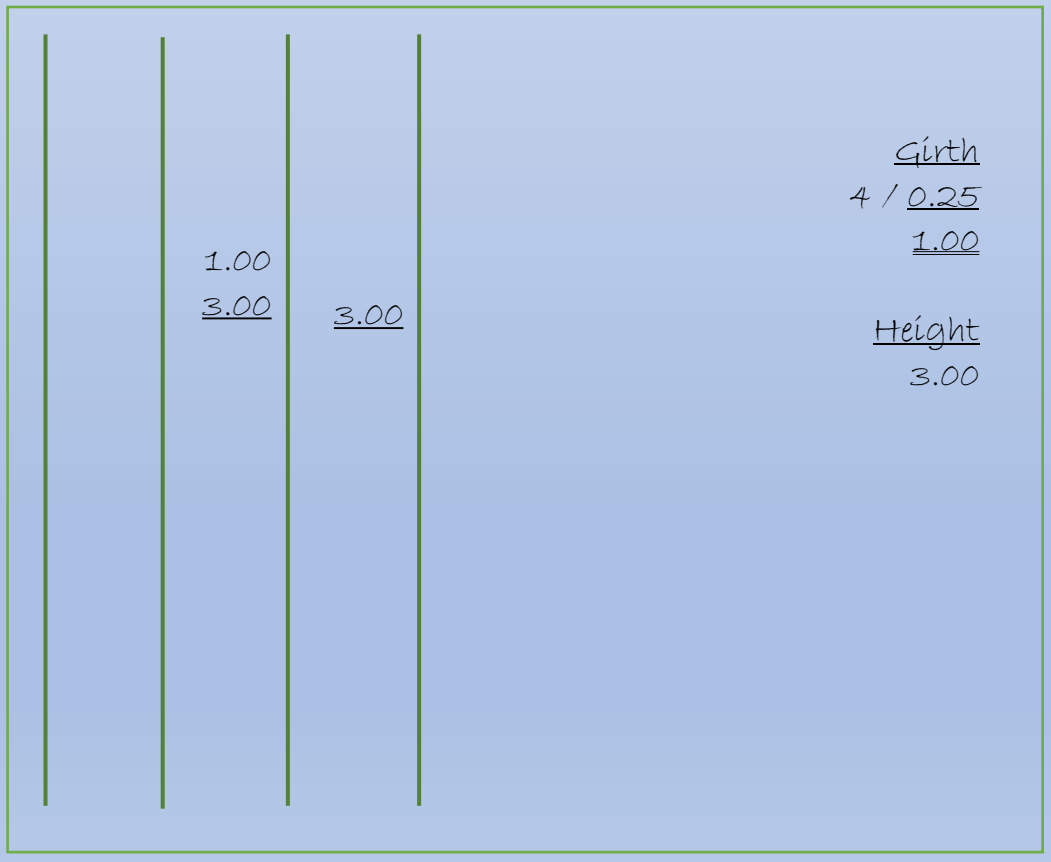


Figure 2.2: Column-beam intersection

Example 2: Formwork to Column (Square Metre)





REINFORCEMENT IN COLUMN

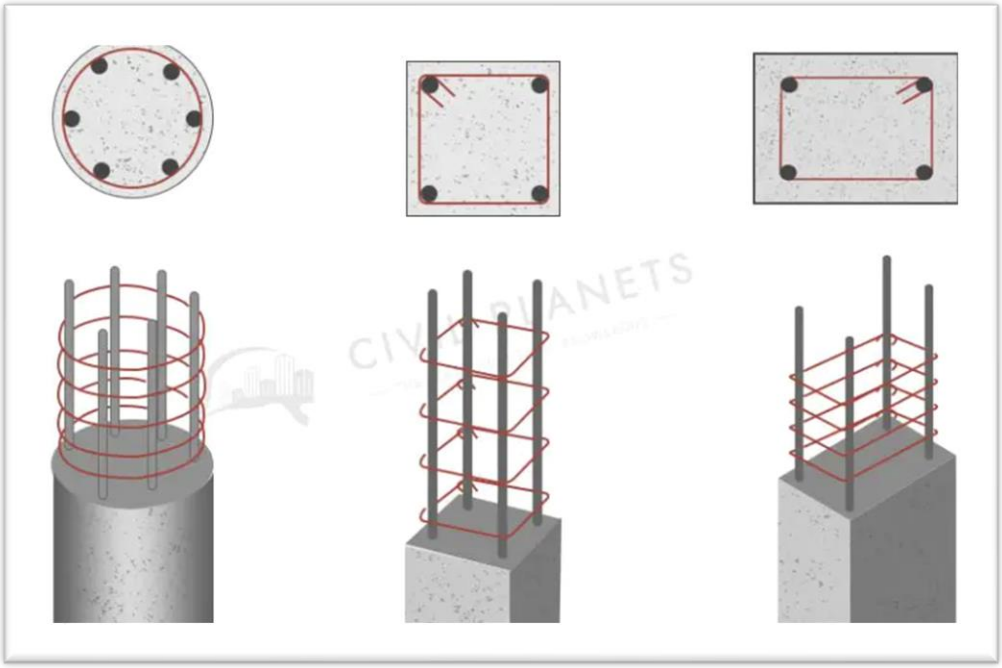
Rebars are placed within the column during the construction process and are secured in place with ties or wire to prevent movement. The purpose of the reinforcement bars is to provide additional strength and support to the concrete column, which can help to prevent cracking or collapse under heavy loads or other stresses.

The spacing and size of the reinforcement bars used in a column will depend on the specific design requirements and the expected load that the column will need to support. It is important that the placement of the bars is done correctly and in accordance with the design specifications to ensure the structural integrity of the column.

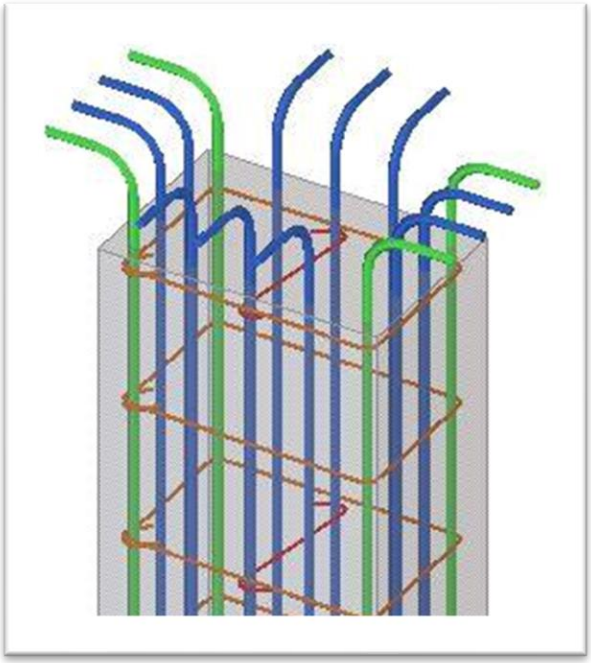
According to section F.8.4j, bar reinforcement for isolated columns, isolated beams and sill are grouped together in a single item. Even so, if the Bills of Quantities are made in the format elements, they must be separated in the quantity of sills because the sill quantities will be listed in another element, either under the door or window element.

According to Section F.8.2, reinforcement bars shall be measured in linear meters and then converted into kilogrammes or tonnes, by expressing the diameter. The kind and quality of steel and section of bars if other than plain circular should be stated in description [F.8.1]. Tests of bar and the restrictions of bending should also be clarified [F.8.1] better incorporated into the specification to simplify the description. Reinforcement separated according to diameter [F.8.2] and whether the bar is straight and bent, curved, stirrup or spacers [F.8.5]. Tying wire used for binding reinforcement bars that intersect with others deemed to include the item reinforcement bar [F.8.3].

The measurement for the reinforcement in the column is divided into two categories which are the main bars; and the links.



Source: https://civilplanets.com/square-or-rectangular-or-circular-column/



Source: *https://teklastructures.support.tekla.com/2019i/en/det_reinforcement_rectangular_column*

Figure 2.3: Reinforcement in column

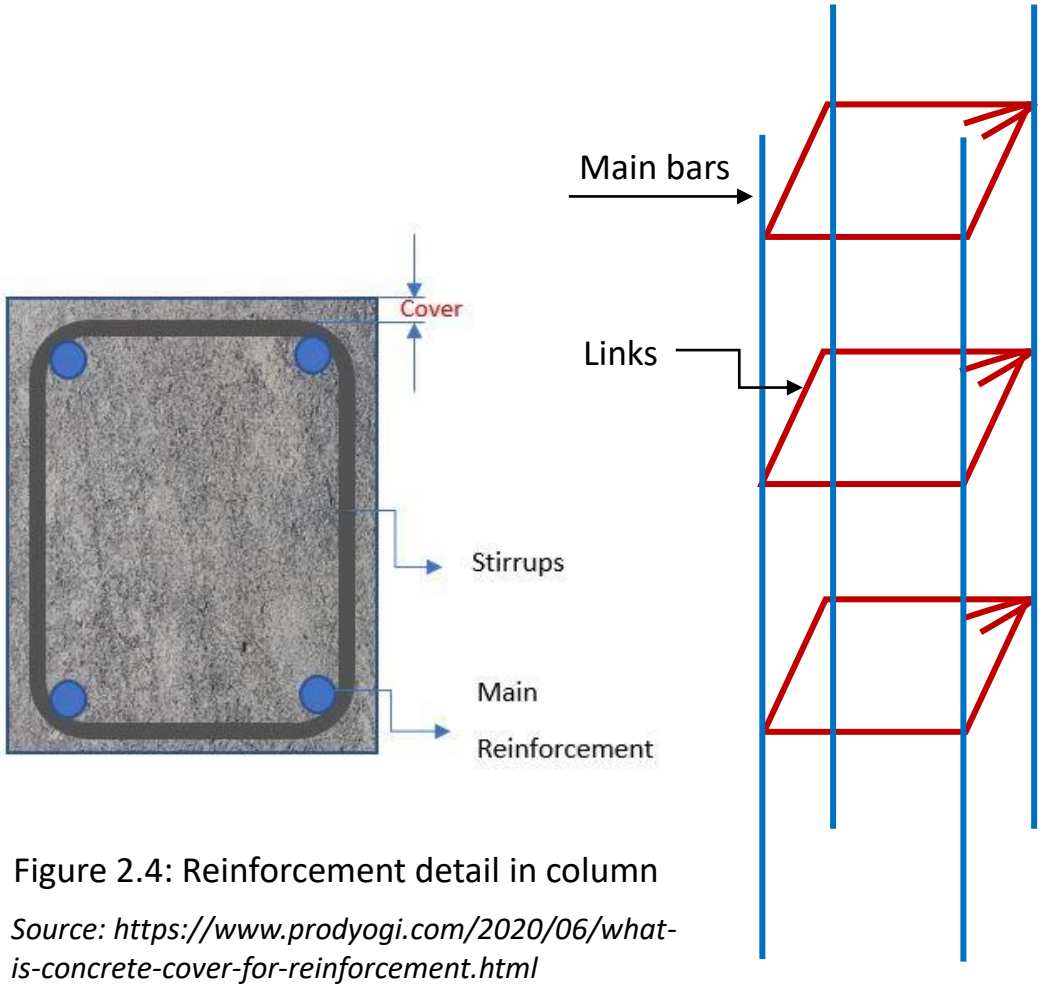


Figure 2.4: Reinforcement detail in column

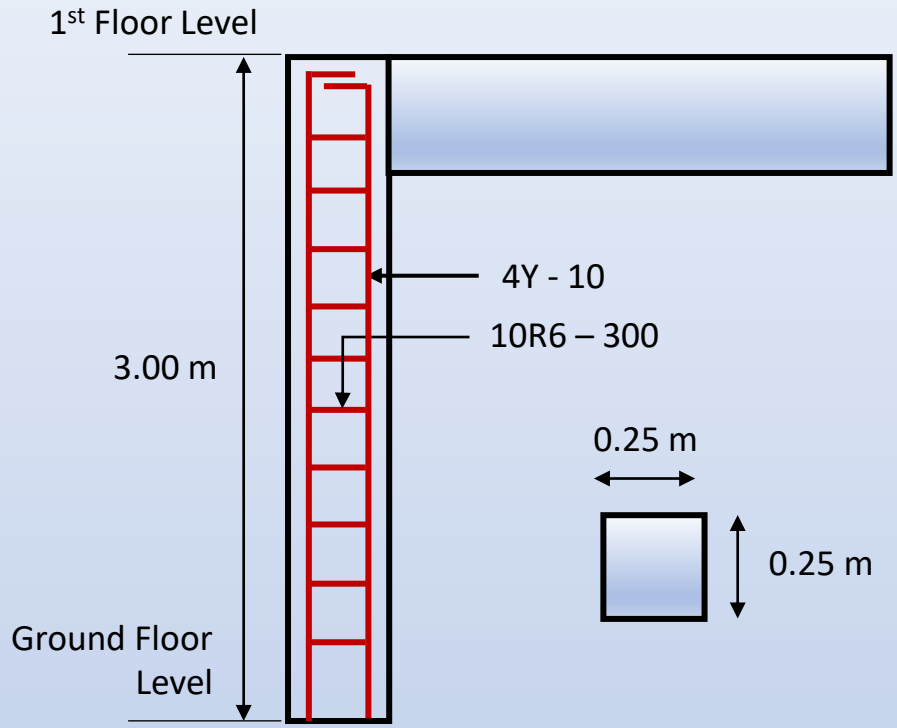
Source: https://www.prodyogi.com/2020/06/what-is-concrete-cover-for-reinforcement.html

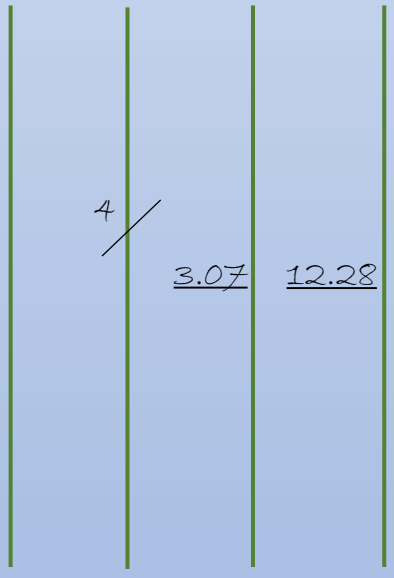
CONCRETE COVER

Concrete cover in concrete measurement refers to the thickness of concrete that separates the surface of the reinforcing steel or other embedded items within concrete from the exposed surface of the concrete. The thickness of the concrete cover depends on various factors such as the type of structure, the environmental conditions it will be exposed to, and the type of reinforcement used.

