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140 Flinders Street, Melbourne, Vic. 3000

IDENTIFICATION FORM

...l No. 184-412 Lesson No. 37

...e MAUNG KYAW NAING

...ress GPO BOX 16558

SUVA, FIJI

...rse Name: COMBINED BUILDING CONSTRUCTION & BUILDERS' DRAUGHTSMANSHIP No. 408

...ject Name: BUILDING CONSTRUCTION No. 412

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2/ Fire rating

Fire rating of material is hour long it can resist the sp...

412 – Building construction

MAUNG KYAW NAING

Assignment (37)

184-412

1/ Reasons for the necessity of adopting fire resisting construction in building

The reasons for the necessity of adopting fire resisting construction in building are to protect the building and its occupants. The selection of fire resisting materials and methods of construction are important in design requirement.

2/ Fire rating

Fire rating of material is how long it can resist the spread of fire and depending on its construction, depending on types of construction and usage of materials.

Fire ratings of materials are obtained by conducting scientific tests on such materials or systems.

The results of such tests give the material or system a fire rating classification of 1 hour, 2 hours, 3 hours or 4 hours.

For examples, 230 mm solid brick or sand lime brick external and internal bearing wall has fire rating of 4 hours.

Ceiling made with 100 mm of reinforced concrete with 20 mm minimum cover to reinforcement has fire rating of 3 hours.

3/ Protection of structural steel is attained by covering the steel columns and steel beams with concrete brick. Thickness of concrete or brick determines the time to resist the fire.

covering the steel structure with brick or concrete is important because although steel is an excellent because of its strength, its one weakness is that in its loaded state in the presence of fire will fold and collapse.

Consequently the fire protection of structural steel is imperative.

4(a) Fire wall

A fire wall means a wall which subdivides a building to resist the spread of fire. Their precise specification is generally determined by the building code which suggests their fire resistance in accordance with their locations. Generally fire walls are used to subdivide different occupations, e.g fire wall which subdivides 2 flats within the same building have a fire resistant rating of 2 hours and floors a rating of 3 hours.

It is for this reason that walls are 270 mm cavity brick and floors of 100mm reinforced concrete.

(b) 1 hour fire rated ceiling

A 1 hour fire rated ceiling is made of wood joist constraction fire stopped by filling all openings around pipes or flues with in combustible materials, and covered with double board floor, having a total thickness of not less than 38mm and with a ceiling of at least 20mm plastered or gypsum plaster on expanded material or wire lath.

The weight of expanded metal or wire lath shall not be less than 1.2kg/m2

(c) Fire partition

A fire partition is an internal partition in a building whose object is to resist spread of fire as for a fire wall but is not load bearing. They are light in construction - slight plaster partition of about 50mm thickness is an example.

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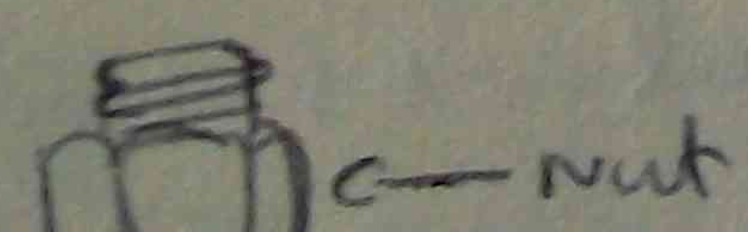
Bolt . Bolt is a pin or bar which is used to lock or un[...] parts while permitting easy disconnection.



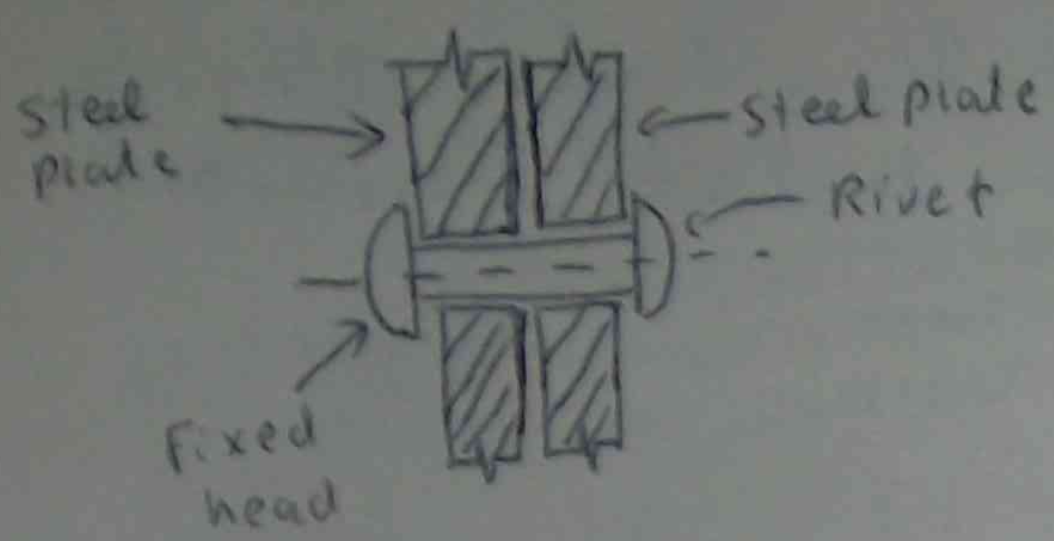
412 BUILDING CONSTRUCTION

MAUNG KYAW NAING
184-412

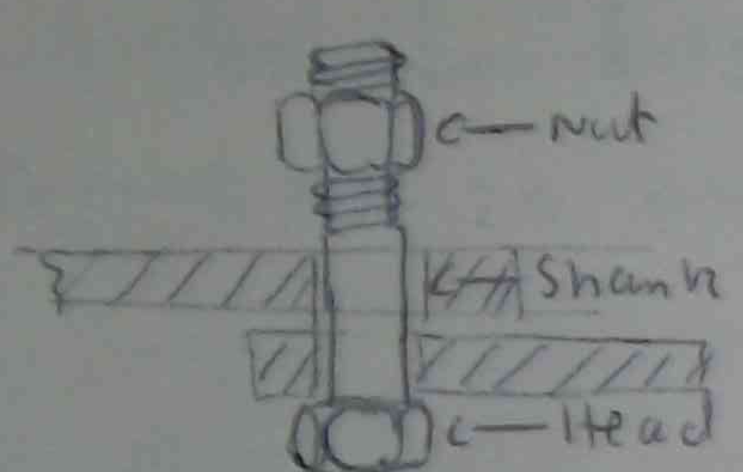
ASSIGNMENT NO (38)

