THE BUILD-UP RATE FOR BUILDING WORKS

NORZAIHASRA BINTI SAABA
HAZLINA BINTI MARWAN
ZULZANA BINTI ZULKARNAIN
Civil Engineering Department
Politeknik Port Dickson

The Build-up Rate
For Building Works

Cataloguing Information (to be informed)

SYNOPSIS

Building estimating is the major process in the construction industry. Every successful project starts with a precise and accurate cost estimation.

Basic knowledge on cost estimation is important in providing the appropriate total cost and expenses of construction projects from start to finish.

The preparation of estimation involves measuring and pricing. Measuring is the process of abstracting the quantity of each building element based on the specified drawings and specification given, meanwhile pricing is the process of calculating the cost of each building element stated.

This book only focus on built-up calculation for concrete works, excavation works, bricks works and reinforcement works.

Hopefully, this book can benefit positively to those who are involved.

ACKNOWLEDGEMENT

TABLE OF CONTENTS

TABLE OF CONTENTS

BUILD-UP RATE METHODS

- Requirement and use of price rate and schedule of rate.

INTRODUCTION

• Building estimating is the major process in the construction industry.

• Every successful project starts with a precise and accurate cost estimation.

• A quantity surveyor will propose the cost estimation to a client as guidance to monitor the project development.

• Cost estimation reflects to the actual price during tendering process for contractor and subcontractor.

• Basic knowledge on cost estimation is important in providing the appropriate total cost and expenses of construction projects from start to finish.

• Direct costs and direct costs are among the ways to classify expenditure.

• The actual building estimation is based on detail drawings and detailed building information before it is opened for tendering.

Direct Cost
• Materials
• Labour
• Machinery

Indirect Cost
• Administrative
• Legal fees & permits
• Utilities
• Security
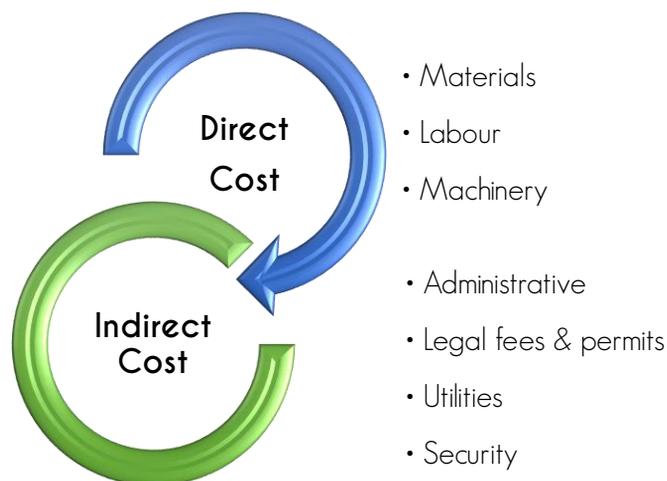
PRINCIPLES OF THE BUILD-UP RATES

• The preparation of estimation involves measuring and pricing.

• Measuring is the process of abstracting the quantity of each building element based on the specified drawings and specification given.

• Pricing is the process of calculating the cost of each building element stated.

• The preparation of build-up rate for each work items are calculated during pricing process,

What is Rate ?
Price per unit of measurement

How rate is read ?

RM 250.00 / m³

Currency   Price of item   Per unit of measurement
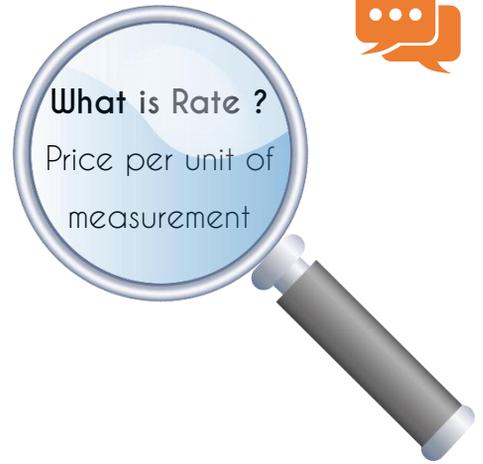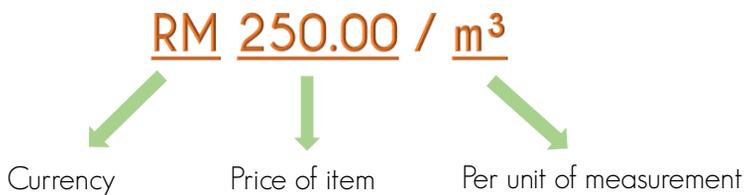
• The unit rates is the amount of money for an item of work inclusive of the amount of materials, labour, plant and machineries and contractor's profit.

Example of market rate :

Description	Unit	Rate (RM)
Excavation (pit)	m³	10.00
Concrete Grade 20	m³	255.00
Formwork	m²	28.00
Reinforcement	kg	3.20

Rate will differ from one project to another due to various factors such as size, nature of work, location, market conditions, etc.

Schedule of Rate

- Is the list of rates of various item of work.
- The schedule is prepared by the Public Works Department (JKR)

- Usage :
i. to facilitate the preparation of estimates
ii. to serve as a guide in setting rates in connection with contract agreement

SCHEDULE OF RATES

BUILDING WORKS IN SARAWAK
CIVIL ENGINEERING WORKS IN SARAWAK
ELECTRICAL INSTALLATION WORKS IN SARAWAK
WATERMAIN CONSTRUCTION IN SARAWAK

JKR SARAWAK
DECEMBER 2018

2018
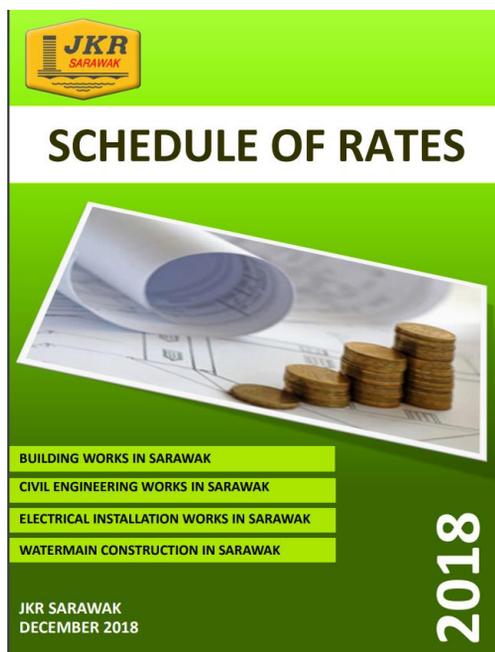
Example of market rate :

C   CONCRETOR

Item No.	Description	Unit	Rate (RM)
1	Lean concrete (Grade 15) in 50mm thick blinding.	M^2	17.80
2	Mass Concrete (Grade 20) in non-structural works such as pavements, upstands, kerbs and the like.	M^3	360.00
3	Reinforced concrete (Grade 25) in sub-structural works such as pile caps, pad footings, column stumps, and the like.	M^3	375.00
4	Reinforced concrete (Grade 30) in sub-structural works such as pile caps, pad footings, column stumps, and the like.	M^3	390.00
5	Reinforced concrete (Grade 35) in sub-structural works such as pile caps, pad footings, column stumps, and the like.	M^3	405.00
6	Reinforced concrete (Grade 40) in sub-structural works such as pile caps, pad footings, column stumps, and the like.	M^3	420.00
7	Reinforced concrete (Grade 25) in sub-structural works such as ground beams, ground slabs, apron slabs, steps, platform slabs, ramp and the like.	M^3	388.00

Build-Up Rate Methods

PRINCIPLES OF THE BUILD-UP RATES

Material Cost

Initial Cost - Cost that is not including profits, transportation cost and other additional cost. Basically this is an initial cost which come straight from the factory. Market price usually will change/vary from time to time and from one place to another.

Transportation Cost - Includes the add on price for transporting construction material to site. Supplier will determine the construction material cost according to where the material will be sent. Transportation cost also includes how the materials are moved whether by manpower, fork lift or other method.

Storage Cost - Cost of storage of construction material such as cement, glass, tiles and flammable material.

Waste and material damage - Waste and material damage is calculated starting from the material delivery from the factory to the construction site.

The percentage of wastage and material damages are as follow :

Cement	5 %
Tiles	2%
Timber	5%
Steel	10%

PRINCIPLES OF THE BUILD-UP RATES

Labour Cost

Labour costs are the total amount of money paid to employees/workers for a period, such as a week or a month

Skilled Labour - is any worker who has special skill, training, knowledge, and (usually acquired) ability in their work. A skilled worker may have attended a college, university or technical school. A skilled worker may have learned their skills on the job. (carpenter, artisan, tiller, plumber, draftsman, engineer etc)

Semi Skilled Labour - is one who has sufficient knowledge of the particular trade or above to do respective work and simple job with the help of simple tools and machines.