In general, a sufficient concrete cover is necessary to protect the reinforcement from corrosion and damage, which could lead to structural failure.

Example 3: Reinforcement in Column (Kilogrammes / Tonnes)





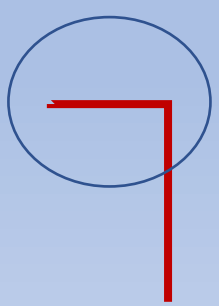
Main bars

Height	
3.00	
Less	
Conc. Cover	0.025
	2.98
Bend	
9.5 D (9.5 x 0.010)	0.095
	3.07

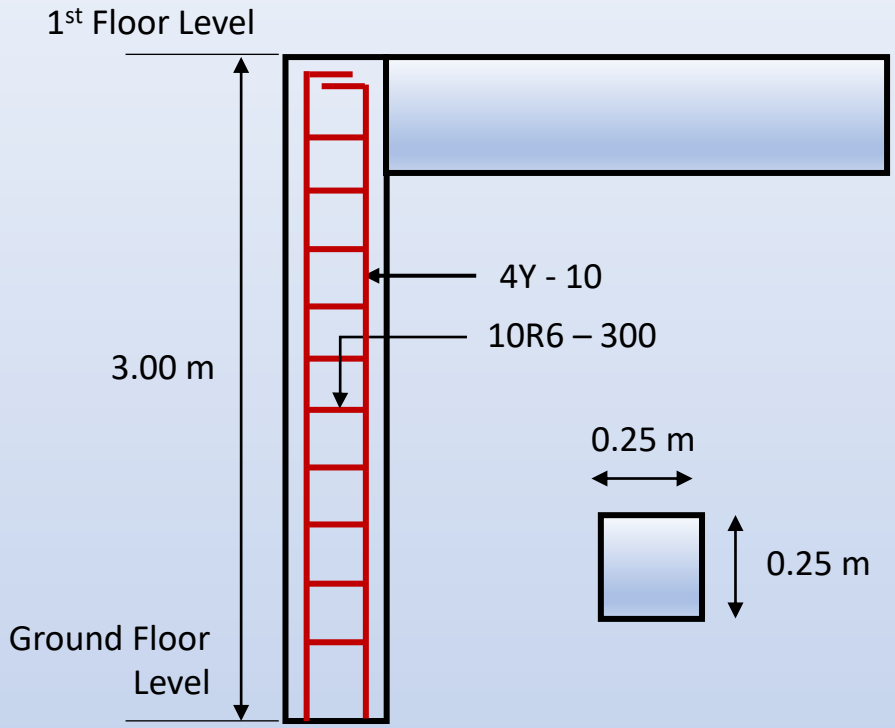
Convert to kg:
12.28m x 0.616 = 7.56kg

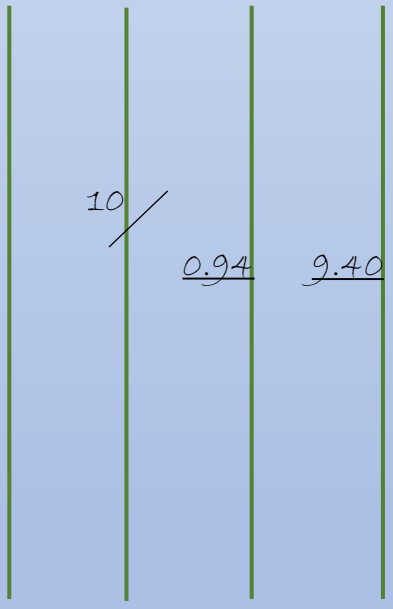
Formula bend:

Mainbars in column = 9.5D
(9.5 x diameter of reinforcement bar)



Example 3: Reinforcement in Column (Kilogrammes / Tonnes)





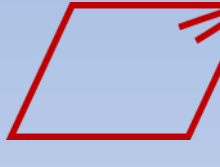
Links

	Girth
4/0.25	1.00
Less	
Conc. Cover (8x0.025)	0.20
	0.80
Bend	
24D (24x 0.006)	0.144
	0.944

Convert to kg:
12.28m x 0.222 = 2.73 kg

Formula bend:

Links = 24D
(24 x diameter of bar reinforcement)



CHAPTER 3:

MEASUREMENT FOR BEAM

BEAM

Beam is a horizontal structural element that is used to support loads across a span or distance. Beams are typically long, slender members that are designed to resist bending and shear forces and are often used in combination with other structural elements, such as columns and trusses to form a complete structural system.

Beams can be made from a variety of materials including wood, steel, concrete and composite materials. The size, shape and spacing of beams will depend on the specific requirements of the structure including its size, height and intended use.

CONCRETE TO BEAM

Concrete in beams shall be measured in cubic metres. The key measurements include the depth, width and length. The volume of the beam is taken from beam cross-sectional area multiplied by length of beam. Beam length is taken between the columns. The secondary beam measured up to the side of the main beam. The thickness of the attached beams with upper floor was measured from the bottom floor.

Figure 3.1: Reinforced concrete beam

According to section F.3.14, attached and isolated beam shall be measured separately. Attached beams means the beam shall be attached with the slab, and the isolated beam are vice versa. However, these beams are in the same categories.

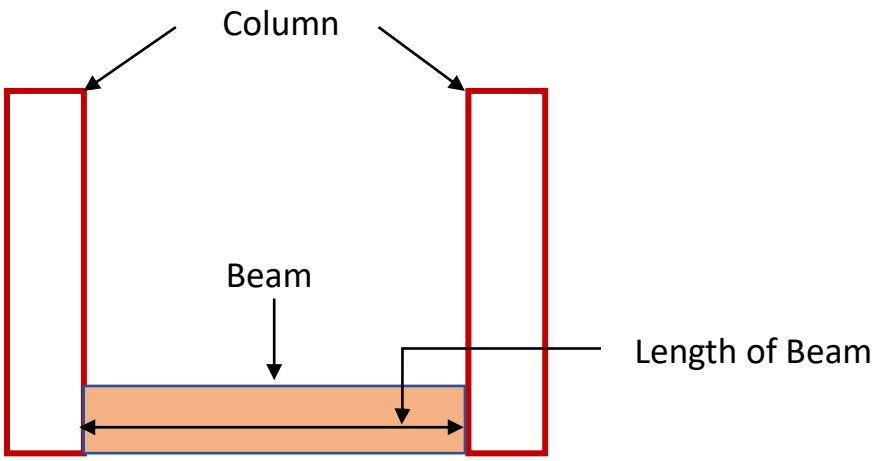
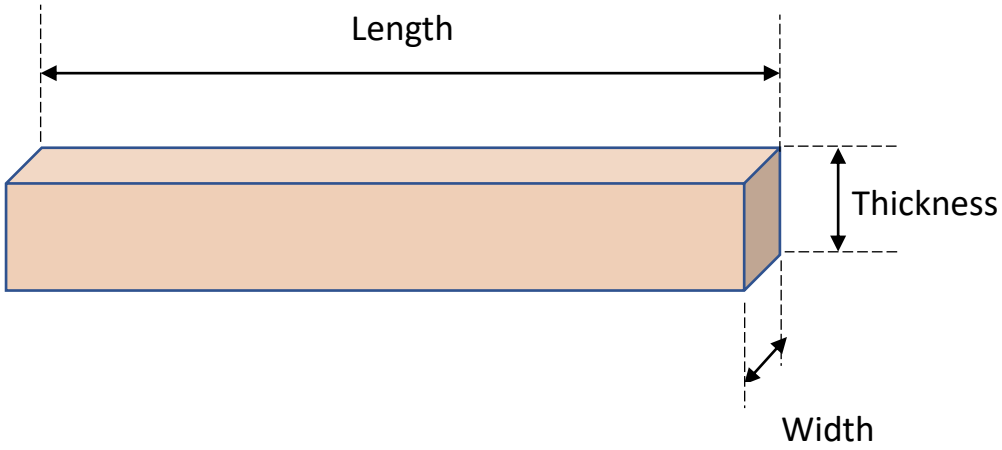
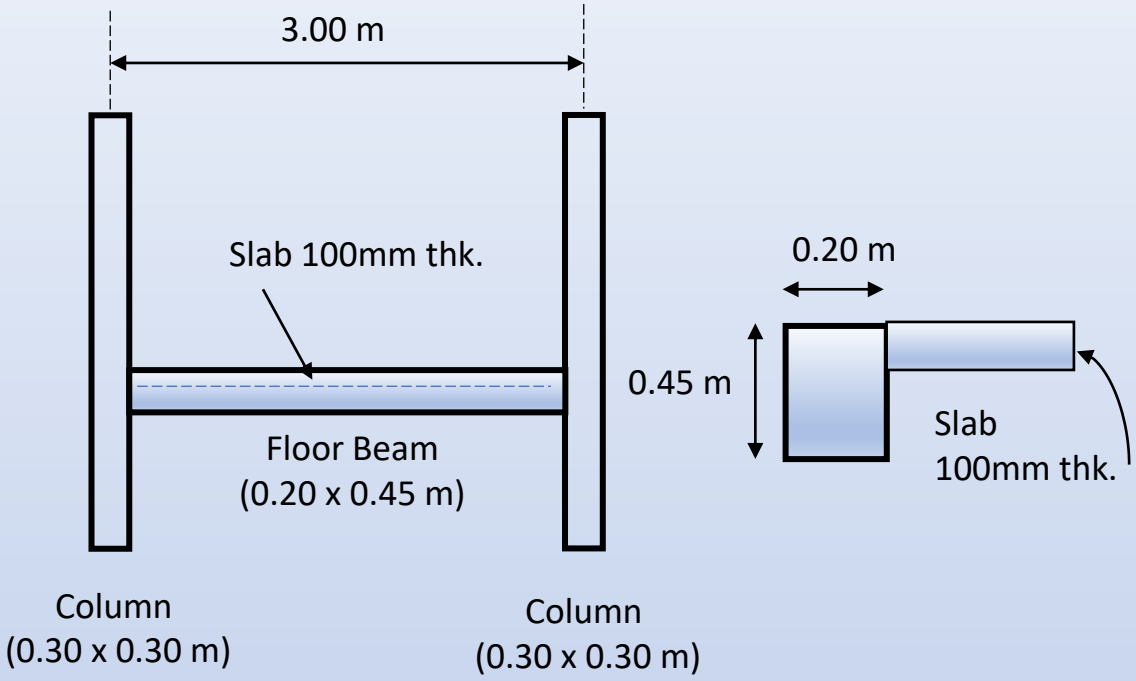