1/ 3 basic methods of jointing steels

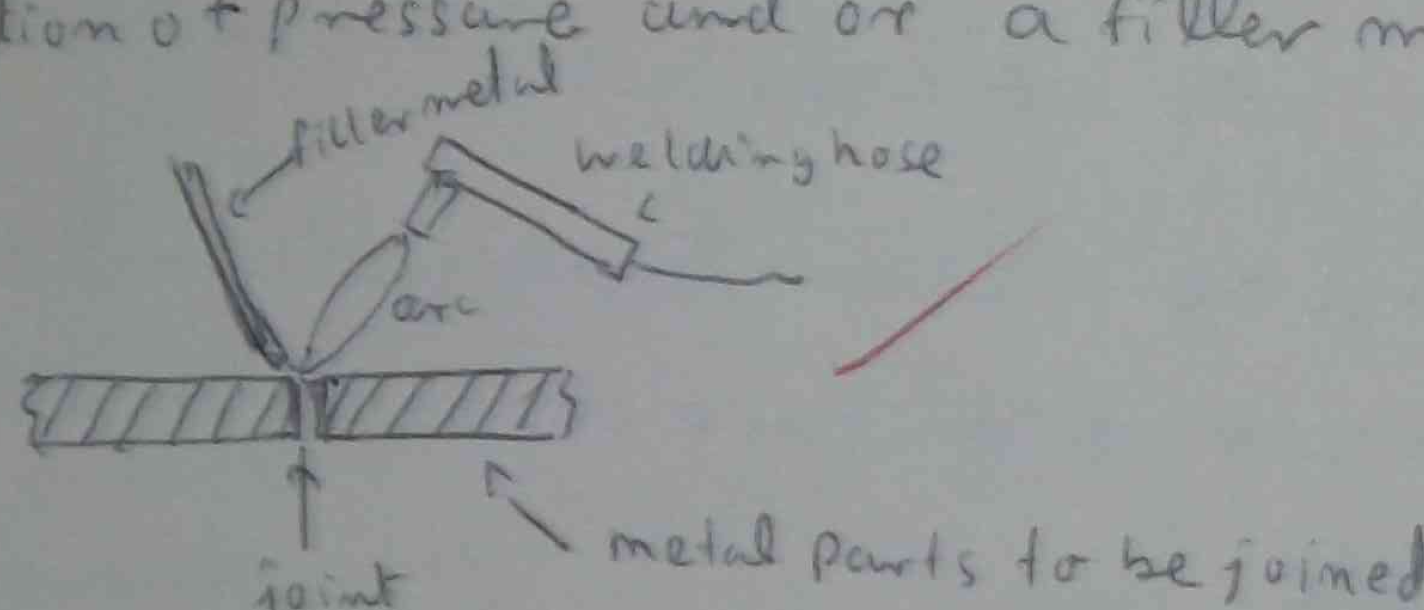
Riveting - Riveting is a permanent fastening steel work by forming a head on the plain end by means of a pneumatic hammer.



Bolt - Bolt is a pin or bar which is used to lock or unite two or more parts while permitting easy disconnection.



Welding - welding is a technique of joining metals by heating with or without application of pressure and or a filler metal.



2| Process of arc welding

An arc is struck between two carbon electrodes or between a carbon electrode or more commonly a welding rod, and the work, in each case with or without filler rod. Arc welding is faster and gives deeper penetration than gas welding and is suitable for both thin and heavy sections and for both sitework and automatic processes.

In arc welding, molten metal combining with oxygen and nitrogen from the air makes the joint brittle and less resistant to corrosion. To prevent this, joints must be protected by a suitable flux by a blanket of inert gas provided from a cylinder or by special coatings on electrodes.

3| Cold welding

Soft metals such as lead and gold can be welded by hammering. Stainless steel and other alloys can be joined by ultra sonic vibrations when the parts are lightly clamped together.

Plastic welding

metals such as wrought iron and less readily, mild steel can be hammer welded at a temperature below their melting points, although the strength of the joint is somewhat less than that of the parent metals.

Fusion

Fusion welding involves melting of the metals to be joined either by a gas flame or an electric arc. In some cases, a filler rod, often of similar composition to that of the parent metal is used.

Properly formed fusion welds are as strong as the parent metals.

4| Before riveting, hole is required to be made on steel plates which are to be rivetted. Diameter of the hole should be 1.5mm bigger than the diameter of rivet to allow for slight inaccuries in the fitting and the expansion of rivet when hot.

The spacing of rivets should not be closer to each other than 3 times their own diameter with a maximum distance of 150 mm or 16 times the thickness of the thinnest plate.

Then, hammer their head on the plain end by means of a pneumatic hammer.

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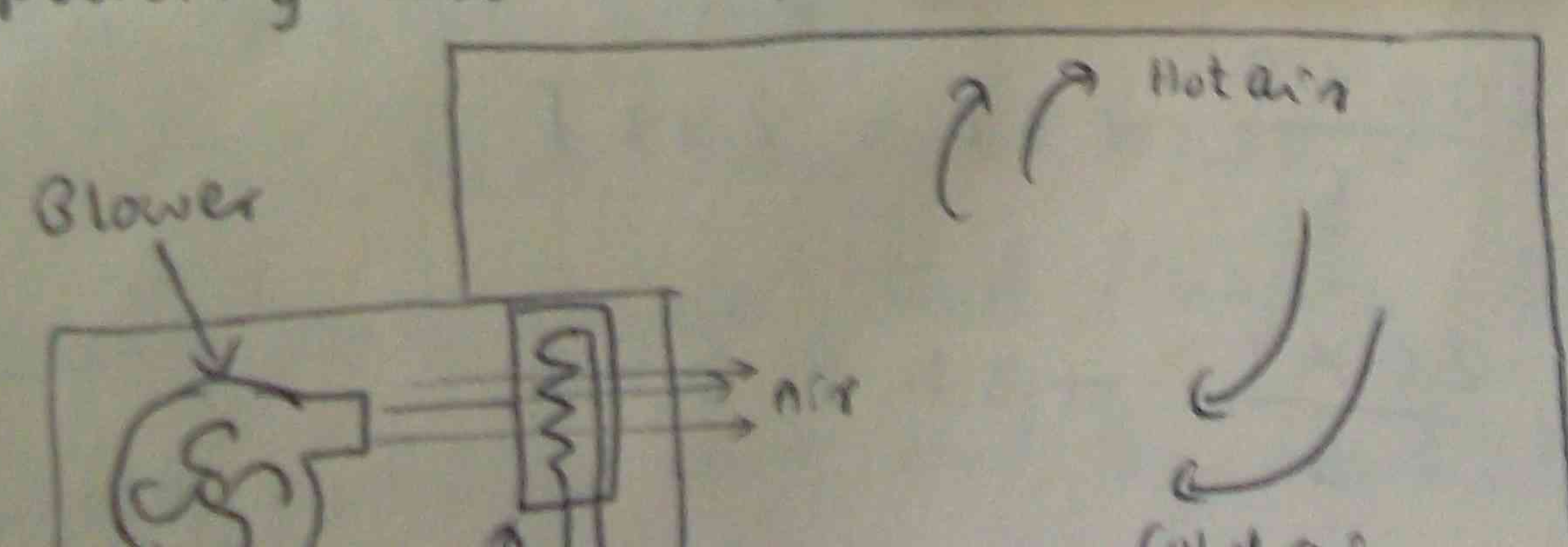
replacing cold air. Example - hot air furnace