Foreman, forewoman or foreperson is a supervisor, often in a manual trade or industry. Foreman may specifically refer to Construction foreman, the worker or tradesman who is in charge of a construction crew

Labourer – is person employed to do unskilled work

PRINCIPLES OF THE BUILD-UP RATES

Plant, machinery and equipment cost	Plant - a place where things are made or where an industrial process takes place . Example; batching (concrete) plant (rented or purchased).
	Machinery is defined as a mechanical device or the parts that keep something working. Example: excavator, tower crane, mobile crane, bending machine etc. (rented or purchased).
	Equipment is a basic equipment such as wheelbarrow, scaffolding, hand tools etc. (rented or purchased).
	Machinery equipment can be purchased or rented. The choice between purchasing or renting usually depends on the amount of time the equipment will be utilized in the contractor's operations.

Purchased
- Ownership Cost
- Operating Cost

Rental
- Rental Cost
- Operating Cost exclusive of services and breakdown maintenance
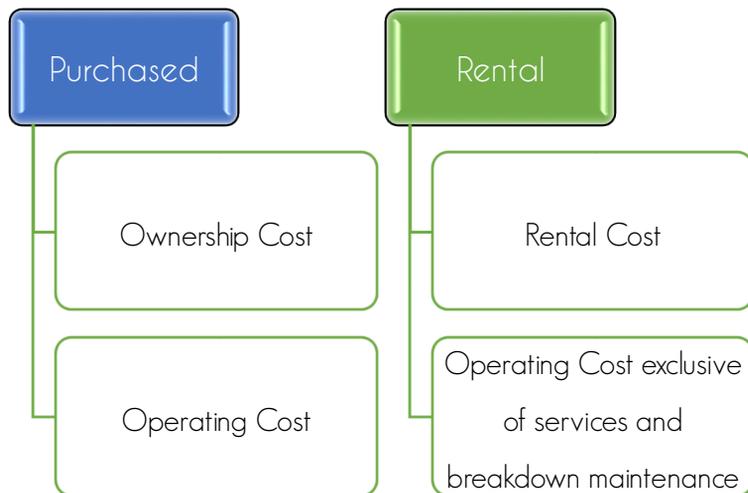
PRINCIPLES OF THE BUILD-UP RATES

Overheads

Overhead expenses refers to an ongoing expense of operating a business; it is also known as an "operating expense".

Overhead is those administrative expenses of a business that are required to operate general corporate functions, and which cannot be definitively attributed to any revenue-generating activities or units of output (such as products to be sold).

Examples of overhead expenses are as follows :

Office supply – papers, photocopiers, fax machine, shop-drawings

Utility bills – electric, water supply, telecommunications

Care and maintenance of site – site cleanliness

Security – for stored materials and plant and machineries

Signage – especially for the health and safety measures

Entertainment – during the conduct of site meeting like refreshment, lunch or tea.

Administrative salaries

PRINCIPLES OF THE BUILD-UP RATES

Profit

The profit costs varies among contractors grade as they have different areas of specialisation. Profit is the amount reserved for the company.

Usually, the percentage of profit varies from 3 - 10% of the nett construction rate. The profit percentage is closely related to the competition in the market

The profit usually translates the frequency of jobs and the number of on-going projects in hand among the contractor.

BUILD-UP RATE CALCULATION FOR CONCRETE WORKS

- Concrete works mixed manually and mixed by machine.

INTRODUCTION

Concrete is widely used in construction industry.
Two (2) types of mixing concrete :

i.   By hand (manually)
Using tool like shovel, bucket etc.

Figure 1. Mixing concrete by hand
(Source: Construction Review Online, 2021)

ii.   By machine
- Various types of mixers are available which are either petrol/diesel or electrically powered.
- Suitable in large projects where large masses of concrete are required.

Figure 2. Mixing concrete by machine
(Source: Mahadev Desai, 2019)

Nowadays, most construction projects use the concrete mixer machine and ready-mixed concrete as it is faster, cheaper, efficient, high productivity, better quality, strength, and durability. Ready-mixed concrete is typically batched and mixed off the work site and then delivered to the work site in a concrete mixing truck.

Concrete mix proportion.

Material	Volume	Weight	Density
Cement	$1m^3$	1.4 tones (28 bag)	1440 kg/m^3
Sand (fine aggregate)	$1m^3$	1.52 tonnes	1640 kg/m^3
Coarse aggregate	$1m^3$	1.62 tonnes	1390 kg/m^3

Concrete is stated according to the proportion of material mixing or its performance.

Grade	Mix Proportion	Characteristic Compressive Strength in N/mm²	Group
5P	1:5:10	5	Lean Concrete
7.5P	1:4:8	7.5	
15P	1:3:6	15	Ordinary Concrete
20P	1:2:4	20	
25P	1:1.5:3	25	
30P	1:1:2	30	
40P		40	Standard Concrete
50P		50	
55P	Design mix	55	
60P		60	High Strength Concrete
M80		80	

Proportion ratio of concrete mixture will influence the cost of concrete per cube metre.

Shrinkage, consolidation and wastage of materials

Normally, when the compose of materials (cement, sand and aggregate) mix with water, it will shrink as the sand and cement filled the void in between aggregates. Thus, the volume of concrete will reduced.

During the process of mixing, removing, carrying or placing some of the materials will go to the waste.

Hence, for such case, allowance of 50% should be added in the material cost for shrinkage, consolidation and wastage in preparing for the concrete price rate.

50%

CONCRETE WORK BY HAND (MANUALLY)

Elementary components for concrete work by hand (manually) price rate calculation :

Material cost **1**

Cement, fine aggregate, coarse aggregate

Shrinkage, consolidation and wastage of materials

Labour cost **2**

Mixing by hand, removing, carrying, compacting, levelling and etc.

Profit and Overhead cost **3**
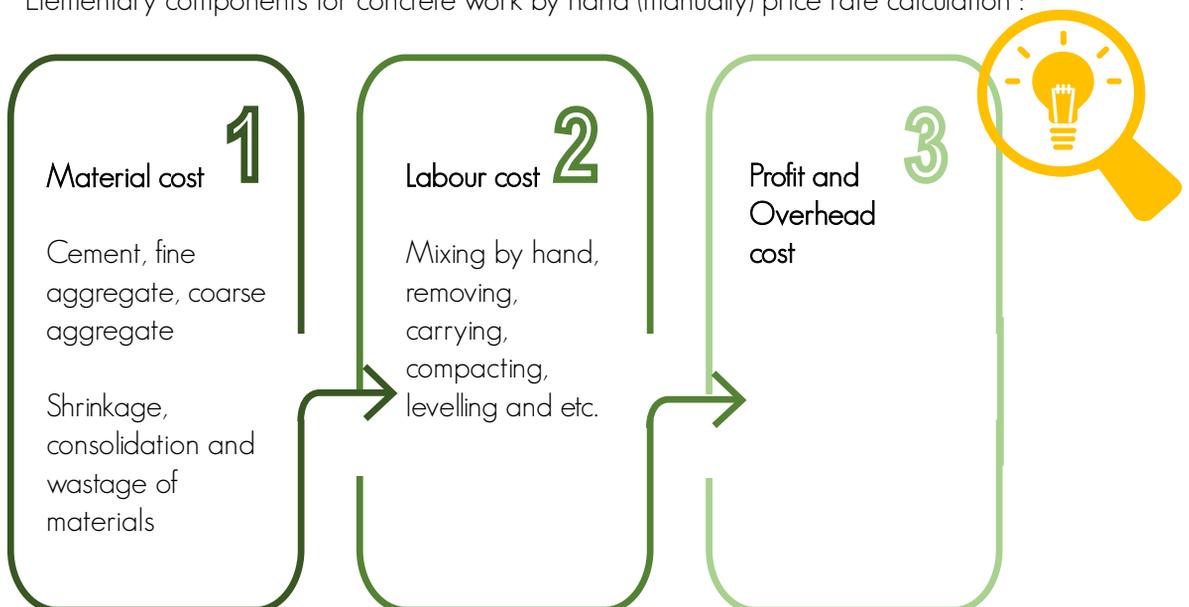
EXAMPLE 1 : Concrete Mixing By Hand

Reinforced in-situ concrete Grade 25 in isolated column – m^3

Data :

Material :		
	Concrete Grade 25	- proportion is 1:1 $\frac{1}{2}$: 3
	Cement Cost	- RM 10.50 /bag
	Sand Cost	- RM 28 /m^3
	Coarse Aggregate Cost	- RM 35 /m^3

Labour output :		
	Mixing	– 2 hour./m^3
	Removing & placing	– 8 hour./m^3
	Labour wages	– RM 40 /day

Profit & Overhead	– 15%

SOLUTION :