Figure 3.2: Beam – Column intersection

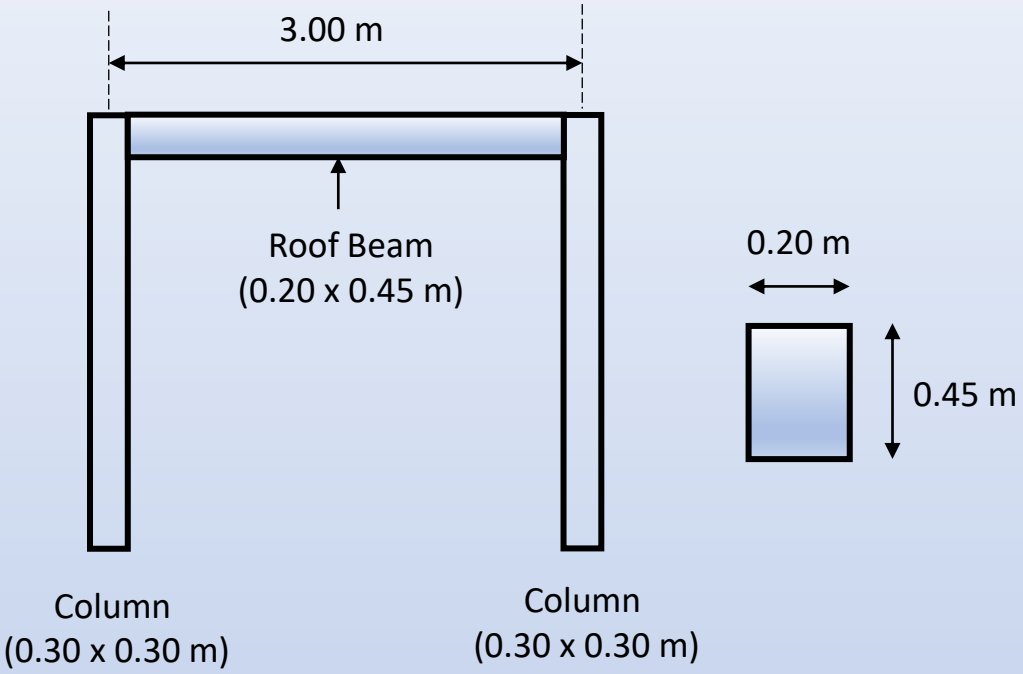


Example 5: Concrete to Floor Beam attached with slab (Cubic Metre)



			Length
2.70			3.00
0.20		Less Column	
0.35	0.19	2/0.15	0.30
			2.70
			Width
			0.20
			Height
			0.45
		Less slab	0.10
			0.35

Example 6: Concrete to Roof beam (Cubic Metre)



2.70
0.20
0.45

0.27

Length
3.00

Less Column
2/0.15

0.30
2.70

Width
0.20

Height
0.45

FORMWORK TO BEAM

Formwork to the sides and soffits of the beam is measured once in one item and in square meters. The formwork shall be classified either horizontal, sloped not more than 15° or more than 15°. Classification of beam as follows:

a. horizontal

b. sloping not exceeding 15˚ from horizontal

c. sloping over 15˚ from horizontal

According to section F.14.3, formwork to sides and soffits of beam, formwork to secondary beams shall be measured up to the sides of main beams, with no deduction allowed where the secondary beam intersect the main beam.

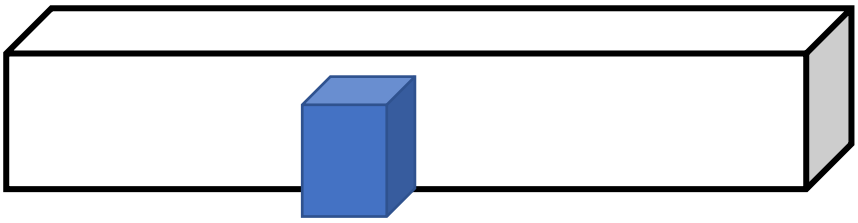


Figure 3.3: Intersection of main beam
with secondary beam

According to section F.10.9, formwork to soffits of beams over 3.50 metres high shall be measured separately and specified the height in stages of 1.50 metres to demonstrate the increasing installation costs.

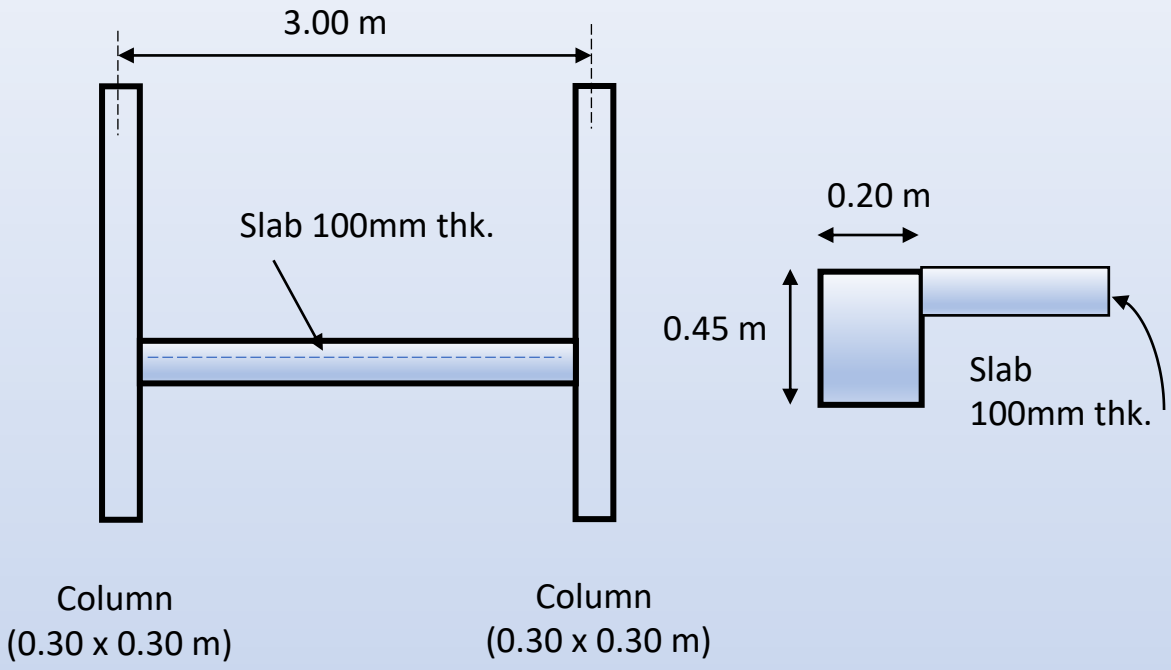
The stages as follows:

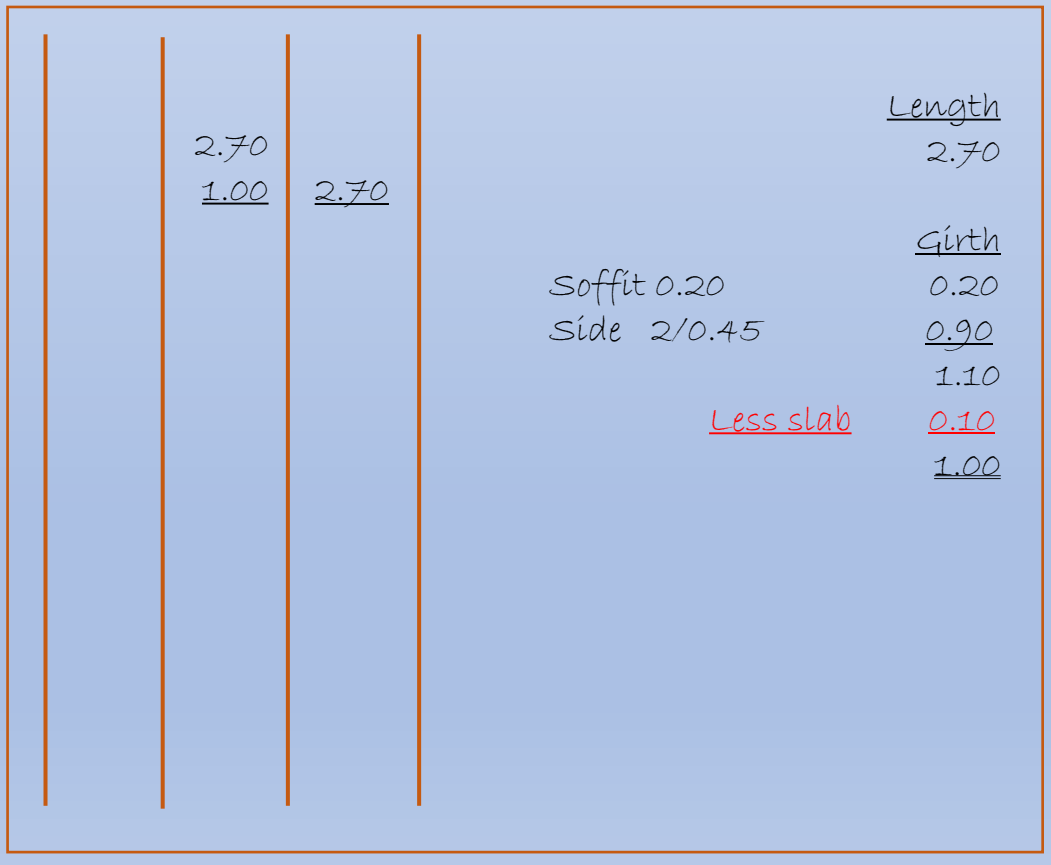
i. ≤ 3.50m high

ii. ≥ 3.50m high

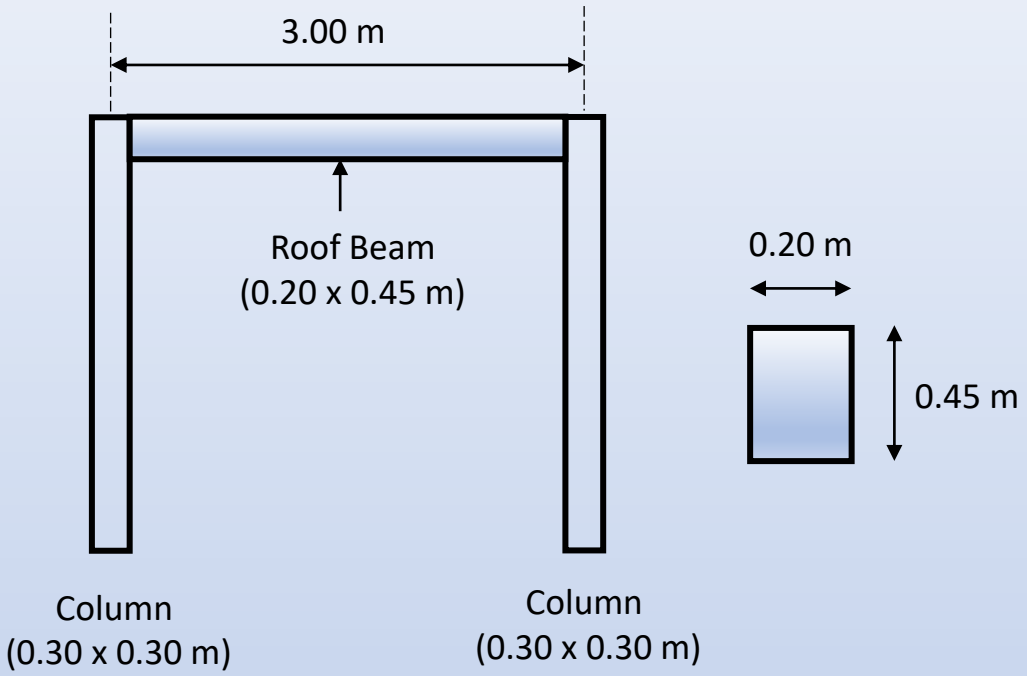
(In further stages of 1.50m, e.g.: 5.00m, 6.50m)

Example 7 : Formwork to Floor Beam (Metre Square)





Example 8: Formwork to Roof Beam (Metre Square)