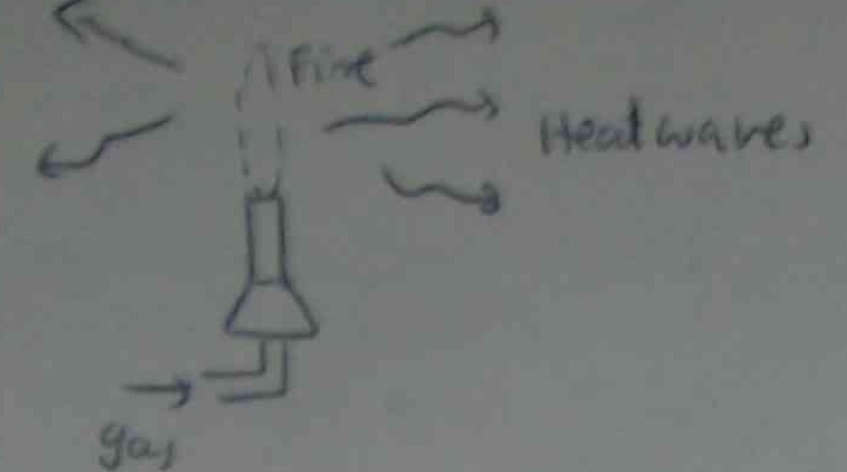
412 - BUILDING CONSTRUCTION

ASSIGNMENT <39>

MAUNG KYAW NAING
184 - 412

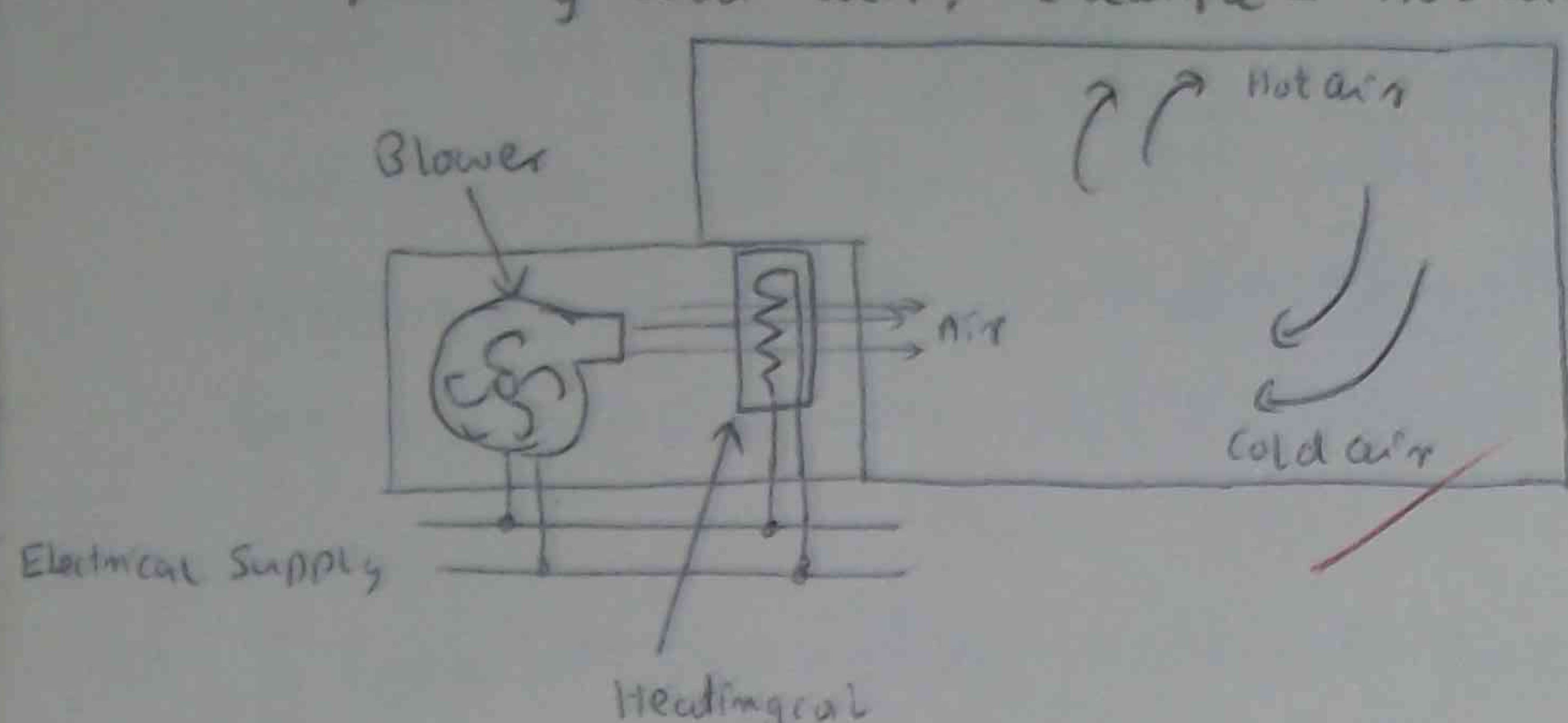
1/ Radiation

Heat rays are emitted and diffused by radiation to surrounding air. Eg- gas fired hot water radiator



convection

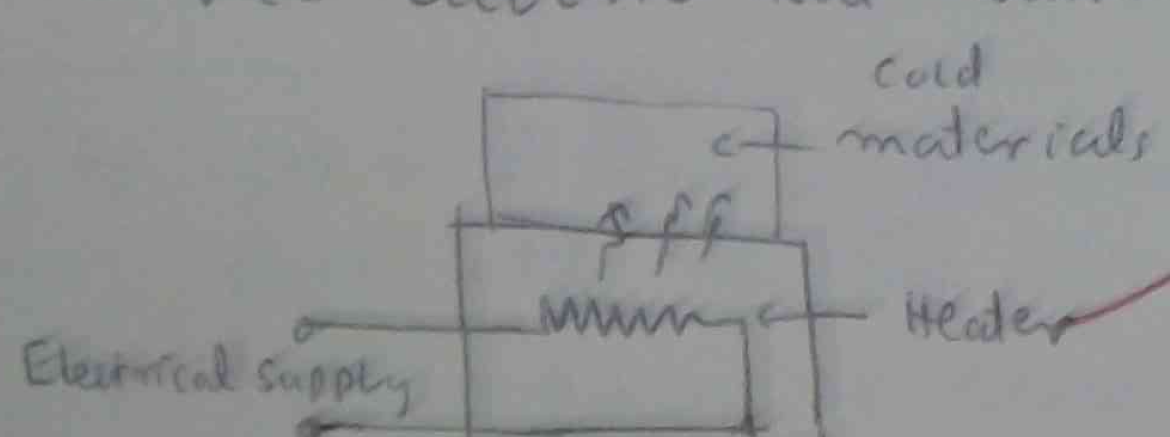
Heat is transmitted by the movement of air currents. Hot air currents rise replacing cold air. Example - hot air furnace



Conduction

Heat is transmitted or conducted from the heat source through its mass to the adjoining air.