	RM	RM
c. Material Cost		
1 m³ cement x 28 bag x RM 10.50	294.00	
1 ½ m³ sand x RM 28	42.00	
3 m³ aggregate x RM 35	105.00	
	441.00	
+) shrinkage, consolidation & wastage		
50% x RM 441.00	220.50	
Material Cost for 5.5 m³	661.50	
Material Cost/m³ = RM 661.50		120.27
5.5 m³		
d. Labour Cost		
Mixing : 2 hours x RM 40		10.00
8 hours		
Remove & Place : 8 hours x RM 40		40.00
8 hours		
		170.27
e. Profit & Overhead		
15% x RM 170.27		25.54
Price Rate/m³		195.81

CONCRETE WORK BY MACHINE (rental)

Elementary components for concrete work by machine (rental) price rate calculation :

Rental Cost	Operational Cost	Material Cost	Labour Cost	Profit & Overhead Cost
	Labour wages for operator machine /assistant	Cement, fine aggregate, coarse aggregate	Removing, carrying, compacting, levelling etc.	
	Fuel Consumption (Diesel, petrol, hydraulic oil etc)	SWC : 50% from material cost		
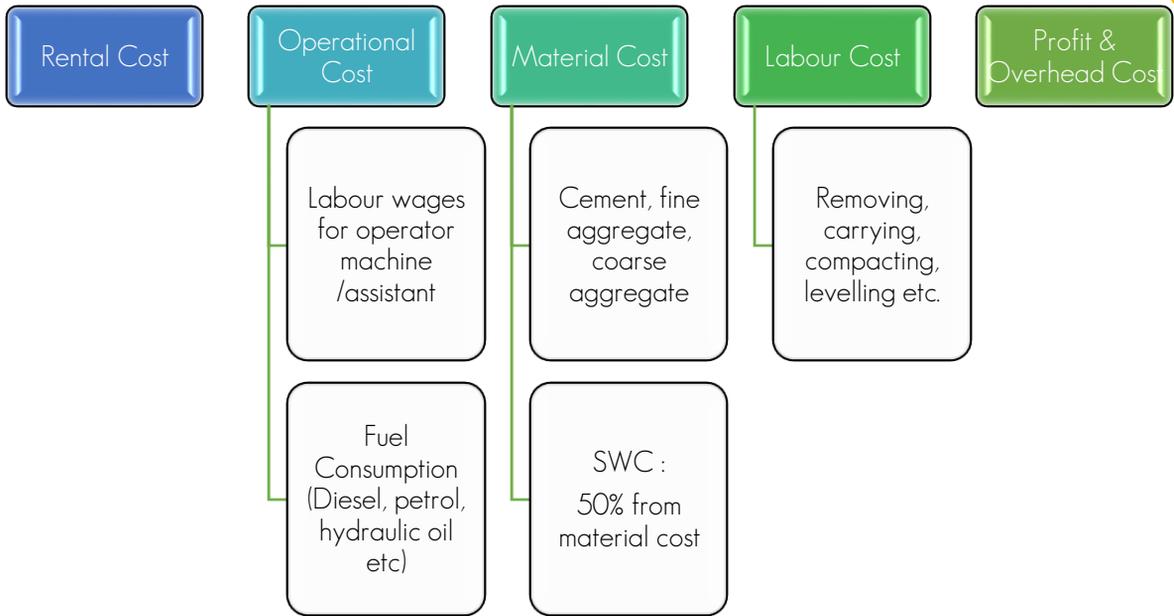
Output of concrete mixer

Size	Labour Quantity	Output/hour (m³)	Diesel/hour (litre)	Lubricant oil/hour (litre)
5/3½	1 operator 1 general worker	1.25	1.10	0.04
7/5	1 operator 3 general worker	2.25	1.60	0.06
10/7	1 operator 4 general worker	3.25	1.80	0.07
14/10	1 operator 4 general worker	4.50	2.10	0.08
18/12	1 operator 6 general worker	5.50	2.40	0.10

All data are subject to change

EXAMPLE 2 : Concrete Mixing By Machine (Rental)

Reinforced in-situ concrete Grade 25 in isolated column – m^3

Data :

Concrete Mixer :	Rental Cost	- RM 200 /day
	No. of Operator	- 1 person; RM 50 /day
	No. of General Labour	- 2 person
	Diesel	- 3 liter /hour ; RM 1.70
	Engine oil	- 3 liter /day ; RM 20
	Machine output	- 7 m^3/hour
Material :	Concrete Grade 25	- proportion is 1:1 $\frac{1}{2}$: 3
	Cement Cost	- RM 10.50 /bag
	Sand Cost	- RM 28 /m^3
	Coarse Aggregate Cost	- RM 35 /m^3
Labour output :	Removing & placing	– 8 hour./m^3
	Labour wages	– RM 40 /day
Profit & Overhead		– 15%

SOLUTION :

	RM	RM
a. Rental Cost		
Rental / hour = RM 200 / 8 hours		25.00
b. Operational Cost		
Operator = 1 person x RM 50	50.00	
General Labour = 2 person x RM 40	80.00	
Diesel = 3 liter x 8 hours x RM 1.70	40.80	
Engine oil = 3 liter x RM 20	60.00	
Operational Cost/day	230.80	
Operational Cost/hour = RM 230.80 / 8 hours		28.85
Total Machine Cost/hour		53.85
Machine output = 5.5 m^3/hour		
Cost of mixing concrete for 1 m^3 = RM 53.85 / 5.5 m^3		7.69

	RM	RM
c. Material Cost		
1 m^3 cement x 28 bag x RM 10.50	294.00	
$1 \frac{1}{2} \text{ m}^3$ sand x RM 28	42.00	
3 m^3 aggregate x RM 35	105.00	
	441.00	
+) shrinkage, consolidation & wastage		
50% x RM 441.00	220.50	
Material Cost for 5.5 m^3	661.50	
Material Cost/$\text{m}^3 = \dfrac{\text{RM } 661.50}{5.5 \text{ m}^3}$		120.27
d. Labour Cost		
Remove & Place: 8 hours x $\dfrac{\text{RM } 40}{8 \text{ hours}}$		40.00
		167.96
e. Profit & Overhead		
15% x RM 167.96		25.19
Price Rate/m^3		**193.15**

CONCRETE WORK BY MACHINE (purchase)

Elementary components for concrete work by machine (purchase) price rate calculation :

Capital Cost	Operational Cost	Material Cost	Labour Cost	Profit & Overhead Cost
Initial cost of machine	Labour wages for operator machine /assistant	Cement, fine aggregate, coarse aggregate	Removing, carrying, compacting, levelling etc.	
Interest on loan	Fuel Consumption (Diesel, petrol, hydraulic oil etc)	SWC : 50% from material cost		
Maintenance Cost				
Transportation Cost				
Salvage Value				
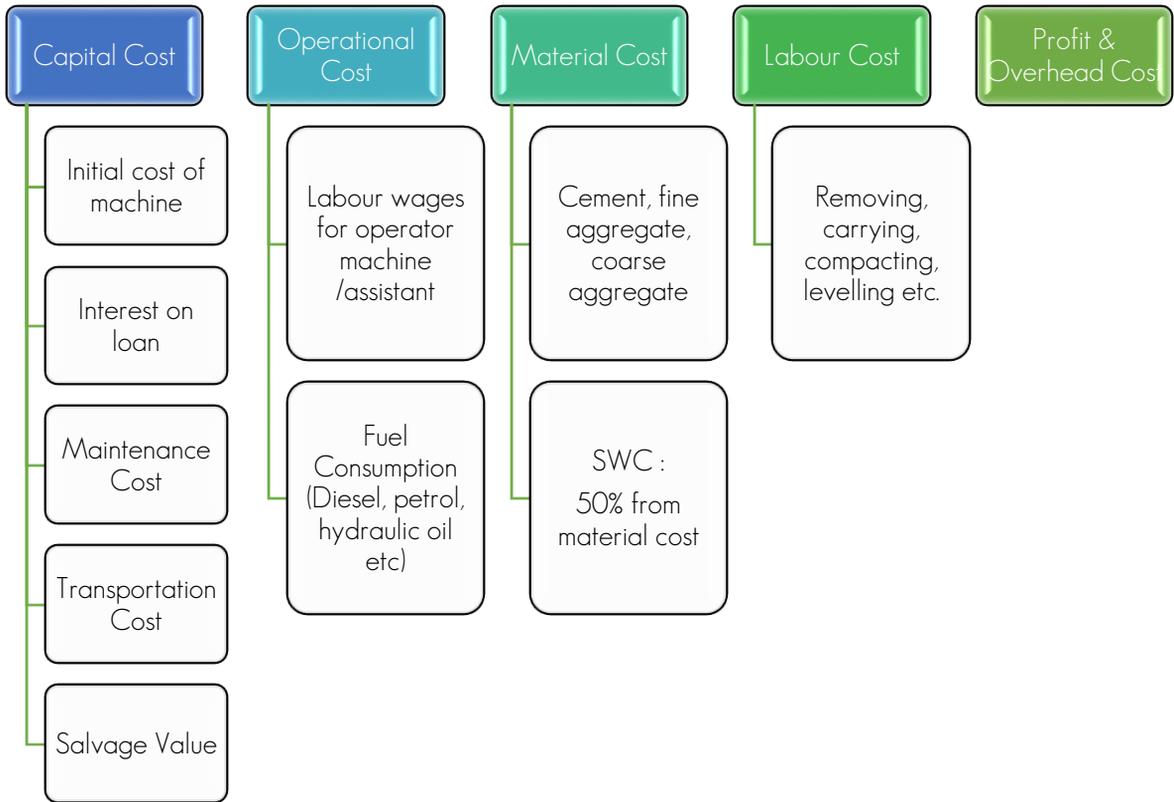
EXAMPLE 3 : Concrete Mixing By Machine (Purchase)