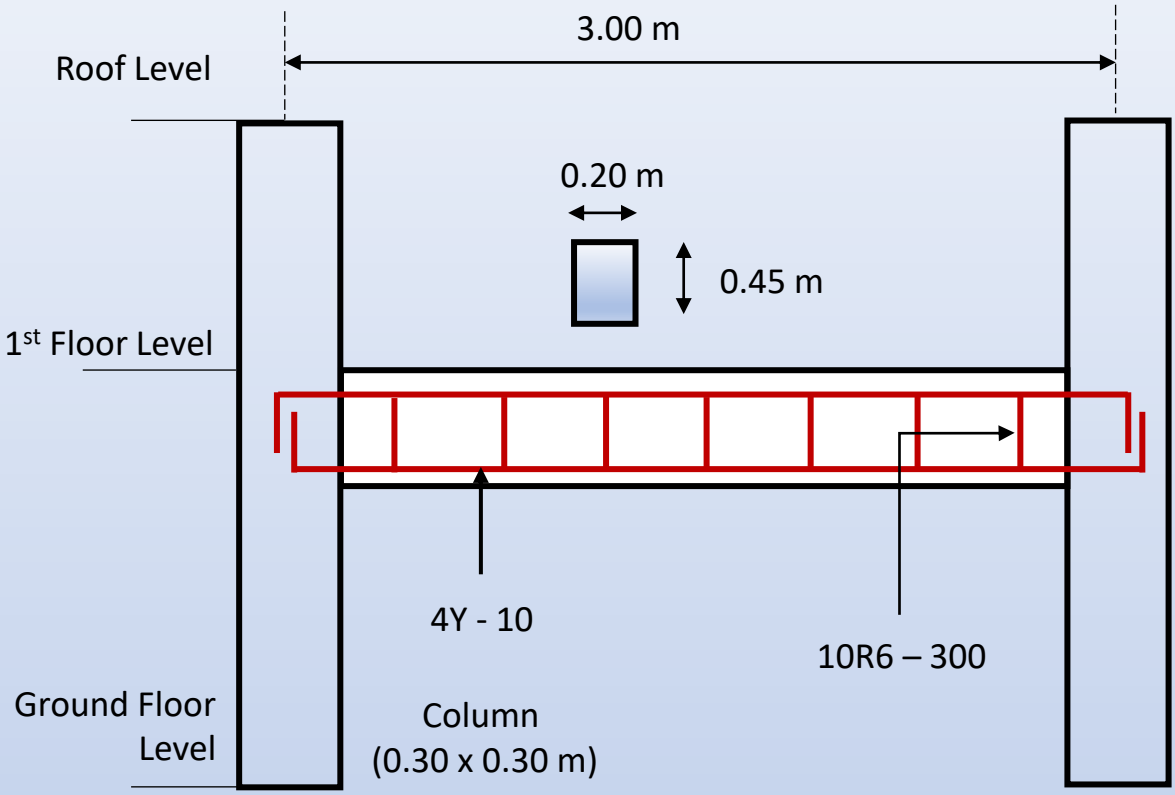
REINFORCEMENT IN BEAMS

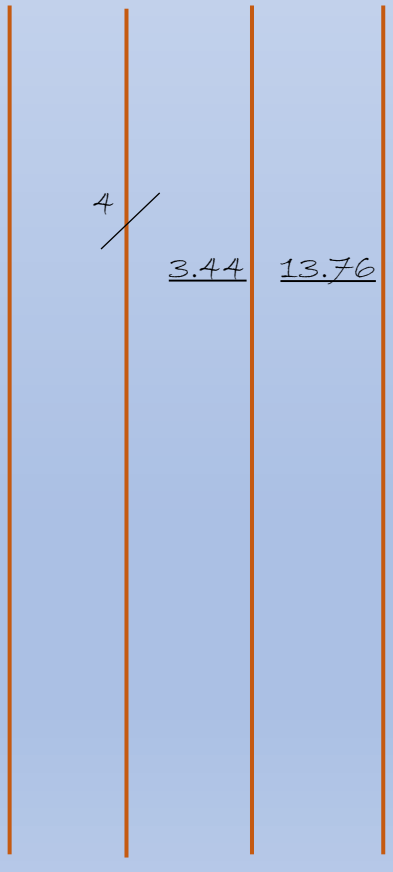
According to section F.8.6, reinforcement bars are installed horizontally and sloping not more than 30° from horizontal measured once in a single item and if it exceeds 12.00 metres, the item should be measured separately by stating the length in metres of the stages of 3.00 metres.

Steel bars are installed vertically and sloping over 30° are grouped together in a single item shall be measured separately if longer than 6.00 metres, specifying the length of the stages of 3.00 metres [F.8.7].

The measurement for the reinforcement in beam is divided into two categories which are the main bars; and the stirrups.

Example 9: Reinforcement in Beam - Mainbars (Kilogrammes / Tonnes)





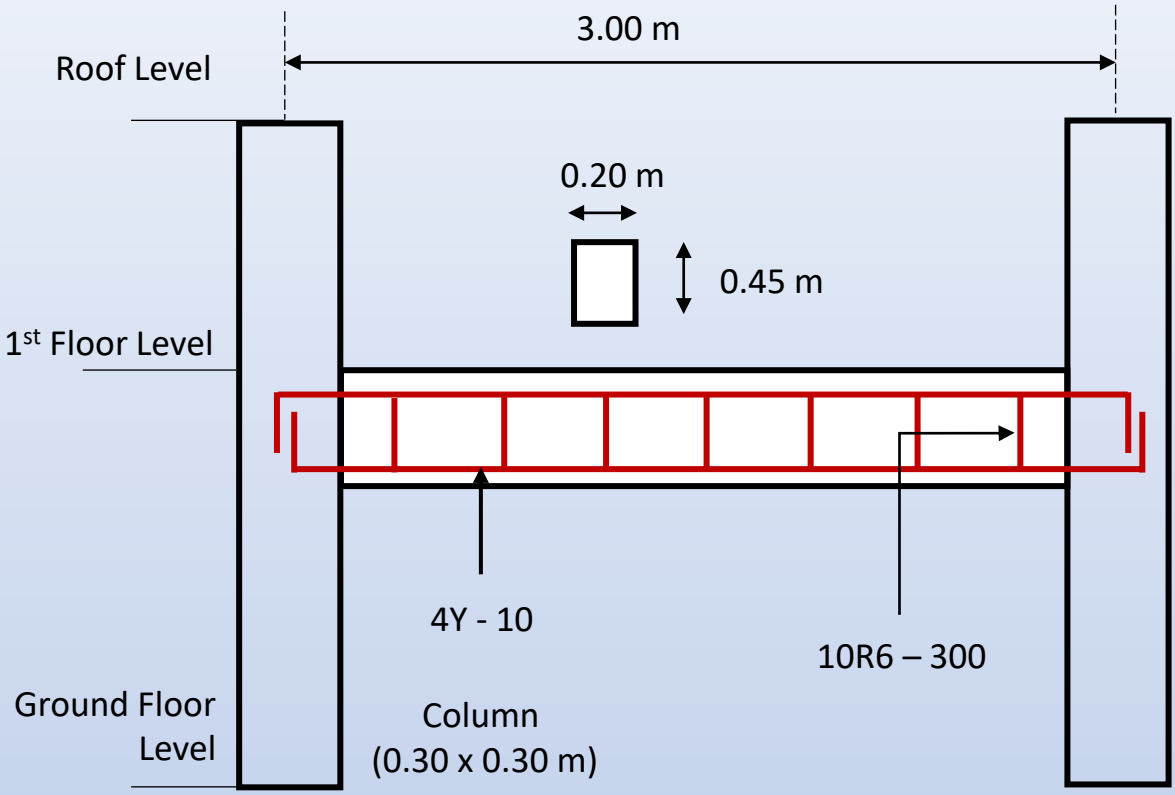
Main bars

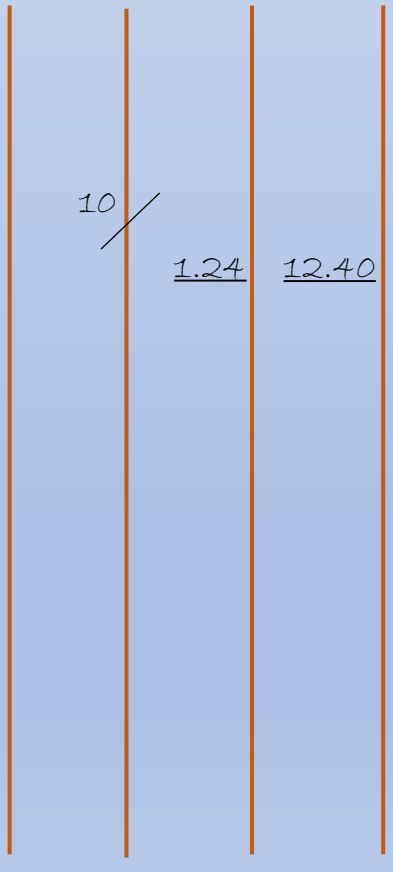
	Length
	3.00
Add Column	
2 x ½ x 0.30	0.30
	3.30
Less Conc. Cover	
2 x 0.025	0.05
	3.25
Bend	
2 x 9.5 D	0.19
	3.44

Convert to kg:

13.76m x 0.616 = 8.48kg

Example 10: Reinforcement in Beam - Stirrups (Kilogrammes / Tonnes)





Stirrups

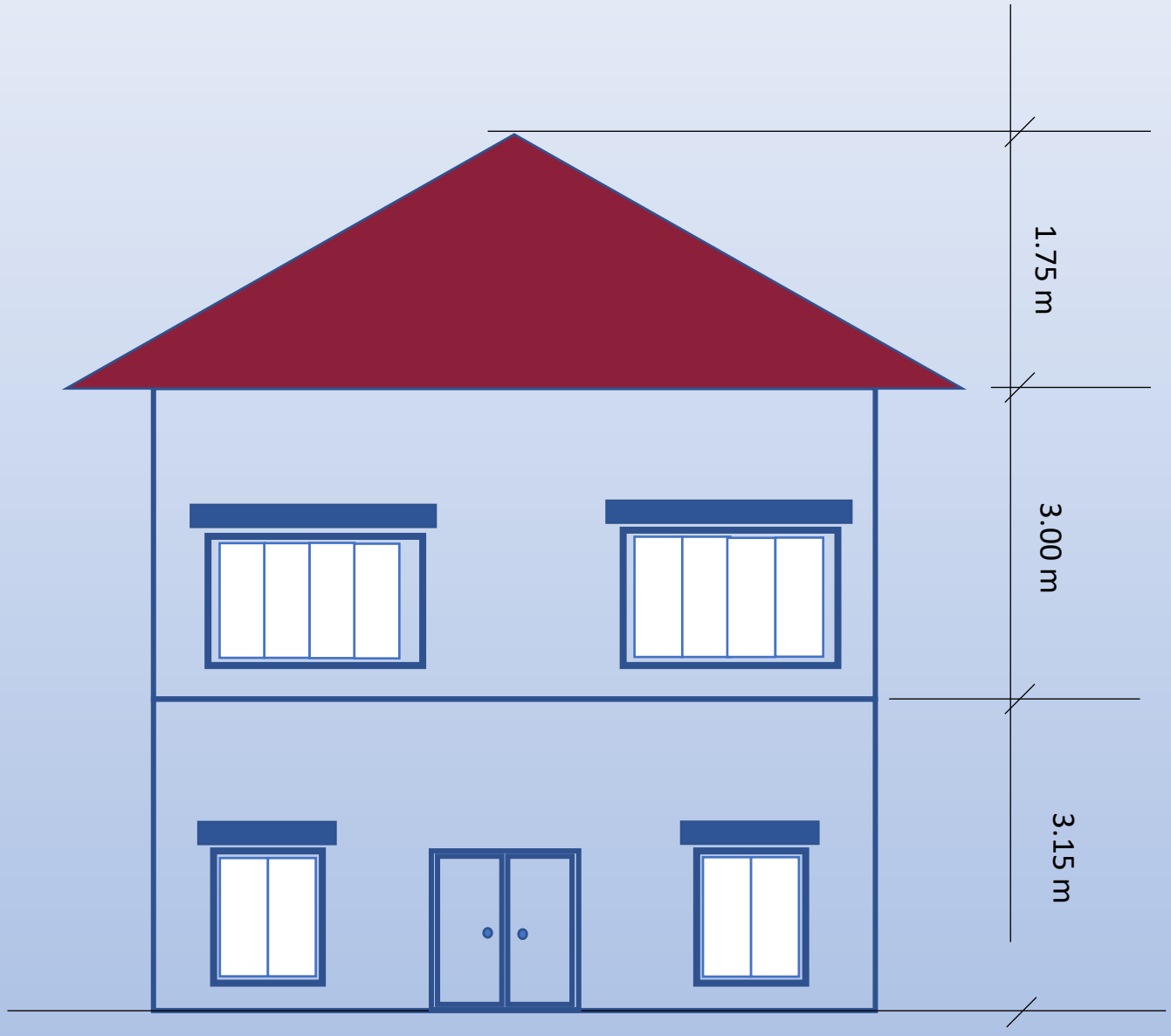
	Girth
2/0.20	0.40
2/0.45	0.90
	1.30
Less	
Conc. Cover (8x0.025)	0.20
	1.10
Bend	
24D (24x 0.006)	0.144
	1.244

Convert to kg:
12.4m x 0.222 = 2.75 kg

CHAPTER 4:

TUTORIAL

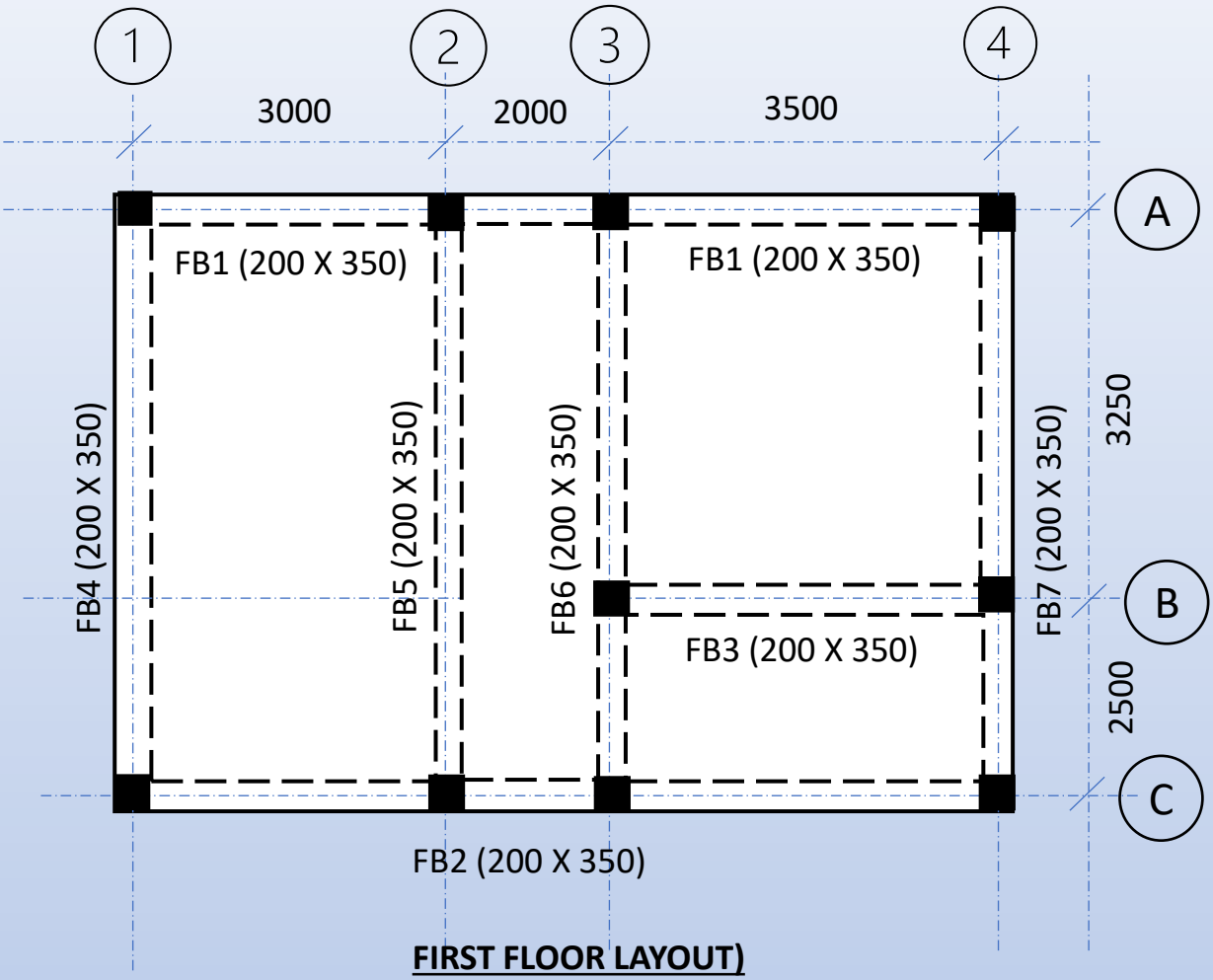
Project:
Proposed construction of 2-storey residential houses of permanent type, on lot 1000, Dioh, Mukim Pilah, district of Kuala Pilah, N. Sembilan Darul Khas.



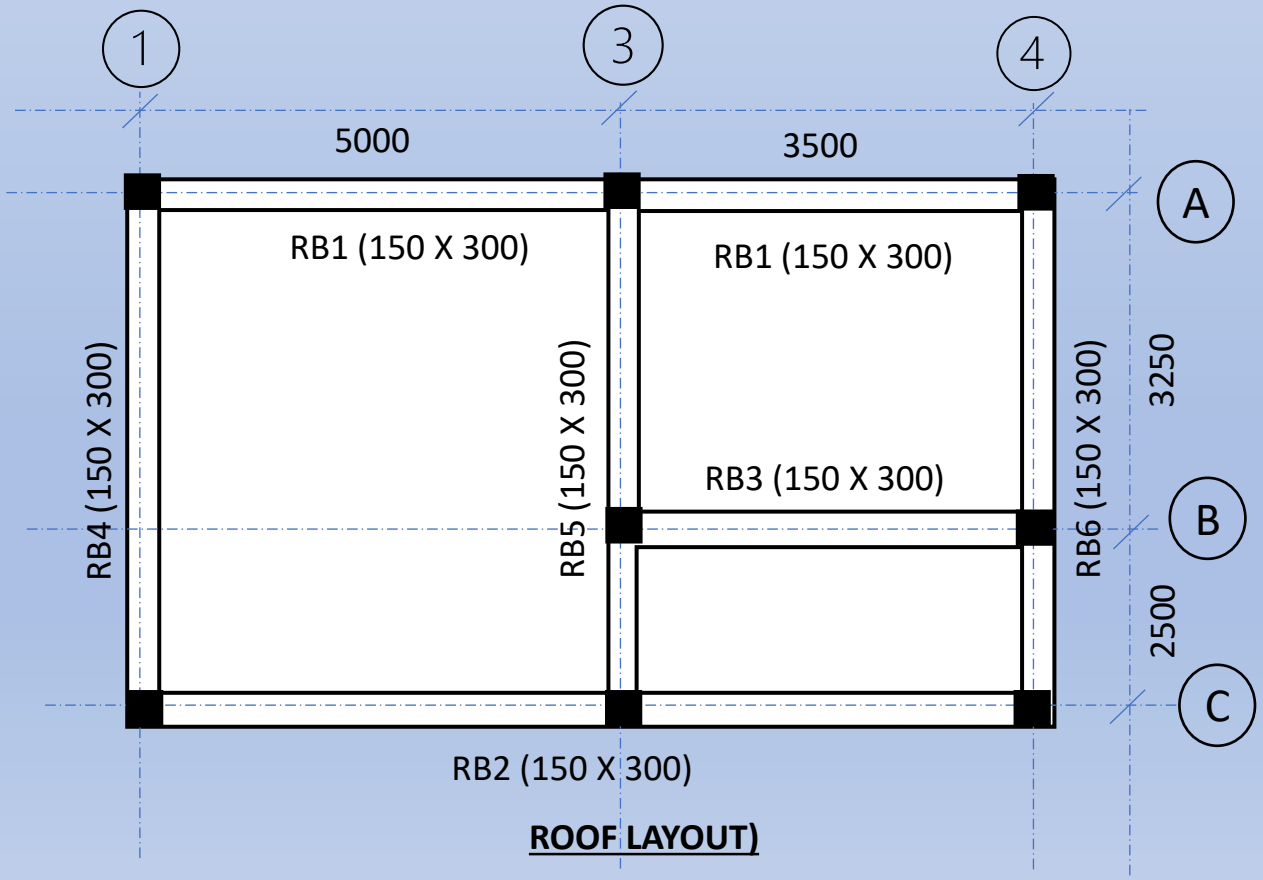
FRONT ELEVATION

NOTES:

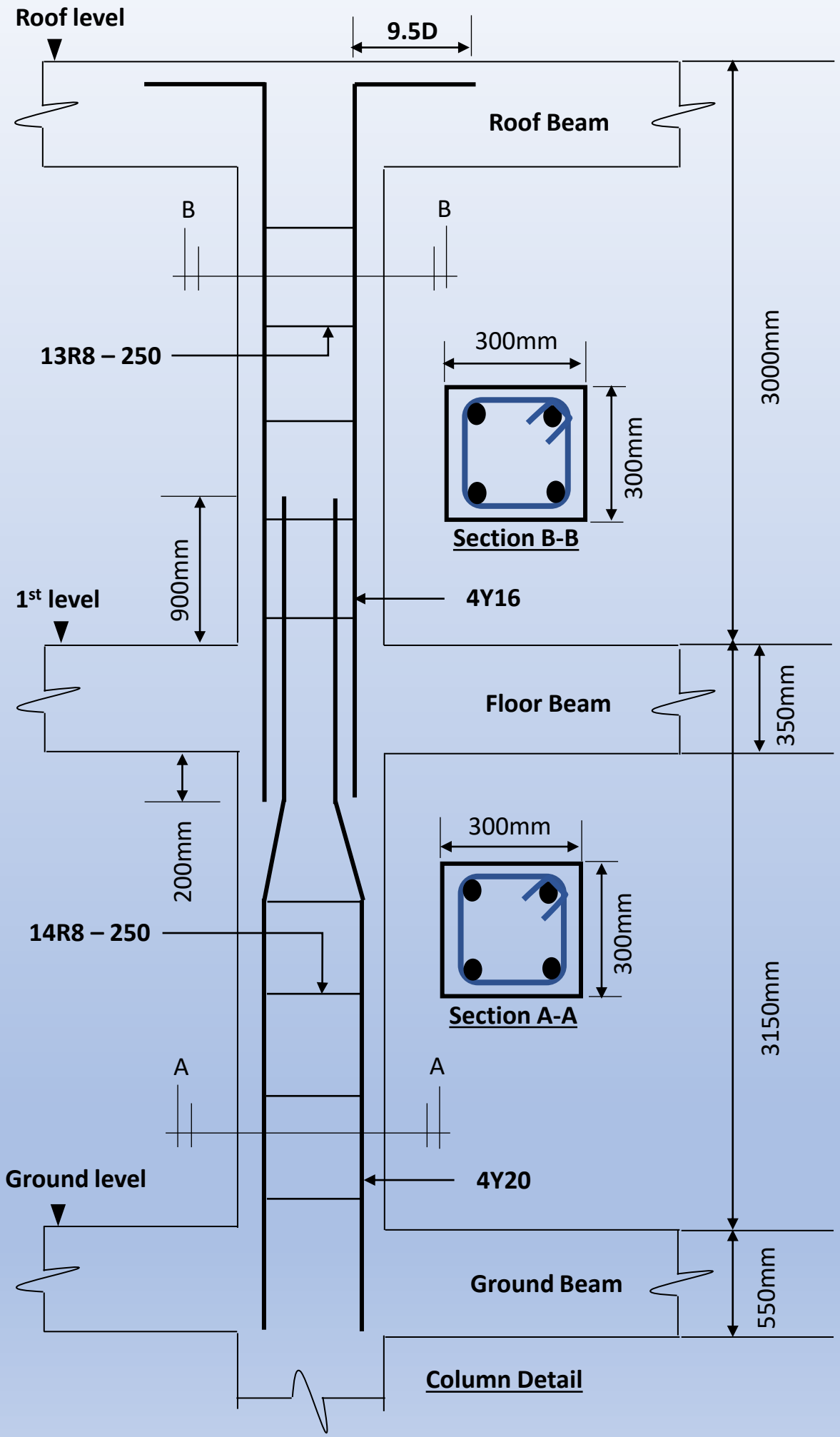
1. ALL CONCRETE SHALL BE IN GRADE 25.
2. ALL COLUMN SHALL BE IN SIZE OF 200 X 200MM.
3. ALL SLAB SHALL BE IN 125MM THICK.
4. ALL CONCRETE COVER SHALL BE IN 25MM THICK.

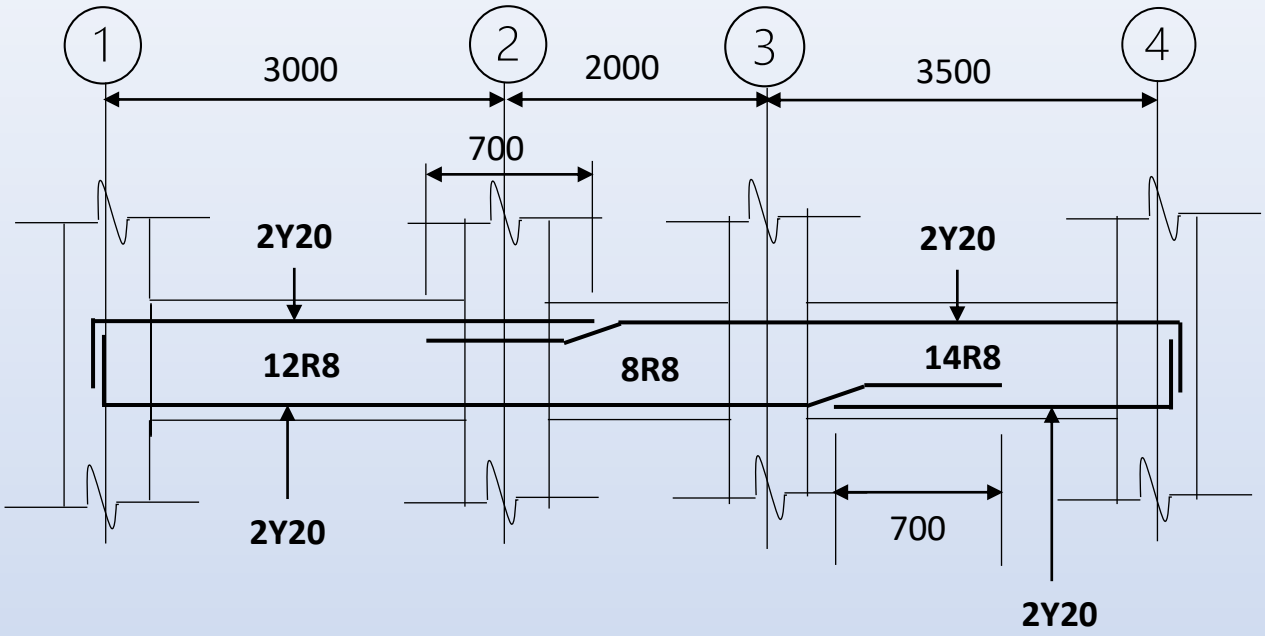


FIRST FLOOR LAYOUT)

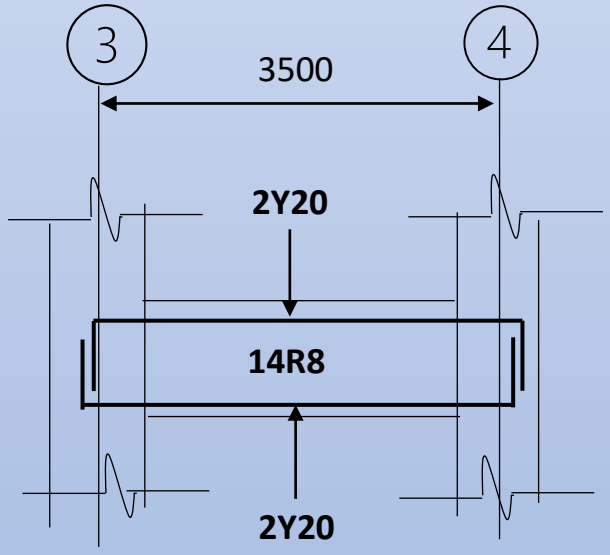


ROOF LAYOUT)