Example - electric heat banks



2/ BTU It is British Thermal unit. It denotes the amount of heat required to raise the temperature of 1lb of water one degree Fahrenheit.

Calorie It is metric unit. It represents the amount of heat required to raise one kilogram of water one degree centigrade.

3/ Fahrenheit scale of heat intensity is heat intensity which on the Imperial scale in terms of the Fahrenheit thermometer with freezing and boiling points of water at 32 degrees and 212 degrees respectively.

Celsius

It is metric heat intensity scale on thermometer with zero degree and 100 degree being freezing and boiling points of water respective

4/ Fahrenheit to centigrade

$$C = \frac{F-32}{9} \times 5 = \frac{65-32}{9} \times 5 = 15^\circ C$$

$$C = \frac{F-32}{9} \times 5 = \frac{32-32}{9} \times 5 = 0^\circ C$$

Centigrade to Fahrenheit

$$F = \frac{C \times 9}{5} + 32 = \frac{100 \times 9}{5} + 32 = 212^\circ F$$

$$F = \frac{C \times 9}{5} + 32 = \frac{20 \times 9}{5} + 32 = 68^\circ F$$

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across the air space and this is absorbed by the coole[r]

hot. The heat then continues its flow by conductio[n]

[illegible]

1/ Heat can be lost from [illegible]
In the simple wall of a [illegible]
the inside of the building [illegible]
The warm surface transfers some [illegible]
the air space, and this air, [illegible]
cooler surface.

In addition, the warm surface emits [illegible]
across the air space and this is absorbed [illegible]
hot. The heat then continues its flow [illegible]
sheathing and stucco, and finally this heat [illegible]
the cold outside air and by radiation to [illegible]

2/ 3 Types of insulating materials are <1> insulat[illegible]
but, which is a more or less loose insulation [illegible]
which can be tacked onto wood joists or studs
<2> loose rock wool (or) vermiculite <3> Reflecti[illegible]

Insulation boards and insulator bats

They are used in filling up air spaces to reduce both conduction [illegible]
Insulating boards add to the strength and rigidity of the building.
Insulation bats are used as sheathing and as the plaster base or in the place of plaster. They are also tacked onto wood joists or studs.

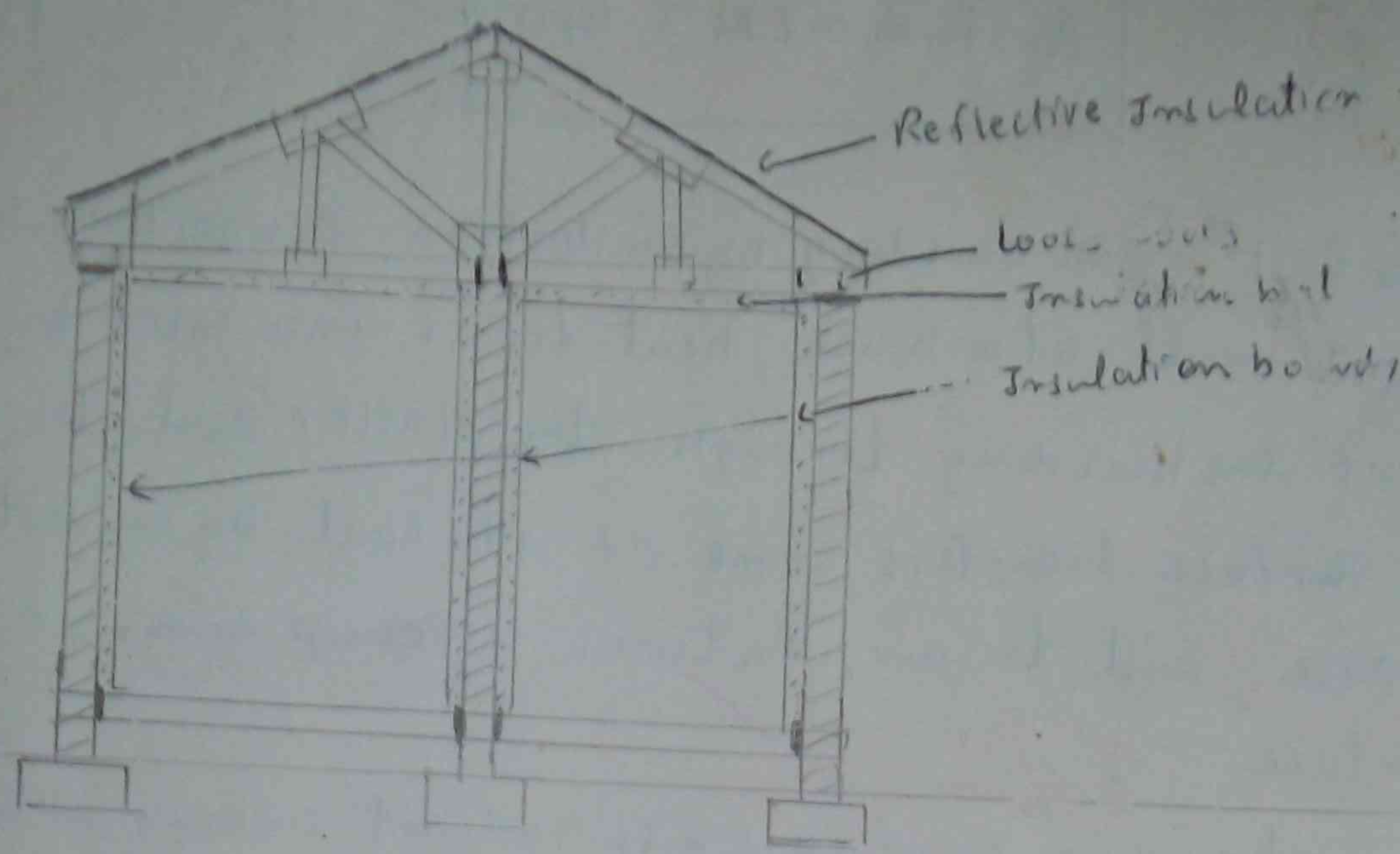
Loose rock wool

They are poured into air space between joists or studs.