Reinforced in-situ concrete Grade 25 in isolated column – m^3

Data :

Concrete Mixer :	Initial Cost	- RM 15,000
	Interest on loan	- 10% per year
	Lifecycle of plant	- 4 years
	Average plant work	- 200 days/year
	Salvage Value	- RM 2000
	No. of Operator	- 1 person ; RM 50 /day
	No. of General Labour	- 2 person
	Diesel	- 1.6 liter /hour. ; RM 1.70 /liter
	Engine oil	- 0.2 liter / hour. ; RM 20 /liter
	Machine output	- 5.5 m^3/hour

Material :	Concrete Grade 25	- proportion is 1:1 ½ : 3
	Cement Cost	- RM 10.50 /bag
	Sand Cost	- RM 28 /m^3
	Coarse Aggregate Cost	- RM 35 /m^3

| Labour output : | Removing & placing | – 8 hour./m^3 |
| | Labour wages | – RM 40 /day |

| Profit & Overhead | | – 15% |

SOLUTION :

	RM	RM
a. Capital Cost		
Initial Cost	15,000.00	
Interest on loan = 10% x 4 years x RM 15,000.00	6,000.00	
Maintenance for 4 years = 10% x RM 15,000.00	1,500.00	
Transport for 4 years = 5% x RM 15,000.00	750.00	
	23,250.00	
(Less) Salvage value	2,000.00	
Capital Cost for 4 years.	21,250.00	
Capital Cost for 1 year. = RM 21,250.00	5,312.50	
4 years		
Total hour for 1 year		
= 200 days x 8 hours = 1,600 hours		
Capital Cost/hour = RM 5,312.50		3.32
1600 hours		
b. Operational Cost		
Operator = 1 person x RM 50	50.00	
General Labour = 2 person x RM 40	80.00	
Diesel = 1.6 liter x 8 hours x RM 1.70	21.76	
Engine oil = 2 liter x 8 hours x RM 20	32.00	
Operational Cost/day	183.76	
Operational Cost/hour = RM 183.76		22.97
8 hours		
Total Machine Cost/hour		26.29
Machine output = 5.5 m^3/hour		
Cost of mixing concrete for 1 m^3 = RM 26.29		4.78
5.5 m^3		

SOLUTION (continue) :

	RM	RM
c. Material Cost		
1m^3 cement x 28 bag x RM 10.50	294.00	
1 $\frac{1}{2}$ m^3 sand x RM 28	42.00	
3m^3 aggregate x RM 35	<u>105.00</u>	
	441.00	
+) shrinkage, consolidation & wastage		
50% x RM 441.00	<u>220.50</u>	
Material Cost for 5.5 m^3	661.50	
Material Cost/m^3 = $\dfrac{\text{RM 661.50}}{5.5 \text{ m}^3}$		120.27
d. Labour Cost		
Remove & Place: $\dfrac{8 \text{ hours x } \underline{\text{RM 40}}}{8 \text{ hours}}$		<u>40.00</u>
		165.05
e. Profit & Overhead		
15% x RM 165.05		24.76
Price Rate/m^3		**189.81**

Build-Up Rate Calculation For Concrete Works

ACTIVITY 1

Reinforced in-situ concrete Grade 30 in floor slab not exceeding 100 mm thick. – m^3

Data :

Concrete Mixer :	Rental Cost	- RM 350 /day
	No. of Operator	- 1 person ; RM 50 /day
	No. of General Labour	- 2 person
	Diesel	- 2.5 liter /hour ; RM 1.70
	Engine oil	- 2 liter /day ; RM 20
	Machine output	- 5 m^3/hour
Material :	Concrete Grade 30	
	Cement Cost	- RM 17.50 /beg
	Sand Cost	- RM 30 /m^3
	Coarse Aggregate Cost	- RM 40 /m^3
Labour Output:	Removing & placing	– 9.25 hour/m^3
	Labour wages	– RM45 /day
Profit & Overhead		– 15%

BUILD-UP RATE CALCULATION FOR EXCAVATION WORKS

- Excavation works done manually and by using machine.

EXCAVATION SOIL BY HAND (MANUALLY)

Excavation soil by hand or manually is uses tools such as hoe, dig, hammer, etc.
This method's cost is also very expensive.

This method is too slow and only suitable for certain situations like:

Figure 3. Excavation soil manually
(Source: Bedrock Drilling, 2021)

i.   Excavation in small quantity and limited working area which are not economical when using machinery.

ii. When machinery/plant cannot be used in certain areas like in services cable area, duct etc.

Excavation and earthworks include formatting ground surfaces to a specified level, excavation down or filling up with approved materials and removing of excavated materials from site.

Elementary components for excavation soil price rate calculation :

1	**2**	**3**	**4**
Labour cost	Adjustment of labour output (depend on type of soils)	Planking & strutting cost (if any)	Profit and Overhead cost
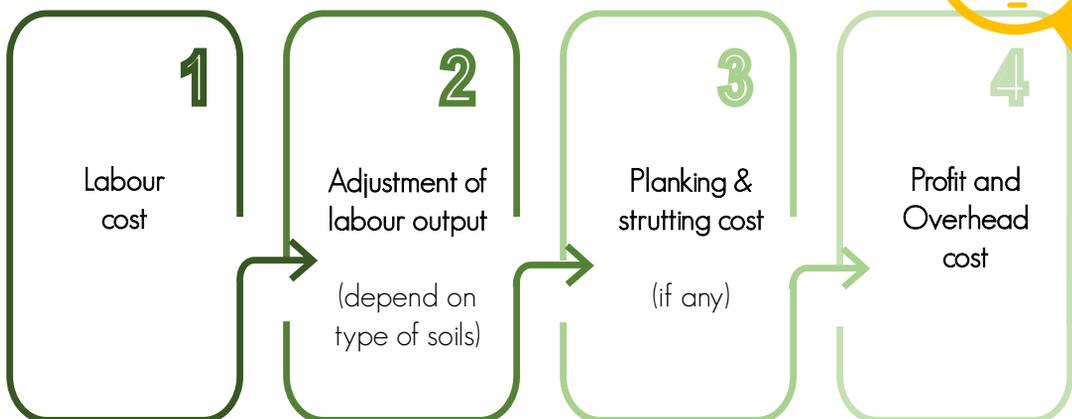
The table below show the material needed for brick wall :

Type Excavation	Unit	Gen.eral Labour (hour)
Excavation top soil average 150 mm depth	m^3	0.35
Excavation over site to reduce level	m^3	1.75
Excavation pit to receive column bases not exceeding 1.00 m depth	m^3	3.50

Not all excavation works are possible using machineries since . Sometimes hand excavation might necessary as limited space is consumed. and more economical.

The adjustment on labour output for excavation work should be considered in calculation except for ordinary soil.

Type of soil	Multiplying factor
Sand	x 0.75
Clay	x 1.50
Soft rock	x 3.00
Rock	x 6.00

Output of excavation depends on soil type, method of excavation and the distance where the being disposed to. These costs are added for a unit volume of excavation to get the rate of excavation.

EXAMPLE 4 : Excavation for column bases

Excavate pit to receive column bases starting from reduced level maximum depth not exceeding 2.00 meter. – m^3

Data :	Labour output	- 4.50 hour/m^3
	Labour wages	- RM 40.00 /day
	Planking and strutting	- RM 3.00 /m^3
	Profit & overhead cost	- 15%

SOLUTION :

	RM
a. Labour cost	
For Excavation: = 4.50 hour x RM 40.00	22.50
8 hour	
Planking and strutting,	3.00
	25.50
b. Profit & overhead cost	
15% x RM 25.50	3.83
Price Rate/m^3	29.33

EXAMPLE 5 : Extra over excavation in rock

Extra over pit excavating in rock (provisional) – m^3

Data :	Labour output	- 4.50 hour/m^3
	Labour wages	- RM 40.00 /day
	Type of soil	- Rock
	Profit & overhead cost	- 15%

SOLUTION :

	RM
a. Labour cost	
For Excavation: = 4.50 hour x <u>RM 40.00</u> x 6.00	135.00
8 hour	
b. Profit & overhead cost	
15% x RM 135.00	20.25
	155.25
-) less excavating in ordinary soil	29.33
Price Rate/m^3	125.92

REMOVE / DISPOSAL SOIL

Excavation is measured 'net' in the Bill of Quantities, i.e. the quantity stated being that 'in the ground' before excavation.