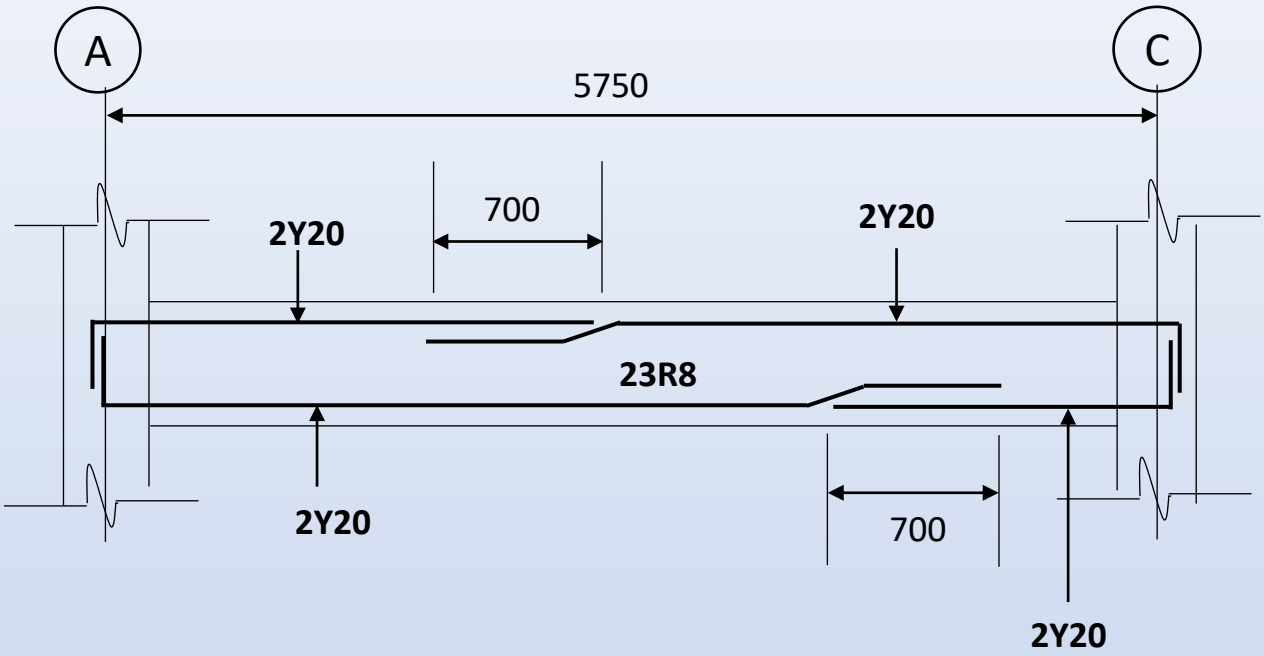

Roof level
9.5D
Roof Beam
B
B
13R8 – 250
300mm
300mm
3000mm
Section B-B
900mm
1st level
4Y16
Floor Beam
350mm
200mm
300mm
300mm
14R8 – 250
Section A-A
3150mm
A
A
Ground level
4Y20
Ground Beam
550mm
Column Detail



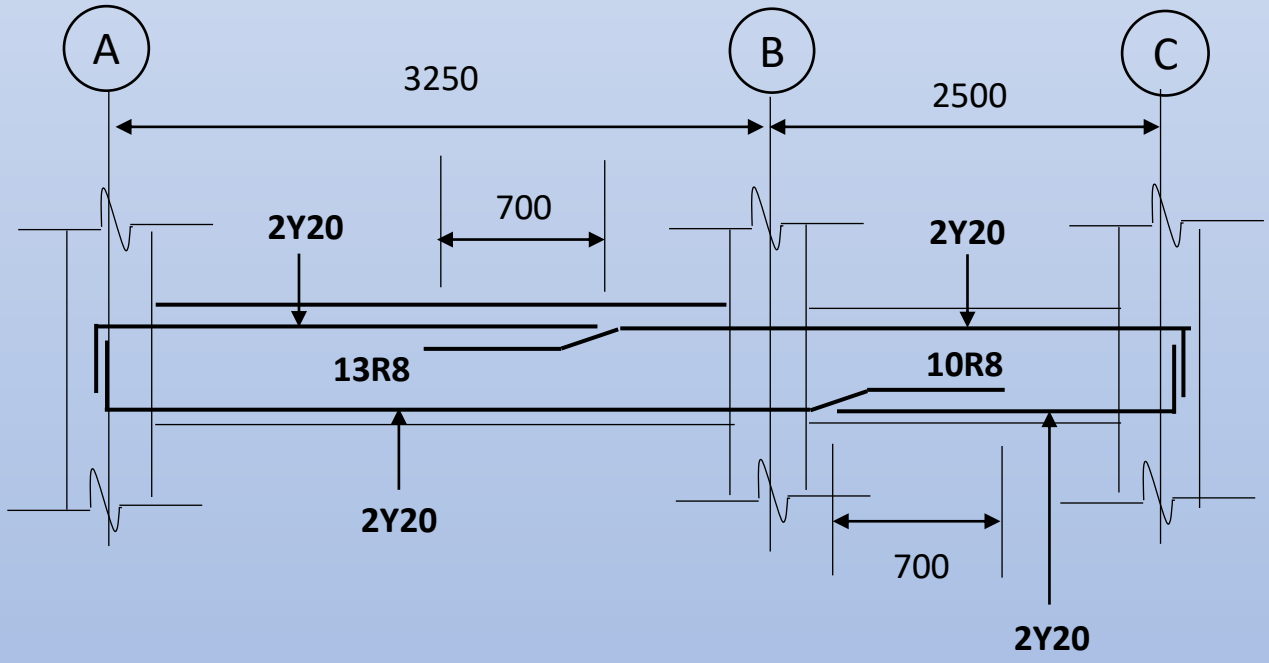
FB1/FB2 (200 X 350)



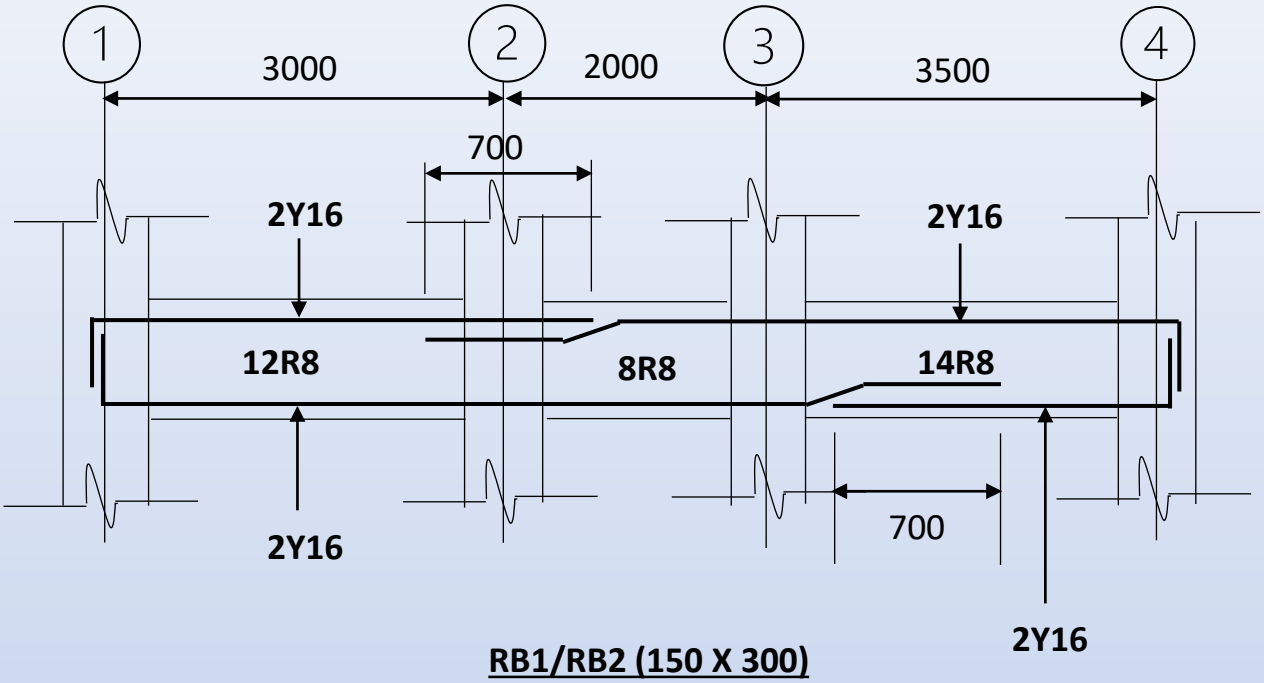
FB3 (200 X 350)



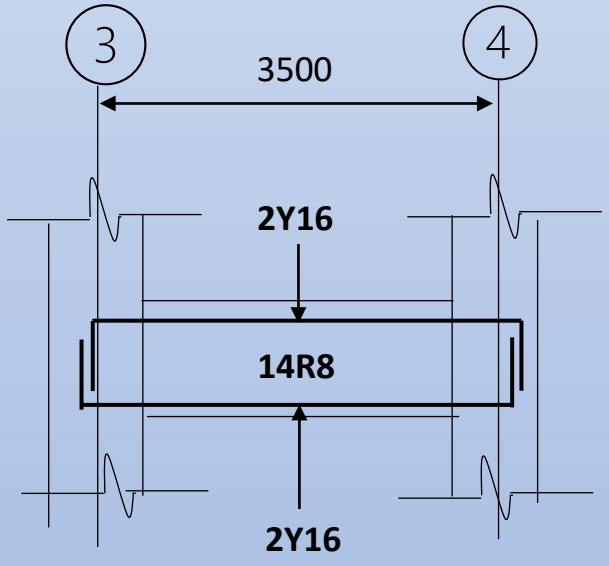
FB4/FB5 (200 X 350)



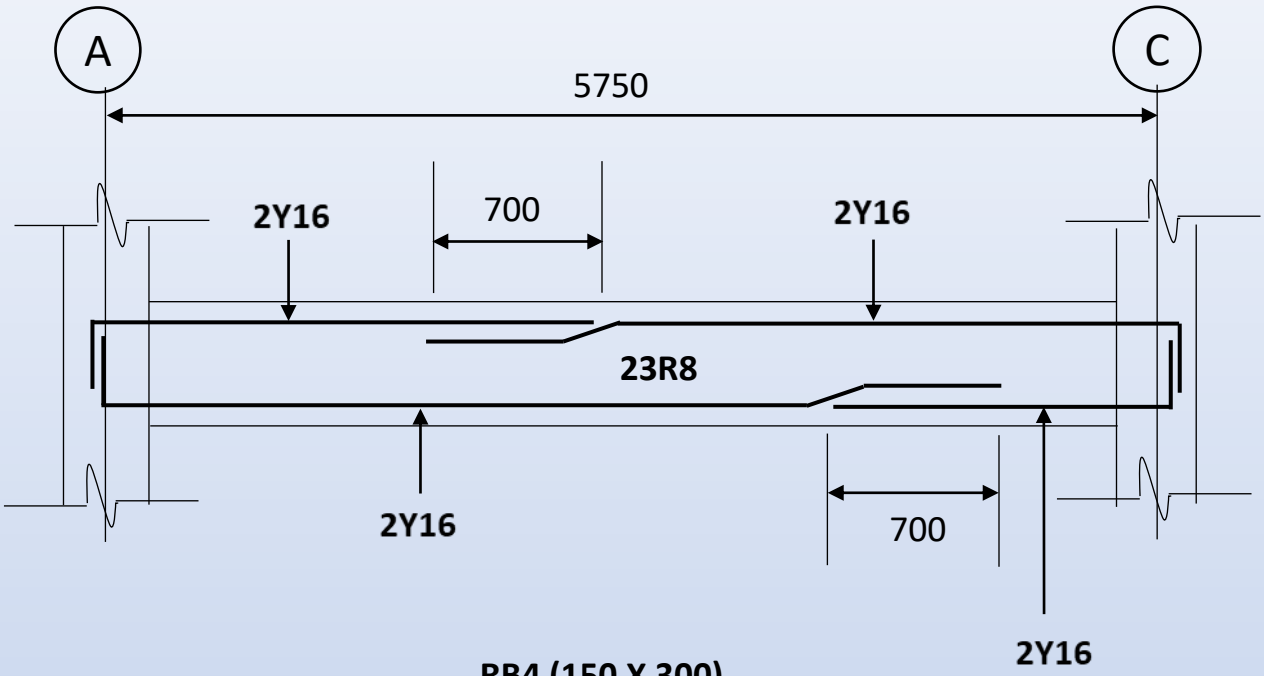
FB6/FB7 (200 X 350)