Reflective foil insulation

They reflect the radiant rays back to their source. Only a very small amount of energy is absorbed as heat by the foil and conducted to the outside. They are not only good reflectors but also a poor radiators of energy. Since the transfer of heat across in air space is aided by convection current, the use of reflective foil insulation is more value in winter for floors than for ceilings. Reflective insulations are especially good insulators in roofs in the summer to prevent heat entering the h[illegible]

P 10 →



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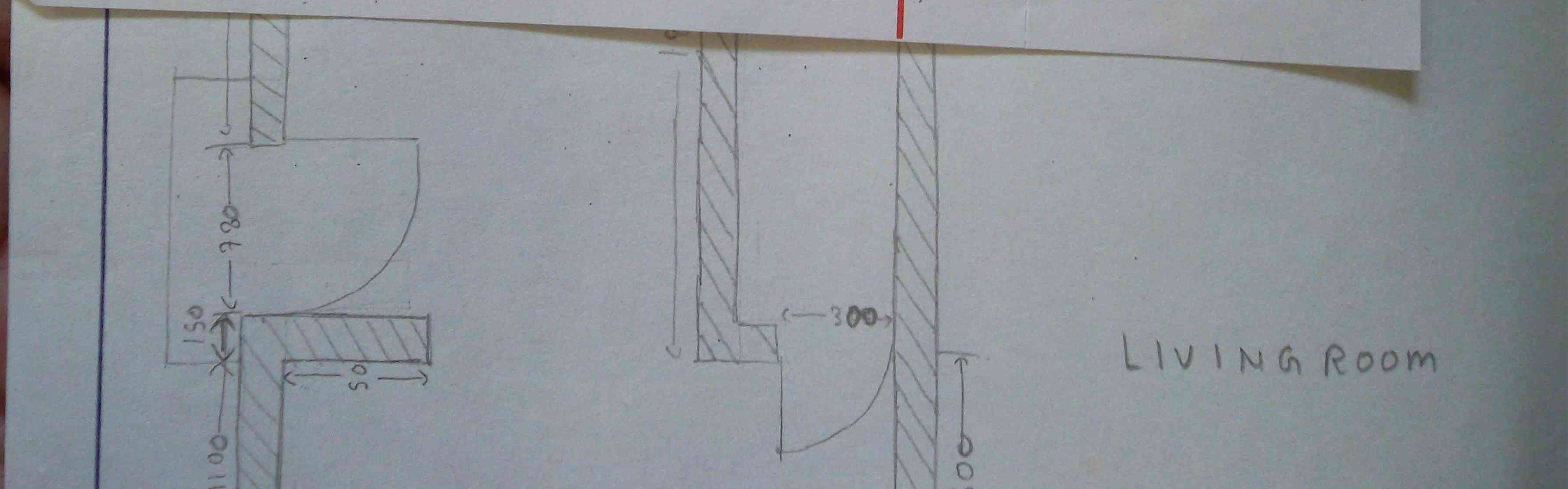

ASSIGNMENT (14)

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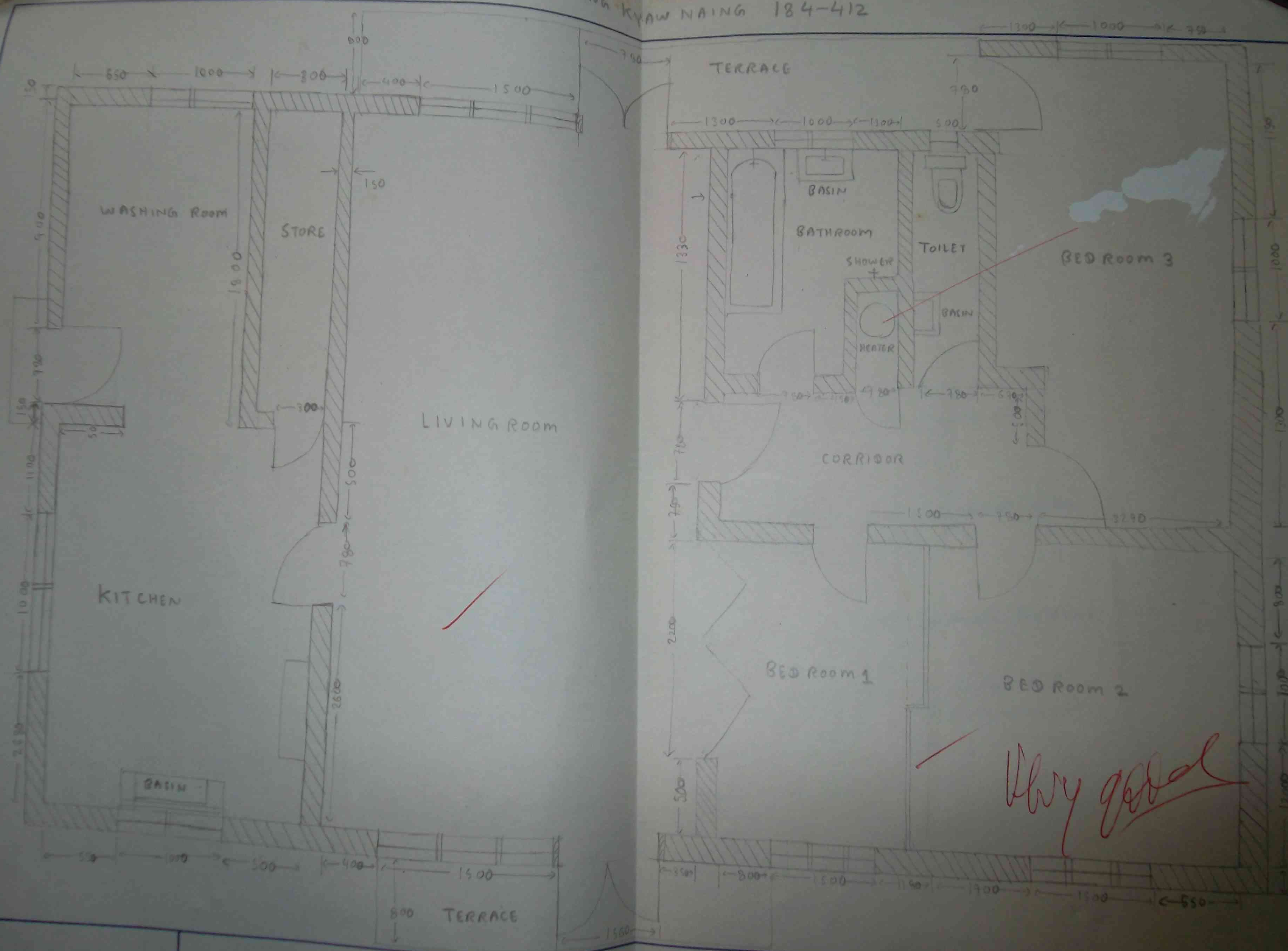

BUILDERS' DRAWING PAPER NO 14

DRAWN BY M...

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ASSIGNMENT (25)

412 - BUILDING CONSTRUCTION

1(a) Ablutionary fixture

Ablutionary fixture is the fixture used for washing the human body. They are usually located in domestic bathrooms and in office or industrial washrooms. Baths, basins, showers, shower bath, ablution troughs, footbaths, bidets, circular wash fountains come into this category.

(b) Boundary Trap

A Trap used to prevent the passage of gases from the sewer to the drain.

(c) IO (Inspection opening)

An access opening in a pipe or fitting sealed with a removable plug or cover, used as an access for purposes of inspection or maintenance and testing where so provided in drains.