After being excavated, soil increases in volume (bulks) to a greater or lesser extent depending on the nature of the soil.

Figure 4. Digging a trench
(Source: Hidustan Steel Suppliers , 2017)

The bulking factor is the ratio or percentage of the volume change of excavated material to the volume of the original in situ volume before excavation. The bulking factor is used to estimate the likely excavated volumes that will need to be stored on site or perhaps removed from site.

Soil removal elementary components price rate calculation :

1

Labour cost

(remove / dispose by manually)

2

Increase of soil in bulk

(depend on type of soils)

3

Profit & overhead cost
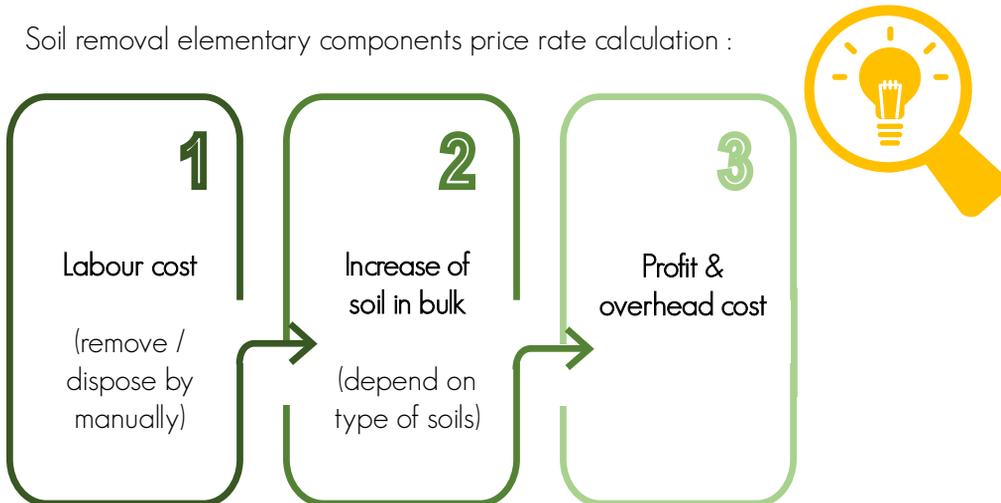
1 m^3 of ordinary soil or similar, when excavated, increase in volume to about 1.25 m^3 – a factor of 25%. This bulking factor affects the pricing of the 'disposal' items

Type of soil	Increase In Bulk (%)	Total Of Increase In Bulk (%)
Sand	10	110
Clay	20	120
Ordinary soil	25	125
Top soil	25	125
Rock	50	150

Labour output : Soil removal

Description	General labour (hour/m^3)
Loading, remove and deposit	1.50
Loading, remove, deposit, spread and levelling	2.00

Build-Up Rate Calculation For Excavation Works

EXAMPLE 6 : Soil removal

Remove excavated material 50.00 meter distance. – m^3

Data :
Labour output	- 1.50 hour/m^3
Labour wages	- RM 40.00 /day
Type of soil	- Ordinary soil
Profit & overhead cost	- 15%

SOLUTION :

	RM
a. Labour cost	
For Removal: = 1.50 hour x RM 40.00 x 125	9.38
8 hour 100	
b. Profit & overhead cost	
15% x RM 9.38	1.41
Price Rate/m^3	10.79

BACKFILLING MANUALLY

There is no extra cost incurred to fill in the excavation if it uses the existing materiasl from the excavation (soil on site).

The allowance of 25% should be added in the material cost of import soil as it analyse built-up rate for filling the excavation with ordinary soil obtained off site (import soil)

The norm labour constant for filling by hand – 0.75 hour/m^3

Figure 5. Backfilling works
(Source: Construction Civil Engineering, n.d)

Elementary components for backfilling soil price rate calculation :

1 Labour cost

2 Profit and Overhead cost
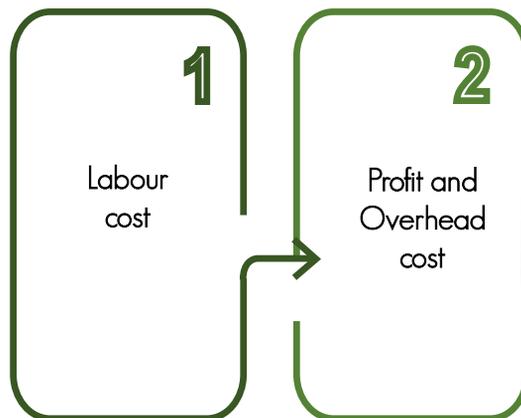
EXAMPLE 7 : Backfilling soil

Filling to excavation with materials arising from excavation. – m^3

Data :   Labour output   - 1.50 hour/m^3

          Labour wages   - RM 40.00 /day

          Type of soil   - Ordinary soil

          Profit & overhead cost   - 15%

SOLUTION :

	RM
a. Labour cost For Filling: = 1.50 hour x <u>RM 40.00</u> 　　　　　　　　　8 hour	7.50
b. Profit & overhead cost 　15% x RM 7.50	<u>1.13</u>
Price Rate/m^3	8.63

ACTIVITY 2

Excavation trench to foundations starting from reduced level maximum depth not exceeding 1.00 meter- m^3

Data :

Labour output	- 3.00 hour/m^3
Labour wages	- RM 45.00 /day
Type of soil	- Clay
Profit & overhead cost	- 15%

ACTIVITY 3

Remove excavated material 50.00 meter distance. - m^3

Data :

Labour output	- 1.50 hour/m^3
Labour wages	- RM 45.00 /day
Type of soil	- Clay
Profit & overhead cost	- 15%

ACTIVITY 4

Filling to excavation with materials arising from excavation. – m^3

Data :

Labour output	- 2.50 hour/m^3
Labour wages	- RM 45.00 /day
Type of soil	- Clay
Profit & overhead cost	- 15%

EXCAVATION WORKS BY MACHINE

Common use plant such as backhoe, dragline, excavator, tractor, crane and etc.

This method is suitable for large excavation work and large working area.

It is cheaper when applied to large excavation work.

Figure 6. Excavation works by machine
(Source: Nemat Syed, 2016)

Plant output

The plant output is depends on :

i.   the type and characteristic of soil

ii.   condition of site

iii. total volume of excavation

iv.   type of plant will be used

.

Capacity of Bucket (m³)	Output (m³/hour)
$\frac{1}{4}$	8
3/8	9
$\frac{1}{2}$	12
$\frac{3}{4}$	18
1	25

In calculation, the adjustment for the output of excavator is needed depending on the type of soil.

Type of soil	Multiplying factor
Sand	x 1.00
Clay	x 1.25
Soft rock	x 1.50
Gravel	x 4.50

EXCAVATION WORKS BY MACHINE - rental

Is buying cheaper than renting in the long-run? It can be, but not always..

Renting is the better choice unless it is frequently used..

Elementary components for excavation works (by machine – rental) price rate calculation :

1 Rental cost	2 Operational cost • Labour wages for operator machine /assistant • Fuel consumption (diesel, petrol, hydraulic oil etc) Planking & strutting cost (if any)	3 Profit & Overhead cost
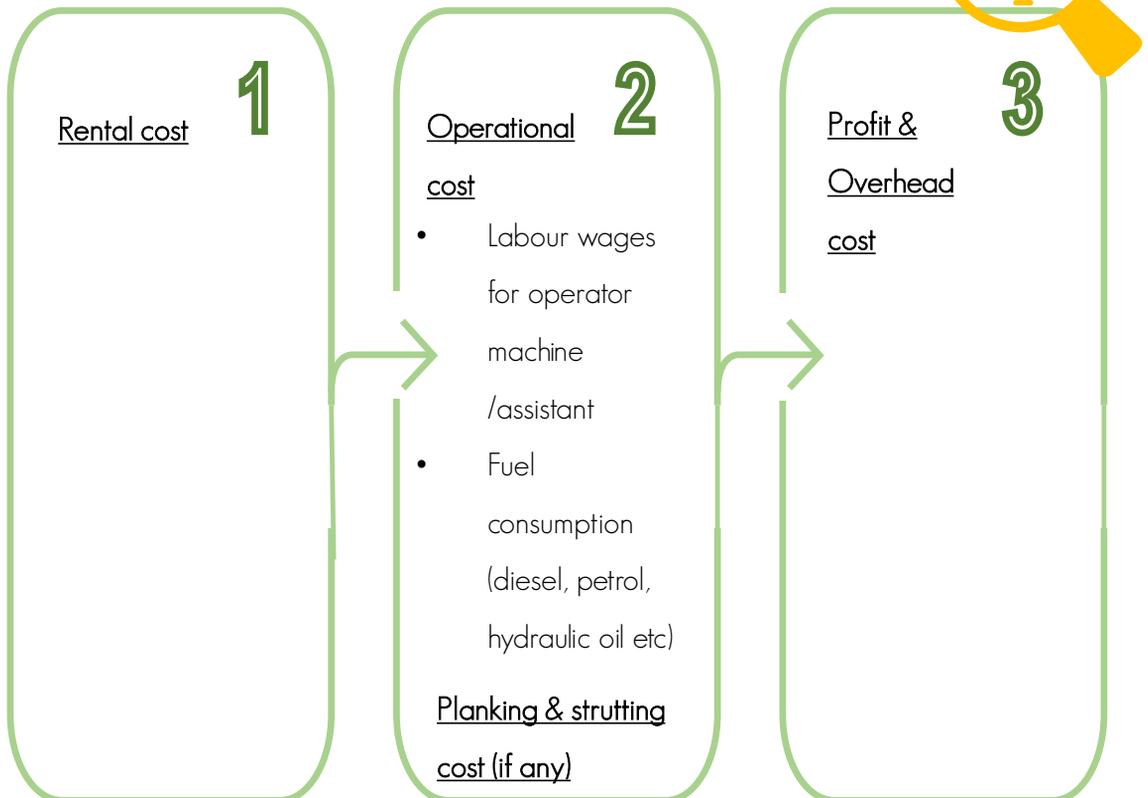
EXAMPLE 8 : Build up rate of excavation works
(by machine – rental)