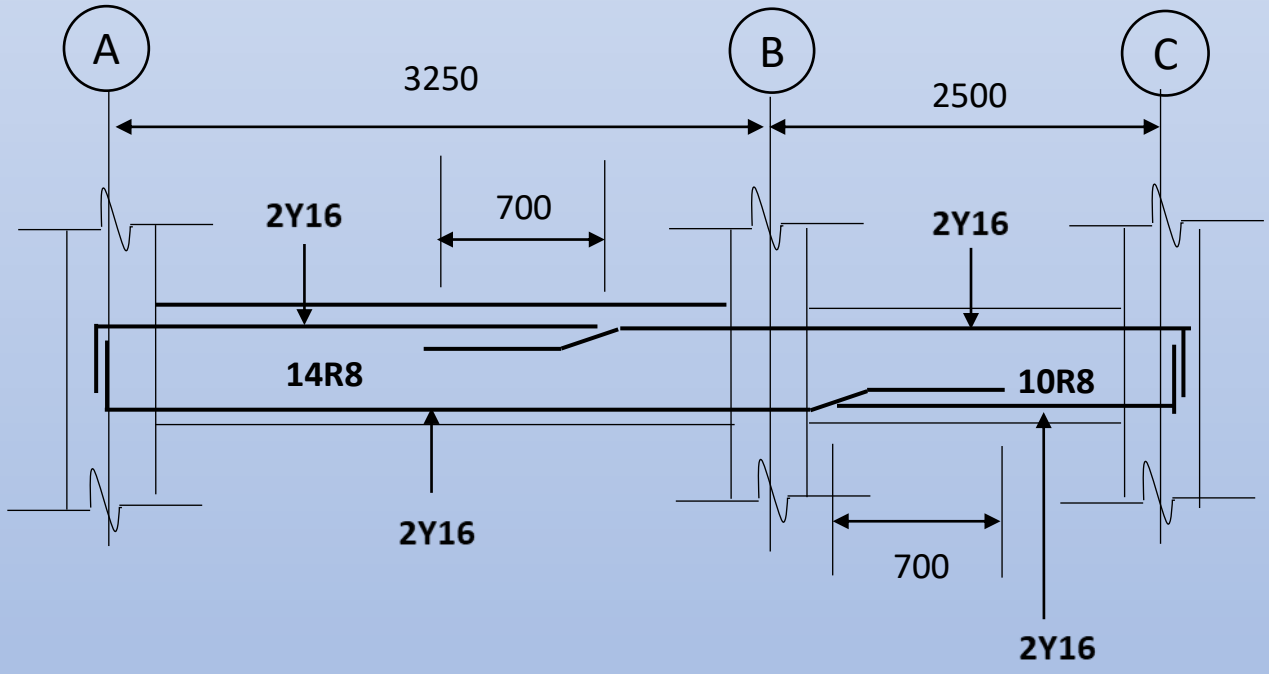
RB1/RB2 (150 X 300)



RB3 (150 X 300)



RB4 (150 X 300)



RB5/RB6 (150 X 300)

TUTORIAL ANSWER

Taking-Off List

No.	Item	Unit
1.	Concrete in isolated column	M3
2.	Formwork to isolated column	M2
3.	Reinforcement bars in isol. Column	Kg
4.	Links in isol. Column	Kg
5.	Concrete in attached beam	M3
6.	Formwork to attached beam	M2
7.	Reinforcement bars in attached beam	Kg
8.	Stirrups in attached beam	Kg

Query List

No.	Queries	Assumptions	Remarks
1.	The thickness of concrete cover	25mm thk.	

Job: Tutorial	Bill No.: 1	Element: Frame	Slip No.: 1
Heading: VRC Grade 20			
Description: In isolated column			Unit: M3
			Quantity: 5

			Ground Floor to 1st Floor lvl.
10			
	0.30		Length
	0.30		0.300
	3.15	2.84	Width
			0.300
			Height
			3.150
			1st Floor lvl to Roof lvl.
8			
	0.30		
	0.30		
	3.00	2.16	Length
		5.00	0.300
			Width
			0.300
			Height
			3.000

Job: Tutorial	Bill No.: 1	Element: Frame	Slip No.: 2
Heading: Sawn formwork			
Description: To sides of isolated column			Unit: M2
			Quantity: 67

			Ground Floor to 1st Floor lvl.
10			Girth
	1.20		4/0.300
	3.15	37.80	1.200
			Height
			3.150
			1st Floor lvl to Roof lvl.
8			Length
	1.20		4/0.300
	3.00	28.80	1.200
		66.60	Height
			3.000

Job: Tutorial	Bill No.: 1	Element: Frame	Slip No.: 3
Heading: Reinforcement bar			
Description: 20mm dia. H.t steel reinf. In straight and bent bars in isolated column			Unit: KG Quantity:

10 4	4.60	184.00	Ground Floor to 1st Floor lvl. Length Add laps 3.150 900 550 1.450 4.600 **Convert to KG:** **184.00m x 2.466 = 453.74 KG**

Job: Tutorial	Bill No.: 1	Element: Frame	Slip No.: 4
Heading: Reinforcement bar			
Description: 16mm dia. H.t steel reinf. In straight and bent bars in isolated column			Unit: KG Quantity: 186

8 / 4 /	3.68	117.76	1st Floor lvl to Roof lvl.

	Length
Add laps	3.000
350	
200	0.550
	3.550
Add bend	
9.5D (0.016)	0.152
	3.700
Less conc. Cover	0.025
	3.680

Convert to KG:
117.76m x 1.578 = 185.83 KG

Job: Tutorial	Bill No.: 1	Element: Frame	Slip No.: 5
Heading: Reinforcement bar			
Description: 8mm dia. Mild steel reinforcement as links in isolated column			Unit: KG Quantity: 115

			Ground Floor to Roof lvl.
10 / 14	1.19	166.60	Girth 4/0.300 1.200
			Less conc. Cover 8 x 0.025 0.200 1.000
			Add hooks 24D (0.008) 0.192 1.192
8 / 13	1.19	123.76 290.36	1st Floor lvl to Roof lvl.
			Convert to KG: **290.36m x 0.395 = 114.69 KG**

Job: Tutorial	Bill No.: 1	Element: Frame	Slip No.: 6
Heading: VRC Grade 20			
Description: In attached floor beam			Unit: M3
			Quantity: 2

			FB 1 & FB2 (200 x 350)	
2				Length
	7.60			8.500
	0.20			
	0.23	0.70	Less column	
			3/0.300	0.900
				7.600
				Width
				0.200
				Thickness
				0.350
			Less slab	0.125
				0.225

Job: Tutorial	Bill No.: 1	Element: Frame	Slip No.: 7
Heading: VRC Grade 20			
Description: In attached floor beam			Unit: M3
			Quantity:

			FB 3 (200 x 350)	
				Length
				3.500
	3.20		Less column	
	0.20			
	0.23	0.15	2 x ½ x0.300	0.300
				3.200
				Width
				0.200
				Thickness
				0.350
			Less slab	0.125
				0.225

Job: Tutorial	Bill No.: 1	Element: Frame	Slip No.: 8
Heading: VRC Grade 20			
Description: In attached floor beam			Unit: M3
			Quantity:

			FB4 & FB5 (200 x 350)	
				Length
2				5.750
	5.45			
	0.20		Less column	
	0.23	0.50	2 x ½ x 0.300	0.300
				5.450
				Width
				0.200
				Thickness
				0.350
			Less slab	0.125
				0.225

Job: Tutorial	Bill No.: 1	Element: Frame	Slip No.: 9
Heading: VRC Grade 20			
Description: In attached floor beam			Unit: M3
			Quantity:

			FB6 & FB7 (200 x 350)	
				Length
2				5.750
	5.15		Less column	
	0.20		2 x 0.300	0.600
	0.23	0.47		5.150
				Width
				0.200
				Thickness
				0.350
			Less slab	0.125
				0.225

Job: Tutorial	Bill No.: 1	Element: Frame	Slip No.: 10
Heading: VRC Grade 20			
Description: In attached floor beam			Unit: M3
			Quantity:

			COLLECTION PAGE
		0.70	Page 6
		0.15	Page 7
		0.50	Page 8
		0.47	Page 9
		1.82	

Job: Tutorial	Bill No.: 1	Element: Frame	Slip No.: 11
Heading: Sawn formwork			
Description: To sides and soffit of attached floor beam			Unit: M2
			Quantity: 26

			FB1 & FB2 (200 x 350)	
				Length
				8.500
2			Less column	
	7.60			
	0.78	11.86	3/0.300	0.900
				7.600
				Girth
			Soffit - 0.200	0.200
			Side - 2/0.350	0.700
				0.900
			Less slab	0.125
				0.780

Job: Tutorial	Bill No.: 1	Element: Frame	Slip No.: 12
Heading: Sawn formwork			
Description: To sides and soffit of attached floor beam			Unit: M2
			Quantity:

			FB3 (200 x 350)	
				Length
				3.500
	3.20		Less column	
	0.65	2.08	2 x ½ x 0.300	0.300
				3.200
				Girth
				0.900
			Less slab	
			2 / 0.125	0.250
				0.650

Job: Tutorial	Bill No.: 1	Element: Frame	Slip No.: 13
Heading: Sawn formwork			
Description: To sides and soffit of attached floor beam			Unit: M2
			Quantity:

			FB4 (200 x 350)
			Length
			5.450
	5.45		Girth
	0.78	1.25	0.780
			FB5 (200 x 350)
			Length
			5.450
	5.45		Girth
	0.65	3.54	0.650
		4.79	

Job: Tutorial	Bill No.: 1	Element: Frame	Slip No.: 14
Heading: Sawn formwork			
Description: To sides and soffit of attached floor beam			Unit: M2
			Quantity:

			FB6 (200 x 350)	Length 5.150 Girth 0.650
	5.15 0.65	3.35		
			FB7 (200 x 350)	Length 5.150 Girth 0.780
	5.15 0.78	4.01 7.37		

Job: Tutorial	Bill No.: 1	Element: Frame	Slip No.: 15
Heading: VRC Grade 20			
Description: In attached floor beam			Unit: M3
			Quantity:

			COLLECTION PAGE
		11.86	Page 11
		2.08	Page 12
		4.79	Page 13
		7.37	Page 14
		26.10	

Job: Tutorial	Bill No.: 1	Element: Frame	Slip No.: 16
Heading: Reinforcement bar			
Description: 20mm dia. H.t steel reinf. In straight and bent bars in attached floor beam			Unit: KG Quantity: 504

			FB1 & FB2	
				Length
2			Add laps	8.500
4	9.30	74.40		0.700
				9.200
			Add column	
			2 x ½ x 0.300	0.300
				9.500
			Add bend	
			2 [9.5D (0.020)]	0.380
				9.880
			Less conc. Cover	
			2/0.025	0.050
				9.930
			Convert to KG:	
			74.40m x 2.466 = 183.47 KG	

Job: Tutorial	Bill No.: 1	Element: Frame	Slip No.: 17
Heading: Reinforcement bar			
Description: 20mm dia. H.t steel reinf. In straight and bent bars in attached floor beam			Unit: KG Quantity:

			FB3	
4	4.13	16.52		Length
				3.50
			Add column	
			2 x ½ x 0.300	0.30
				3.80
			Add bend	
			2 [9.5D (0.020)]	0.380
				4.18
			Less conc. Cover	
			2/0.025	0.050
				4.130
			Convert to KG: **16.52m x 2.466 = 40.74 KG**	

Job: Tutorial	Bill No.: 1	Element: Frame	Slip No.: 18
Heading: Reinforcement bar			
Description: 20mm dia. H.t steel reinf. In straight and bent bars in attached floor beam			Unit: KG Quantity:

2 / 4 /	7.08	56.64	FB4 & FB5

	Length
Add laps	5.750
	0.700
	6.450
Add column	
2 x ½ x 0.300	0.300
	6.750
Add bend	
2 [9.5D (0.020)]	0.380
	7.130
Less conc. Cover	
2/0.025	0.050
	7.080

Convert to KG:
56.54m x 2.466 = 139.67 KG

Job: Tutorial	Bill No.: 1	Element: Frame	Slip No.: 19
Heading: Reinforcement bar			
Description: 20mm dia. H.t steel reinf. In straight and bent bars in attached floor beam			Unit: KG
			Quantity: 98

			FB6 & FB7
			Length
2 / 4 /	7.08	56.64	Add laps 5.750
			0.700
			6.450
			Add column
			2 x ½ x 0.300 0.300
			6.750
			Add bend
			2 [9.5D (0.020)] 0.380
			7.130
			Less conc. Cover
			2/0.025 0.050
			7.080
			Convert to KG: **56.64m x 2.466 = 139.67 KG**

Job: Tutorial	Bill No.: 1	Element: Frame	Slip No.: 20
Heading: VRC Grade 20			
Description: In attached floor beam			Unit: M3
			Quantity:

			COLLECTION PAGE
		183.47	Page 16
		40.74	Page 17
		139.67	Page 18
		139.67	Page 19
		503.55	