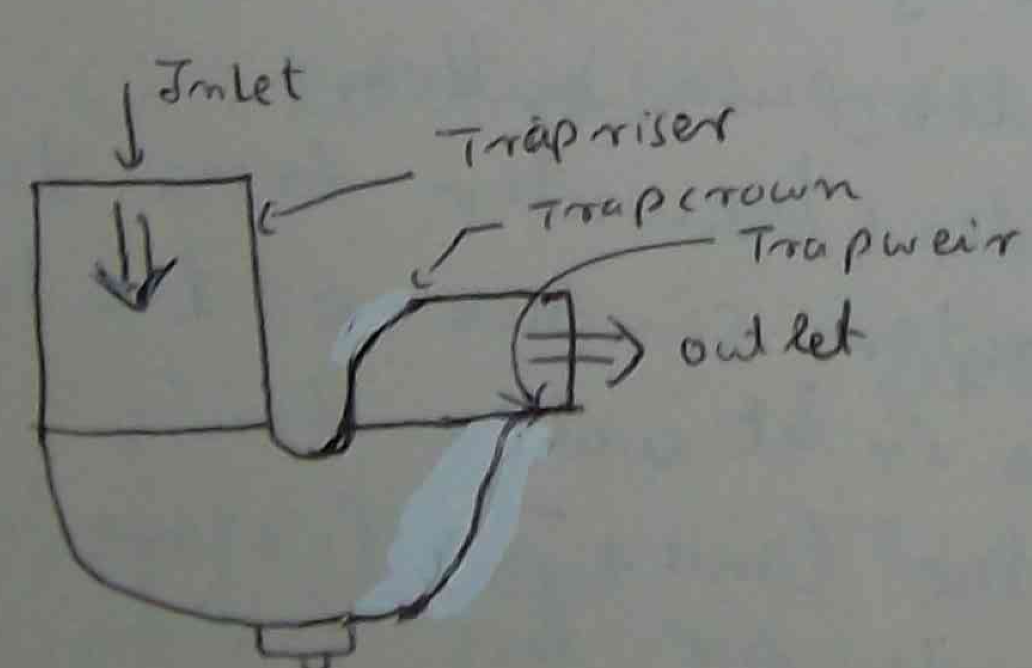
(d) Invert

The lowest point of the internal surface of a pipe or channel at any cross section.

(e) Floor waste

Grated inlet within a graded floor intended to drain the floor.

2 P TRAP



P Trap is installed in drainage and waste system to prevent the discharge of noxious gases from the sewer through plumbing fixtures in to house.

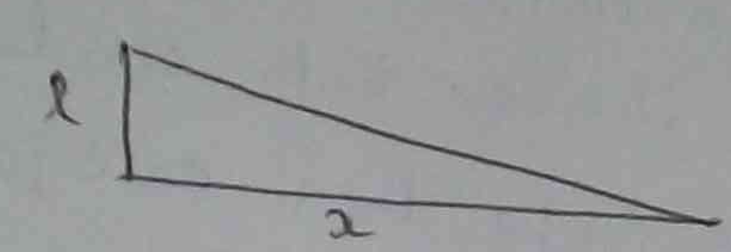
The trap is so designed that sealing off is obtained by retaining an amount of water in a U shaped bend.

The formation of sewer gases produces an increase in pressure in the system, and to ensure that this increases pressure does not break the water seal in the trap, the seal depth and therefore the water column that gases would have to displace.

is increased by allowing at least an extra 75mm in water column height between the level of the dip and the crown weir.

Installation of P Trap is prefered because it has less tendency to lose its water seal through syphon action.

3. (a)



l = The fall between highest and lowest points of the trench

x = length of trench = (85m)

Gradient = $\frac{l}{x}$

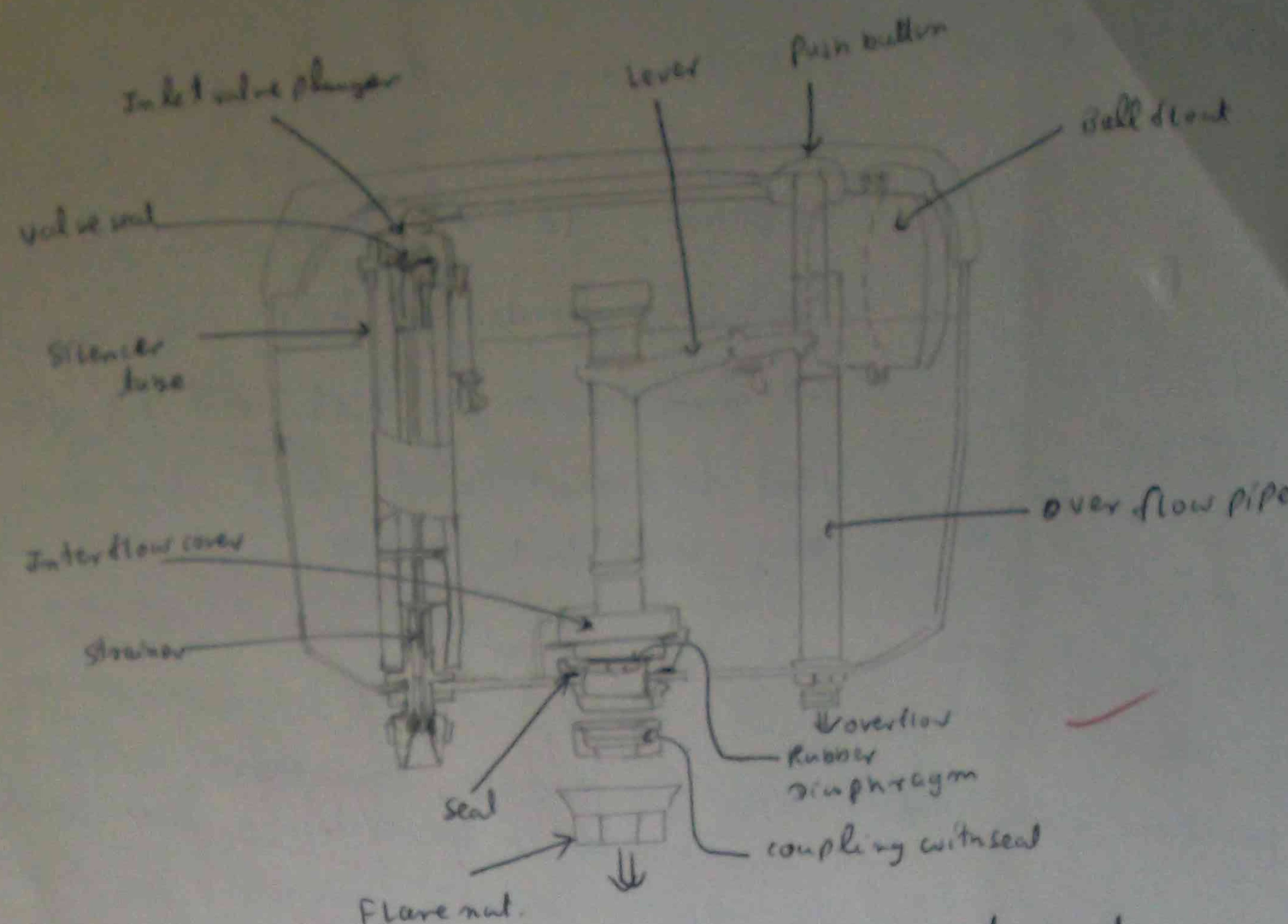
$\frac{1}{60} = \frac{l}{85}$ $\therefore l = \frac{85}{60} = 1.41m.$

(b) Gradient = $\frac{1.062\ m}{85m} = \frac{1}{80}$ $\therefore$ 1:80 gradient.