Excavate trench to receive foundations starting from reduced level maximum depth not exceeding 1.00 meter. – m^3

Data :	Rental cost	– RM 300.00/day
	Operator	– 1 person ; RM 50.00 /day
	Diesel	– 5 liter/hour
	Hydraulic oil	– 12 liter/week
	Diesel cost	– RM 1.70 /liter
	Hydraulic oil cost	– RM 20.00 /liter
	Plant output	– 9 m^3/hour
	Profit & overhead cost	– 15%
	Planking & Strutting	– RM 3.00 /m^3

SOLUTION :

	RM	RM
a. Rental cost		
Rental cost/hour = $\dfrac{RM\ 300.00}{8\ hour}$		37.50
b. Operational cost		
Operator = 1 person. x RM 50.00	50.00	
Diesel = 5 liter x 8 hours x RM 1.70	68.00	
Hydraulic oil = $\dfrac{12\ liter}{7\ days}$ x RM 20.00	34.29	
Operational cost/day	152.29	
Operational cost/hour = $\dfrac{RM\ 152.29}{8\ hours}$		19.04
Total machine cost/hour		**56.54**
Plant output = 9 m^3/hour		
Excavate cost/m^3 = $\dfrac{RM\ 56.54}{9\ m^3}$		6.28
Planking & strutting (if any)		3.00
		9.28
c. Profit & Overhead cost		
15 % x RM 9.28		1.39
Price Rate/m^2		10.67

EXCAVATION WORKS BY MACHINE - purchase

If you foresee consistent projects ahead, then buying may be more cost-effective in the long-run.

Figure 8. Excavator in Construction Site (Source: Zhaojiankangphoto./123rf, n.d)

Elementary components for excavation works (by machine - purchase) price rate calculation :

1

Capital cost

- Initial cost of machine
- Interest on loan
- Maintenance cost
- Transportation cost
- Salvage / resale value

2

Operational cost

- Labour wages for operator machine /assistant
- Fuel consumption (diesel, petrol, hydraulic oil etc)

3

Profit & Overhead cost
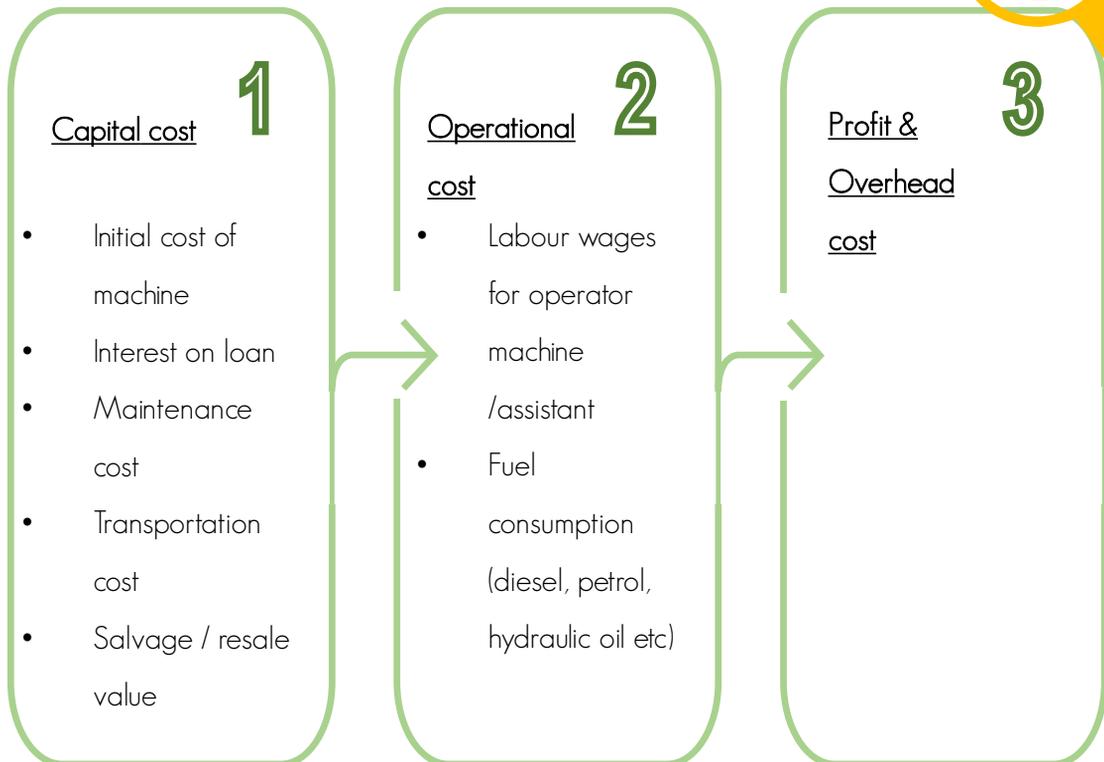
EXAMPLE 9 : Build up rate of excavation works

(by machine – purchase)

Excavate oversite to reduced level maximum depth not exceeding 1.00 meter. - m^3

Data :	Initial cost	– RM 150,000.00
	Interest on loan	– 10%
	Lifecycle of plant	– 5 years
	Resale value	– RM 8,000.00
	Average plant works	– 200 days / year
	Diesel	– 6 liter/hour ; RM 1.70 /liter
	Hydraulic oil	– 14 liter/week ; RM 20 /liter
	Operator	– 1 person ; RM 50.00 /day
	Plant output	– 12 m^3/hour
	Profit & overhead cost	– 15%

SOLUTION :

	RM	RM
a. Capital cost		
Initial cost	150000.00	
Interest on loan for 5 years,		
= 10% x 5 years x RM 150000.00	75000.00	
Maintenance cost for 5 years, = 10% x RM 150000.00	15000.00	
Transportation cost for 5 years, = 5% x RM1 50000.00	7500.00	
	247500.00	
(Less) Salvage value	8000.00	
Capital cost for 5 years	**239000.00**	
Capital cost for 1 year = RM 239500.00	47900.00	
5 years		
Total hour for 1 year = 200 days x 8 hours = 1600 hours		
Capital cost/hour = RM 47900.00		29.94
1600 hours		

Build-Up Rate Calculation For Excavation Works

SOLUTION :

	RM	RM
b. Operational cost		
Operator = 1 person. x RM 50.00	50.00	
Diesel = 6 liter x 8 hours x RM 1.70	81.60	
Hydraulic oil = $\underline{14\ liter}$ x RM 20.00	40.00	
7 days		
Operational cost/day	171.60	
Operational cost/hour = $\underline{RM\ 171.60}$		21.45
8 hours		
Total machine cost/hour		51.39
Plant output = 12 m^3/hour		
Excavate cost/m^3 = $\underline{RM\ 51.39}$		4.28
12 m^3		
c. Profit & Overhead cost		
15 % x RM 4.28		0.64
Price Rate/m^3		4.92

ACTIVITY 5

Excavate pit to column bases starting from reduced level maximum depth not exceeding 1.00 meter. – m^3

Data :

Initial cost	– RM 180,000.00
Interest on loan	– 10%
Operator	– 1 person ; RM 70.00 /day
Lifecycle of plant	– 6 years
Resale value	– RM 10,000
Average plant works	– 150 days /year
Diesel	– 6 liter/hour
Hydraulic oil	– 3 liter/day
Diesel cost	– RM 1.70 /liter
Hydraulic oil cost	– RM 20.00 /liter
Plant output	– 15 m^3/hour
Profit & overhead cost	– 15%