Job: Tutorial	Bill No.: 1	Element: Frame	Slip No.: 21
Heading: Reinforcement bar			
Description: 8mm dia. Mild steel reinforcement as stirrups in attached floor beam			Unit: KG
			Quantity: 75

2 / 34	1.09	74.12	FB1 & FB2	Girth
			Side - 2/0.200	0.400
			Thick - 2/0.350	0.700
				1.100
			Less conc. Cover 8 x 0.025	0.20
				0.900
			Add hooks 24D (0.008)	0.192
				1.092

Total No. of stirrups
12+8+14 = 34

Convert to KG:
74.12m x 0.395 = 29.28 KG

Job: Tutorial	Bill No.: 1	Element: Frame	Slip No.: 22
Heading: Reinforcement bar			
Description: 8mm dia. Mild steel reinforcement as stirrups in attached floor beam			Unit: KG Quantity:

14	1.09	15.26	FB3 Girth Side - 2/0.200 0.400 Thick - 2/0.350 0.700 1.100 Less conc. Cover 8 x 0.025 0.20 0.900 Add hooks 24D (0.008) 0.192 1.092 Total No. of stirrups 14 **Convert to KG:** **15.26m x 0.395 = 6.03 KG**

Job: Tutorial	Bill No.: 1	Element: Frame	Slip No.: 23
Heading: Reinforcement bar			
Description: 8mm dia. Mild steel reinforcement as stirrups in attached floor beam			Unit: KG Quantity:

2 / 23	1.09	50.14	FB4 & FB5	Girth
			Side - 2/0.200	0.400
			Thick - 2/0.350	0.700
				1.100
			Less conc. Cover 8 x 0.025	0.20
				0.900
			Add hooks	
			24D (0.008)	0.192
				1.092
				Total No. of stirrups 23
			Convert to KG: **50.14m x 0.395 = 19.81 KG**	

Job: Tutorial	Bill No.: 1	Element: Frame	Slip No.: 24
Heading: Reinforcement bar			
Description: 8mm dia. Mild steel reinforcement as stirrups in attached floor beam			Unit: KG Quantity:

2 23	1.09	50.14	FB6 & FB7 Girth Side - 2/0.200 0.400 Thick - 2/0.350 0.700 1.100 Less conc. Cover 8 x 0.025 0.20 0.900 Add hooks 24D (0.008) 0.192 1.092 Total No. of stirrups 13+10 = 23 **Convert to KG:** **50.14m x 0.395 = 19.81 KG**

Job: Tutorial	Bill No.: 1	Element: Frame	Slip No.: 25
Heading: VRC Grade 20			
Description: In attached floor beam			Unit: M3
			Quantity:

			COLLECTION PAGE
		29.28	Page 21
		6.03	Page 22
		19.81	Page 23
		19.81	Page 24
		74.93	

Job: Tutorial	Bill No.: 1	Element: Frame	Slip No.: 26
Heading: VRC Grade 20			
Description: In roof beam			Unit: M3
			Quantity: 2

			RB 1 & RB2 (150 x 300)	
				Length
2				8.500
	7.90		Less column	
	0.15		2/0.300	0.600
	0.30	0.71		7.900
				Width
				0.150
				Thickness
				0.300

Job: Tutorial	Bill No.: 1	Element: Frame	Slip No.: 27
Heading: VRC Grade 20			
Description: In roof beam			Unit: M3
			Quantity:

			RB 3 (150 x 300)	
				Length
	3.20			3.500
	0.15		Less column	
	0.30	0.14	2 x ½ x 0.300	0.300
				3.200
				Width
				0.150
				Thickness
				0.300

Job: Tutorial	Bill No.: 1	Element: Frame	Slip No.: 28
Heading: VRC Grade 20			
Description: In roof beam			Unit: M3
			Quantity:

			RB 4 (150 x 300)	
				Length
				5.750
	5.15		Less column	
	0.45			
	0.30	0.25	2 x ½ x 0.300	0.300
				5.450
				Width
				0.150
				Thickness
				0.300

Job: Tutorial	Bill No.: 1	Element: Frame	Slip No.: 29
Heading: VRC Grade 20			
Description: In roof beam			Unit: M3
			Quantity:

			RB 5 & RB6 (150 x 300)	
				Length
2				5.750
	5.15		Less column	
	0.15			
	0.30	0.46	2/0.300	0.600
				5.150
				Width
				0.150
				Thickness
				0.300

Job: Tutorial	Bill No.: 1	Element: Frame	Slip No.: 30
Heading: VRC Grade 20			
Description: In attached floor beam			Unit: M3
			Quantity:

			COLLECTION PAGE
		0.71	Page 26
		0.14	Page 27
		0.25	Page 28
		0.46	Page 29
		1.56	

Job: Tutorial	Bill No.: 1	Element: Frame	Slip No.: 31
Heading: Sawn formwork			
Description: To sides and soffit of roof beam			Unit: M2
			Quantity: 26

			RB 1 & RB2	
				Length
2				8.500
	7.90			
	0.75	11.85	Less column	
			2/0.300	0.600
				7.900
				Girth
			Soffit - 0.150	0.150
			Side - 2/0.300	0.600
				0.750
	2.90			
	0.75	2.18	RB3	
		14.03		Length
				3.200
			Less column	
			2 x ½ x 0.300	0.300
				2.900
				Girth
				0.750

Job: Tutorial	Bill No.: 1	Element: Frame	Slip No.: 32
Heading: Sawn formwork			
Description: To sides and soffit of roof beam			Unit: M2
			Quantity:

			RB 4	
				Length
				5.750
	5.45			
	0.75	4.31	Less column	
			2 x ½ x 0.300	0.300
				5.450
				Girth
			Soffit - 0.150	0.150
			Side - 2/0.300	0.600
				0.750
2			RB5 & RB6	Length
	5.15			5.750
	0.75	7.73		
		12.04	Less column	
			2/0.300	0.600
				5.150
				Girth
				0.750

Job: Tutorial	Bill No.: 1	Element: Frame	Slip No.: 33
Heading: VRC Grade 20			
Description: In attached floor beam			Unit: M3
			Quantity:

			COLLECTION PAGE
		14.03 12.04 26.07	Page 31 Page 32

Job: Tutorial	Bill No.: 1	Element: Frame	Slip No.: 34
Heading: Reinforcement bar			
Description: 16mm dia. H.t steel reinf. In straight and bent bars in roof beam			Unit: KG Quantity: 265

2 4	9.75	78.00	RB1 & RB2 Length Add laps 8.500 0.700 9.200 Add column 2 x ½ x 0.300 0.300 9.500 Add bend 2 [9.5D (0.016)] 0.304 9.804 Less conc. Cover 2/0.025 0.050 9.754 **Convert to KG:** **78.00m x 1.578 = 123.08 KG**

Job: Tutorial	Bill No.: 1	Element: Frame	Slip No.: 35
Heading: Reinforcement bar			
Description: 16mm dia. H.t steel reinf. In straight and bent bars in roof beam			Unit: KG Quantity:

			RB3
4	2.85	11.40	Length 3.500 Add column 2 x ½ x 0.300 0.300 3.200 Add bend 2 [9.5D (0.016)] 0.304 2.896 Less conc. Cover 2/0.025 0.050 2.846 **Convert to KG:** **11.40m x 1.578 = 17.99 KG**

Job: Tutorial	Bill No.: 1	Element: Frame	Slip No.: 36
Heading: Reinforcement bar			
Description: 16mm dia. H.t steel reinf. In straight and bent bars in roof beam			Unit: KG Quantity:

			RB4
			Length
4	5.60	22.40	Add laps 5.750
			0.700
			5.050
			Add column
			2 x ½ x 0.300 0.300
			5.350
			Add bend
			2 [9.5D (0.016)] 0.304
			5.654
			Less conc. Cover
			2/0.025 0.050
			5.604
			Convert to KG: **22.40m x 1.578 = 35.35 KG**

Job: Tutorial	Bill No.: 1	Element: Frame	Slip No.: 37
Heading: Reinforcement bar			
Description: 16mm dia. H.t steel reinf. In straight and bent bars in roof beam			Unit: KG Quantity:

2 4	7.05	56.40	RB5 & RB6 Length Add laps 5.750 0.700 6.450 Add column 2 x ½ x 0.300 0.300 6.750 Add bend 2 [9.5D (0.016)] 0.304 Less conc. Cover 2/0.025 0.050 7.054 **Convert to KG:** **56.40m x 1.578 = 89.00 KG**

Job: Tutorial	Bill No.: 1	Element: Frame	Slip No.: 39
Heading: VRC Grade 20			
Description: In attached floor beam			Unit: M3
			Quantity:

			COLLECTION PAGE
		123.08	Page 35
		17.99	Page 36
		35.35	Page 37
		89.00	Page 38
		265.42	

Job: Tutorial	Bill No.: 1	Element: Frame	Slip No.: 40
Heading: Reinforcement bar			
Description: 8mm dia. Mild steel reinforcement as stirrups roof beam			Unit: KG
			Quantity: 54

2 / 34 /	0.89	60.52	RB1 & RB2

	Girth
Side - 2/0.150	0.300
Thick - 2/0.300	0.600
	0.900
Less conc. Cover 8 x 0.025	0.200
	0.700
Add hooks	
24D (0.008)	0.192
	0.892

Total No. of stirrups
12+8+14 = 34

Convert to KG:
60.52m x 0.395 = 23.91 KG

Job: Tutorial	Bill No.: 1	Element: Frame	Slip No.: 41
Heading: Reinforcement bar			
Description: 8mm dia. Mild steel reinforcement as stirrups roof beam			Unit: KG
			Quantity:

			RB3	
				Girth
14	0.89	12.46	Side - 2/0.150	0.300
			Thick - 2/0.300	0.600
				0.900
			Less conc. Cover	
			8 x 0.025	0.200
				0.700
			Add hooks	
			24D (0.008)	0.192
				0.892
				Total No. of stirrups 14
			Convert to KG:	
			12.46m x 0.395 = 4.92 KG	

Job: Tutorial	Bill No.: 1	Element: Frame	Slip No.: 42
Heading: Reinforcement bar			
Description: 8mm dia. Mild steel reinforcement as stirrups roof beam			Unit: KG
			Quantity:

			RB4	
				Girth
23	0.89	20.47	Side - 2/0.150	0.300
			Thick - 2/0.300	0.600
				0.900
			Less conc. Cover	
			8 x 0.025	0.200
				0.700
			Add hooks	
			24D (0.008)	0.192
				0.892
				Total No. of stirrups 23
			Convert to KG:	
			20.47m x 0.395 = 8.09 KG	

Job: Tutorial	Bill No.: 1	Element: Frame	Slip No.: 43
Heading: Reinforcement bar			
Description: 8mm dia. Mild steel reinforcement as stirrups roof beam			Unit: KG Quantity:

2 / 24 /	0.89	42.72	RB5 & RB6 Girth Side - 2/0.150 0.300 Thick - 2/0.300 0.600 0.900 Less conc. Cover 8 x 0.025 0.200 0.700 Add hooks 24D (0.008) 0.192 0.892 Total No. of stirrups 14+10 = 24 **Convert to KG:** **42.72m x 0.395 = 16.87 KG**

Job: Tutorial	Bill No.: 1	Element: Frame	Slip No.: 44
Heading: Reinforcement bar			
Description: 8mm dia. Mild steel reinforcement as stirrups roof beam			Unit: KG
			Quantity:

			COLLECTION PAGE
		23.91	Page 40
		4.92	Page 41
		8.09	Page 42
		16.87	Page 43
		53.79	

BILL OF QUANTITY

Item	Description	Unit	Quantity	Rate	Amount
	ELEMENT NO. 02: FRAME				
	Vibrated Reinforced Concrete Grade 20:				
A	Column	M3	5		
B	Floor beam	M3	2		
C	Roof beam	M3	2		
	Sawn formworks:				
D	To sides of isolated columns	M2	67		
E	To sides and soffit of suspended floor beams	M2	26		
F	To sides and soffit of roof beams	M2	26		
	High Tensile reinforcement in straight and bents bars:				
G	16mm diameter in column	KG	187		
H	Ditto, in roof beam	KG	504		
J	20mm diameter in floor beam	KG	265		
	TO COLLECTION				

BILL OF QUANTITY

Item	Description	Unit	Quantity	Rate	Amount
	ELEMENT NO. 02: FRAME				
	Mild Steel reinforcement bars as links:				
A	8mm diameter in column	KG	115		
B	Ditto, in floor beam	KG	75		
C	Ditto, in roof beam	KG	54		
	TO COLLECTION				

REFERENCES

1. Malaysian Standard Method of Measurement of Building Works Second Edition. The Institution of Surveyors, Malaysia (2000)

2. Ahmad Abdullah & Khairuddin Abdul Rashid. Pengukuran Kuantiti Bangunan Edisi Kedua. Prentice Hall (2009)

3. Nor Asma Binti Mamat. Measurement for Superstructure Works. Politeknik Sultan Azlan Shah (2019)

QUANTIFICATION OF REINFORCED CONCRETE BUILDING FRAME

e ISBN 978-629-98438-0-1

NOR ASMA BINTI MAMAT

(online)