4 / Modern cistern

The illustration shows modern cistern design.
When the push button is depressed, the diaphragm is lifted into the interflow cover where, through the pressure of the escaping water, it is kept floating and away from its seat until the cistern is empty.
The discharge value is then closes.
At this stage, the ball float, now not supported by the water, has dropped and has opened the water inlet valve to which it is connected by a pivoted arm.
As the water level rises, it takes with it the ball float which, as it rises, gradually closes the water inlet valve until it reaches a preset ~~lo~~ level when the valve is completely closed, stopping the water supply until the next operation of the push button.
A silencer tube has been fitted which guides the water from the inlet valve to flow out around the outer surface of the tube into the tank. In other designs, the inlet water flows directly from the valve outlet into the tank. The fixture must deliver between 10-12 litres in 7 seconds or less for each flushing operation.

The overflow pipe is necessary to prevent flooding of the ~~floo~~ flour in case of a faulty or worn inlet valve rubber or seat which would allow over filling of the cistern beyond its



Preset water level. Tanks are designed so that the water connection can be made either on the right or left hand sides by fitting the inlet assembly on the side where the water connection is located. This one is provided with a stop tap to cut off the water supply to the tank when repairs to the mechanism have to be carried out.

<u>Location</u>

5| (i) Trap vent - Trap vent is connected to discharge pipe

(ii) group vent - Group vent is used for ventilating the traps of a group of fixtures ~~to~~ connected to a common discharge branch pipe.

(iii) Relief vent It is connected as stack branching from the discharge stack at a point below the lowest fixture.

(iv) crossvent The cross vent is interconnected the relief vent with the stack it serves.

(v) Terminal vent It is connected at the end of venting system

(vi) Vent Top - Vent tops are installed within a distance of 3m from a chimney top or similar type of opening to a building.

It must be located at least 2m above or 600mm below the level of the opening.

Vent tops must be at least 5m away from any air duct intake.

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the gr...

Therefore, rainwater stored in metal tanks will contain little hardness and is considered to be soft.

Hard water prevents problems in both domestic and commercial uses. The poor lathering properties of some water supplies, particularly those from underground ... are well known. ... used in boilers ...

1 (a) Static Head

The intensity of pressure exerted by water is directly proportional to depth of the water and is measured in kilopascals (kPa)

(b) Hard water

Hardness in water is due to the presence of lime and magnesium salts in solution in the water. These are taken into the water from the ground on which it is stored or through which it passes.

Therefore, rainwater stored in metal tanks will contain little hardness and is considered to be soft.

Hard water prevents problems in both domestic and commercial uses. The poor lathering properties of some water supplies, particularly, those from underground sources are well known.

Commercially, problems arise when hard water is used in boilers and for specialized processes. Chlorides, sulphates, and carbonates salts cause water to become hard. Types of hardness are temporary and permanent hardness.

To remove temporary hardness, water is to be heated.

To remove permanent hardness, base exchange method is to be used.

(c) Trunk service

Circumstances, particularly in outlying areas, may make it necessary to connect a pipe of larger diameter than the usual service pipe size to accomodate local requirements. Such lines tapped into the mains to service an area are called trunk service lines or trunk service or joint service.

(d) STOP TAP

A screw down pattern tap with a loose jumper valve and with the inlet and outlet both having suitable means for connection to a pipe line.

(e) Sedimentation

Sedimentation is the settling of particles of dirt and foreign matter to the bottom of storage tanks. Dirt should be allowed to settle in the tank instead of being released into the delivery pipe. The inlet level of outlet pipe should be mounted a little higher than the tank bottom surface to allow for this.

Also, the supply valve outlet and the outlet pipe inlet should not be in line or close together because such arrangement would allow

(1) direct flow from supply to outlet, allowing the bulk of water stored to remain stagnant

(2) stagnant water to be supplied to fixtures in cases when the normal supply would fail, or be interrupted for a while.

(d) Breeching piece

Breeching piece is device which is used to connect the outlet of hot and cold water for water mixing

mixing takes place at the junction of the two branches and the flow to the required temperature is controlled by the degree to which each of the two taps is connected.

2 Thermostatic mixing valve

Thermostatic mixing valve is the valve which is kept at constant temperature and used for providing water of the desired temperature at outlets by intermixing of two water supply source by manipulation of one or two valves.

operation

The outlet temperature is kept to that selected by the operator by the action of an inbuilt thermostat which consists of a bimetallic coil. The thermostat serves any changes in temperature and being connected to a valve controlled mechanism, it compensates by altering the setting of the valve, for any change of temperature recorded in the mixing chamber by adjusting the volume of either hot or cold water admitted.

water hammer

water hammer is sometimes refered to as line hammer, It is due to sudden arrest of a column of water moving at speed through the pipes. The conditions is recognized by a noise similar to a hammer blow on the pipe and can, through the increase in pressure within the pipes. weaken them or even burst them.

If water moved slowly through the pipes and was compressible no line would occur but, for all intents and purposes, water can not be compressed.

Prevention of water hammer

water hammer can be eliminated by

- Installing line hammer arrestors
- Installing concussion nipples in to the pipe lines
- providing dash pots in fittings

4 | The purpose of fire sprinkler is to operate automatically in the event of fire to hold the fire under control until the arrival of the fire brigade.

operation

The sprinkler has spherical valve made of glass or stainless steel is held on its seat by metal strips soldered together and supported by frame.

Should a fire occur, and surroundings of the sprinkler head reach a predetermined temperature, the special solder will melt and the metal strip will fall apart.

The water pressure will then force the valve off its seat and water will be sprayed over the area by the deflector which breaks up the water jet from outlet.