ACTIVITY 6

Excavate pit to column bases starting from reduced level maximum depth not exceeding 1.00 meter. – m^3

Data :

Rental cost	– RM500.00/day
Operator	– 1 person; RM 60.00/day
Diesel	– 3 liter/hour
Hydraulic oil	– 3 liter/day
Diesel cost	– RM 1.70/liter
Hydraulic oil cost	– RM20.00/liter
Plant output	– 10 m^3/hour
Profit & overhead cost	– 15%

ACTIVITY 7

Excavate pit to column bases starting from reduced level maximum depth not exceeding 1.00 meter. – m^3

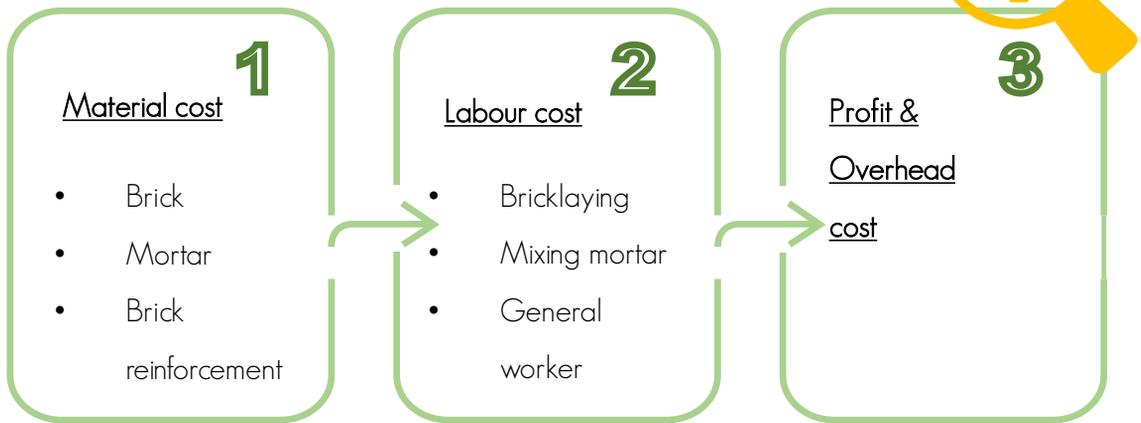| Data :	Initial cost	– RM 210,000.00
	Interest on loan	– 9% per annum
	Operator	– 2 persons; RM 80.00 /day
	Lifecycle of plant	– 7 years
	Salvage value	– RM 9,000.00
	Average plant works	– 200 days /year
	Diesel	– 7 liter/hour
	Hydraulic oil	– 2.5 liter/day
	Diesel cost	– RM 2.00/liter
	Hydraulic oil cost	– RM 19.00/liter
	Plant output	– 13 m^3/hour
	Profit & overhead cost	– 15%

BUILD-UP RATE CALCULATION FOR BRICK WORKS

INTRODUCTION

Brick wall is built manually on site and it is bonded with mortar.

In calculation, brick works shall be measured in square meter (m^2), stating the thickness of the wall, type of brick, type of bond and proportion of mortar.

Elementary components for brick works price rate calculation :

1 Material cost

- Brick
- Mortar
- Brick reinforcement

2 Labour cost

- Bricklaying
- Mixing mortar
- General worker

3 Profit & Overhead cost

Brick

Standard size of a brick is 215 mm (length) x 102.5 mm (width) x 65 mm (thick).

There are two type of brick :

i. Clay brick

ii. Cement brick

Figure 9. Clay and Cement Bricks
(Source: Builtory, 2018)

Calculation of quantities of brick for 1 m^2 half brick wall :

No. of brick/m^2 wall	=	$\dfrac{1000 \text{ mm} \times 1000 \text{ mm}}{225 \text{ mm} \times 75 \text{ mm}}$	= 59.26	= 60 no.
(+) 5 % wastage				= 3 no.
Total				= 63 no.

The table below show the material needed for brick wall :

Description	Mortar (m³)	Number of brick (No.)
½ brick wall	0.025	63
1 brick wall	0.050	125
1 ½ brick wall	0.075	188

Mortar

The composite material of mortar is cement, fine aggregate (sand) and water.

Mortar proportion of cement and sand (1:3), (1:4) and (1:6).

Some additive such as lime is use as a retarded agent.

Mortar proportion of cement, lime and sand is 1:1: 6

Shrinkage, wastage and consolidation for mortar – 33.33% or 1/3 of materials shall be added

Brick reinforcement
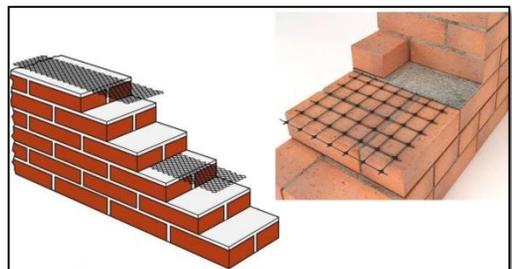
Brick reinforcement is needed for ½ brick wall.

Figure 10. Reinforced Brickwork Mesh
(Source: Engineering Brother, 2021)

Labour output

Description	Bricklayer (hour/m²)	General labour (hour/m²)
½ Brick wall in common brick	1.00	0.35
1 Brick wall in common brick	1.75	0.70
½ Brick wall in facing brick	2.00	0.50
1 Brick wall in facing brick	3.50	1.00

Build-Up Rate Calculation For Brick Works

EXAMPLE 10: Build-up rate of 1 m³ mortar

Cement, lime and sand mortar (1:1:6). – m³

Data :	Lime cost	= RM 3.50/bag (10 kg)
	1 m³ lime	= 400 kg = 40 bags
	Labour wages	= RM 40/day
	Labour output for mixing mortar	= 2 hours/m³

SOLUTION :

	RM
a. Material cost	
1 m³ cement x 28 bags x RM 10.50	294.00
1 m³ lime x 40 bag x RM 3.50	140.00
6 m³ sand x RM 30.00	180.00
	614.00
+) shrinkage, consolidation & wastage 1/3 x RM 614.00	204.67
Material Cost for 8 m³	818.67
Material cost/m³ = $\frac{RM\ 818.67}{8\ m³}$	102.33
b. Labour cost	
Mix mortar = $\frac{2\ hour\ \times\ RM\ 40.00}{8\ hour}$	10.00
Price rate/m³ mortar	112.33

EXAMPLE 11 : Build-up rate of brick works

Half brickwork in common bricks in cement lime and sand mortar (1:1:6) in Stretcher bond with brick reinforcement at every forth course, non-load bearing. – m^2

Data :	Common brick cost	- RM 0.24 /piece
	Brick Reinforcement	- 3.50 m/m^2 brick wall ; RM0.60 /m
Labour output :	Bricklayer	- 1.00 h/m^2
	General labour	- 0.35 h/m^2
	Profit & Overhead cost	- 15 %

SOLUTION :

	RM	RM
a. Material cost		
Brick = 63 nos. x RM 0.24	15.12	
Mortar = 0.025 m^3 x RM 112.33	2.81	
Brick reinforcement = 3.50 m x RM 0.60	2.10	20.03
b. Labour cost		
Bricklayer = 1.00 hr x RM 60.00 / 8 hour	7.50	
General labour = 0.35 hr x RM 40.00 / 8 hour	1.75	9.25
		29.28
c. Profit & Overhead cost		
15 % x RM 29.28		4.39
Price Rate/m^2		33.67

ACTIVITY 8

One brickwork in common bricks in cement mortar (1:3) in English bond, load bearing. – m^2

Data:	Cement cost	- RM 12.50 /bag
	Sand cost	- RM 45 /m^3
	Labour wages	- RM 40 /day
	Labour output for mixing mortar	- 2 hours/m^3
	Common brick cost	- RM 0.30 /No.
Labour output :	Bricklayer	- 2.50 h/m^2 ; RM70 /day
	General labour	- 0.45 h/m^2
	Profit & Overhead cost	- 15 %

BUILD-UP RATE CALCULATION FOR REINFORCEMENT WORKS

INTRODUCTION

Bar reinforcement is commonly used in reinforced concrete and pre-stressed concrete structure.

The common type of bar reinforcement used in concrete works are mild steel and high tensile steel.
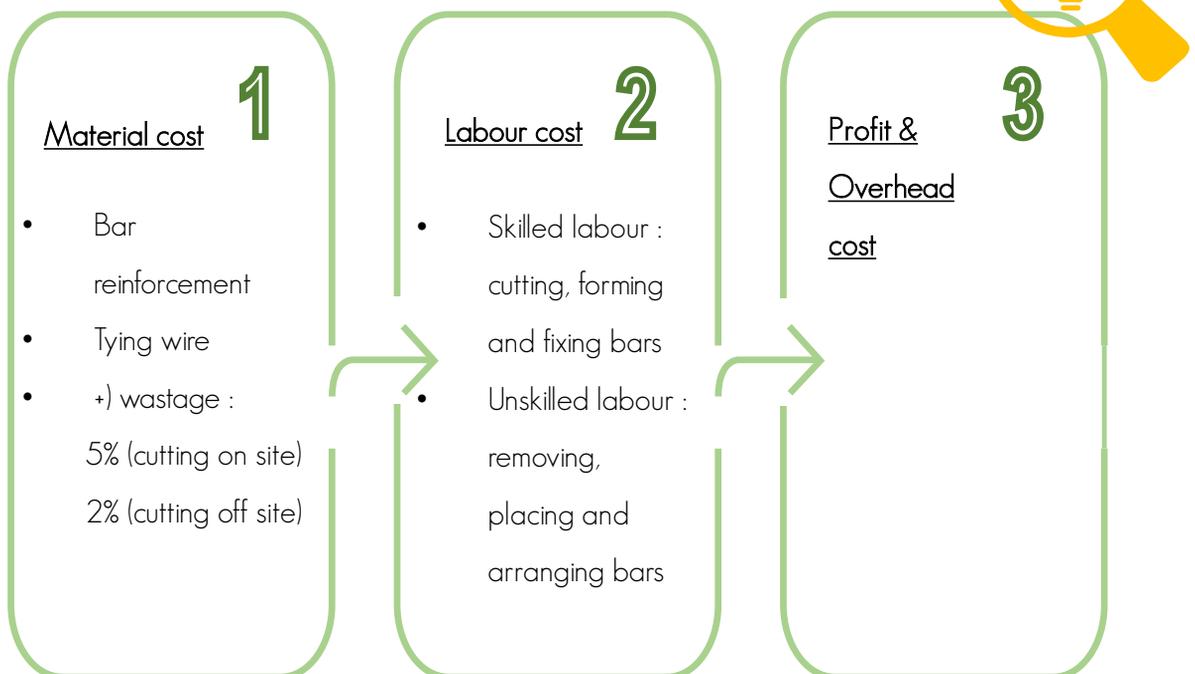

Figure 11. High Tensile Steel
(Source: Guiderom./Shutterstock, n.d)

Figure 12. Mild steel bar
(Source: Civil engineers BlogSpot, 2020)

Elementary components for reinforcement works price rate calculation :

1 Material cost	2 Labour cost	3 Profit & Overhead cost
• Bar reinforcement • Tying wire • +) wastage : 5% (cutting on site) 2% (cutting off site)	• Skilled labour : cutting, forming and fixing bars • Unskilled labour : removing, placing and arranging bars	

Weight of bar reinforcement

Diameter of bar (mm)	Weight of bar (kg/m)
6	0.222
8	0.395
10	0.616
12	0.888
16	1.579
20	2.466
25	3.854
32	6.313
40	9.864
50	15.413

The quantity of tying wire for 1 tonne bar reinforcement

Diameter of bar (mm)	Tying wire for 1 tonne bar (1000 kg)
6 – 12	10
16 – 25	6
32 - 50	5

The smaller the bar reinforcement steel size, the more tying wire is needed to complete 1 tonne of steel bar reinforcement.

Labour output : Cutting & bending bar reinforcement

Location	Hour per tonne of bar reinforcement (every 1000 kg reinforcement)			
	6 - 8 mm ø	10 - 12 mm ø	16 - 20 mm ø	> 25 mm ø
Straight & bend bar	40	30	20	15
Link / stirrup	65	50	30	-

Labour output : Fixing bar reinforcement

Location	Hour per tonne of bar reinforcement (every 1000 kg reinforcement)			
	6 - 8 mm ø	10 - 12 mm ø	16 - 20 mm ø	> 25 mm ø
Foundation & ground floor	40	30	25	20
Upper floor and roof	50	40	30	25
Wall, column, beam and stair	70	50	35	30
Link / stirrup	90	70	60	-

The smaller the steel bar reinforcement, the more time is needed to complete 1 tonne of steel.

EXAMPLE 12

16mm Diameter high tensile reinforcement in straight and bent bars in foundations. – kg.

Data (material; per 1000kg) :

	16mm ø high tensile steel reinforcement	– RM 1800/tonne
	Tying wire	– 6 kg; RM 3.50 /kg
Labour Output :	Cutting and bending bar	– 20 hours
	Fixing	–. 25 hours
	Removing & arranging	– 1.5 hours
Labour Wages :	Bar bender	– RM 55 /day
	General labour	– RM 40 /day
Profit and Overhead Cost		– 15%

SOLUTION :

	RM
a. Material cost [1000 kg]	
Bar reinforcement	1,800.00
+) wastage and spacer, 5% x RM1,800.00	90.00
Tying wire, 6 kg x RM3.50	21.00
b. Labour cost [1000 kg]	
Cut & bend : 20 hr. x RM 55/8hr	137.50
Fixing : 25 hr. x RM 55/8hr	171.88
Remove & arrange :1.5 hr. x RM 40/8hr =	7.50
c. Profit & Overhead cost	
15% x RM 2,227.88	334.18
Price rate for 1000kg	2,562.00
Price Rate / kg = RM 2,562.06 / 1000 kg	2.56

Build-Up Rate Calculation For Reinforcement Works

ACTIVITY 9

12mm Diameter high tensile reinforcement in straight and bent bars in staircases. – kg

Data (material; per 1000kg) :

12mm ø high tensile steel reinforcement	– RM 2500 /tonne
Tying wire	– 10 kg; RM 3.50 /kg

Labour Output :

Cutting and bending bar	– 30 hours
Fixing	– 50 hours
Removing & arranging	– 2 hours

Labour Wages :

Bar bender	– RM 60 /day
General labour	– RM 40 /day

Profit and Overhead Cost   – 15%

REFERENCES

Mastura Jaafar, Lim Yoke Mui & Izyan Yahaya (2003). *Elementary Estimating for Building Works.* Pulau Pinang : Penerbit Universiti Sains Malaysia

Abdullah, A. (2005). *Anggaran Kos Kerja Bangunan Berdasarkan SMM2.* Petaling Jaya : Pearson / Prentice Hall

Kharani Haji Ahmad (2011). *Construction Economics.* Petaling Jaya : Pearson Custom Publishing

Construction Review Online. (2021, 3 May). *Mixing concrete by hand DIY in 4 simple steps* [Image]. Retrieved from https://constructionreviewonline.com/concrete/mix-concrete-by-use-of-hand/

Mahadev Desai. (2019, 17 September). *Methods for Mixing of Concrete Their Procedure & Precautions!* [Image]. Retrieved from https://gharpedia.com/blog/methods-for-mixing-of-concrete-their-procedure-precautions/

Bedrock Drilling. (2021). *Hydro Vacuum & Traditional Excavation In The Illawarra* [Image]. Retrieved from https://lirp.cdn-website.com/19e21ea6/dms3rep/multi/opt/226-602w.jpg

Hidustan Steel Suppliers (2017). *Foundation digging* [Image]. Retrieved from https://cdn.shopify.com/s/files/1/1402/9129/articles/dsc04743_1024x1024.jpg?v=1490612963

Construction Civil Engineering (n.d). *Advantages of Sand Filling in Footing* [Image]. Retrieved from http://www.constructioncivilengineering.com/images/sand-filling-in-footing.jpg

REFERENCES

Construction Civil Engineering (n.d). *Advantages of Sand Filling in Footing* [Image]. Retrieved from http://www.constructioncivilengineering.com/images/sand-filling-in-footing.jpg

Nemat Syed (2016, 29 January). *Earthwork* [Image]. Retrieved from https://buluqalmuhandisalmadaniwordpresscom.wordpress.com/2016/01/29/earthwork/

Juan Rodriguez.(2021, 8 May). *Backfilling Trenches and Other Excavations* [Image]. Retrieved from https://www.thebalancesmb.com/how-to-backfill-foundations-and-trenches-844871

Zhaojiankangphoto. (n.d). *Excavator in construction site on sunset sky background* [Stock Photo]. Retrieved from https://www.123rf.com/photo_76009857_excavator-in-construction-site-on-sunset-sky-background.html

Builtory. (2018, 25 September). *Types of Brick* [Image]. Retrieved from https://builtory.my/builtory-image/JbeWMPOKq/brick-types.jpg

Engineering Brother. (2021). *What is Reinforced Brickwork? Types And Construction of Reinforced Brickwork* [Image]. Retrieved from https://engineeringbrother.com/wp-content/uploads/2021/03/reinforced-brickwork-mesh.webp

Guiderom. (n.d). *Reinforcement steel rod and deformed bar with rebar at construction site.* [Image]. Retrieved from https://www.shutterstock.com/image-photo/reinforcement-steel-rod-deformed-bar-rebar-1898158726

Civil engineers blogspot (2020, 12 May). *What is Steel Reinforcement? And REBARS* [Image]. Retrieved from https://civilengneers.blogspot.com/2020/05/what-is-steel-reinforcement-and-rebars.html