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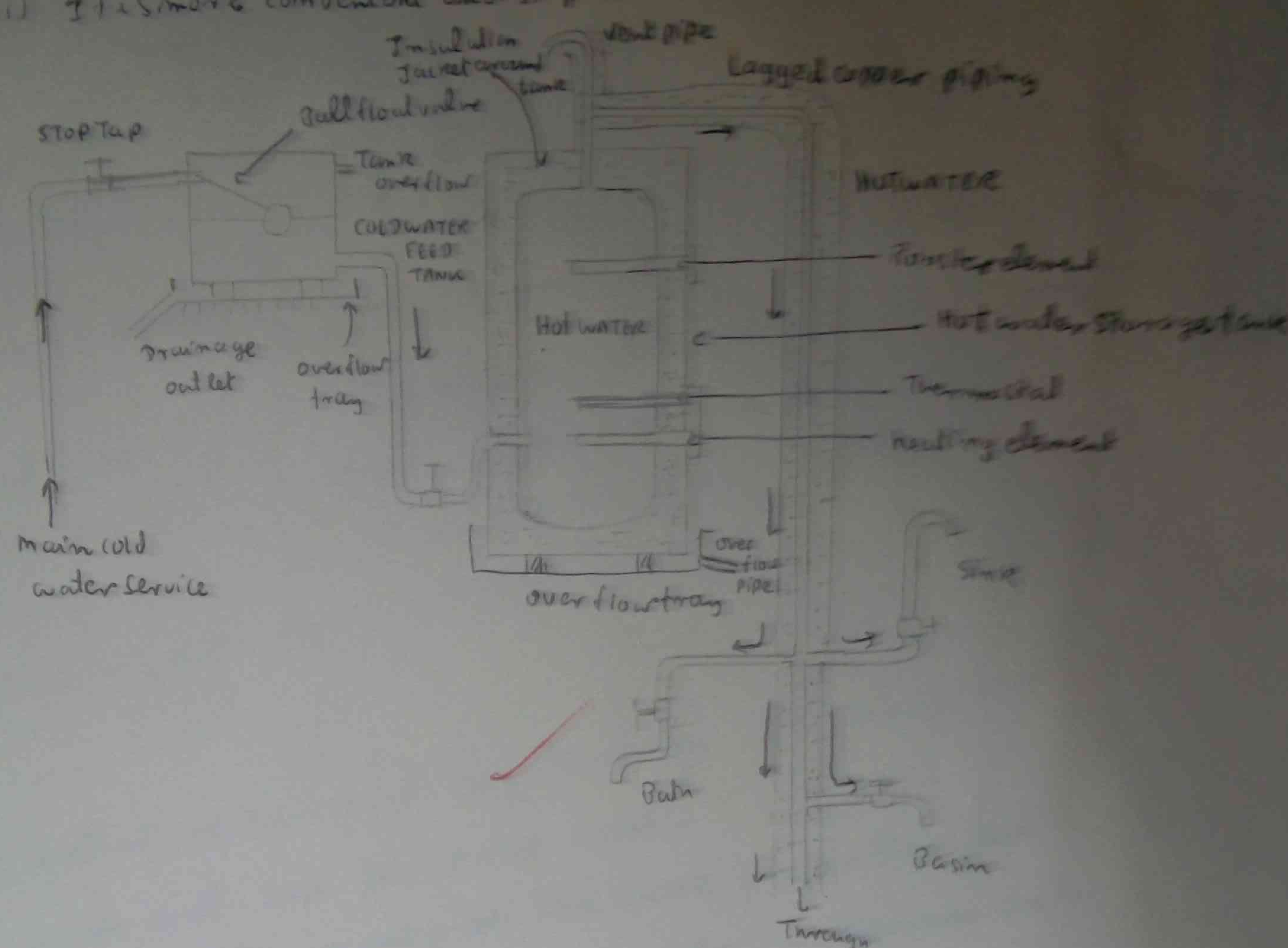
ASSIGNMENT (27)

1 Two advantages of electricity over coal

(i) Sudden heavy draw off ~~in~~ hot water can be catered by electric storage heater

(ii) It is more convenient and simpler to use electricity.

2



ELECTRIC STORAGE HOT WATER SYSTEM

3 (a) The purpose of booster element in electric hot water service is to boost the heating to water. Since hot water is lighter than cold water, it goes upward in tank. Heat can be lost from hot water to fresh cold water. This heat is compensated by booster element which is installed at upper position in boiler

(b) The purpose of thermostat is to adjust the temperature of hot water. When water temperature reaches required value, thermostat cuts off the supply. Otherwise too hot water will become steam.

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heated, water is expelled and a white, grey

obtained. It is known as plaster of paris.

[illegible] in a few minutes so it [illegible]

412-BUILDING CONSTRUCTION

ASSIGNMENT (28)

MAUNG KYAW NAING

184-412

1(a) Lime putty

Lime putty is the non hydraulic (or) fat lime prepared in a pit on the site one month before use by mixing quick lime obtained by burning limestone in a kiln with water to form lime putty.

(b) Gypsum

Gypsum is the raw material and is mined. When gypsum is heated, water is expelled and a white, grey or pink powder is obtained. It is known as plaster of paris. When mixed with water, it sets within a few minutes, so it is unsuitable for general plaster work but it may be used for patching.

(c) Rough cast

Rough cast is one method of external plastering. It has 1:0:3 to 1:1:6 for both under coat and the second coat.
Whilst the latter is still soft, a mix of the same proportion but including 60% of 6mm gravel in the aggregate is thrown onto the wall to give the wet dash finish.

(d) Floating coat

Floating coat is second layer of plastering which has 6mm. It has 1 lime putty and 2 sand. Now for much general building work, the render coat is omitted and floating coat is made thicker.

(e) Plaster board

Plasterboard consists of a core of gypsum plaster bonded between two sheets of heavy paper. There are four types from 10 to 13mm thick. Base board, lath, plank and insulating base board.

They are all similar except that the latter has a covering of aluminium foil on one side and are obtainable in several sizes, 1.2m by 1.8m wall board being commonly used. The boards are nailed to the joists at 150mm centres with 32 mm by 22mm galvanized plaster board nails. They should be fastened so that the joints are staggered.

2| vermiculite plaster is used for fire proofing, 38mm of gypsum vermiculite plaster is placed over expanded metal lath weighing not less than 1.6kg/m^2 spaced 12mm from the faces and edges of the steel by means of steel channels 1.6mm in thickness at 600 mm vertical spacings and expanded metal corner heads, the space between the resultant casing and column being not necessarily filled.

By applying vermiculite plaster in this way, fire rating becomes 4 hours.

3| 3 plastering defects and reasons for such failures

1| popping, pitting, blowing
2| poor adhesion
3| cracking

- Popping, pitting and blowing are caused by unsound lime and that which has not been slaked properly. The unslaked particles expand to leave small holes in the plaster.

- poor adhesion is caused by a high suction of backing, too rapid drying out or by moisture being imprisoned in the wall which subsequently emerges through the plaster in the form of blister. Due also to incorrect choice of plaster.

- Cracking is due to shrinkage on drying out is associated with cement or lime mixes. movement of background is also responsible. Caused also by sands containing more than 5% silt and clay. Failure to provide discontinuity where the background change is another reason.

Very good

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140 Flinders Street, Melbourne, Vic. 3000

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IDENTIFICATION FORM

Enrol No. 184-412 Lesson No. 29

Name MAUNG. KYAW NAING

Address G.P.O. BOX 16558

SUVA, FIJI

Course Name: COMBINED BUILDING CONSTRUCTION AND BUILDERS' DRAUGHTSMANSHIP No. 408

Subject Name: BUILDING CONSTRUCTION No. 412

Grading: Very good

(For Instructor's use only)

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Address G.P.O. BOX 16...

Scrimming is one of the most important operatio... After panching has been completed, the ...

412 - BUILDING CONSTRUCTION

MAUNG KYAW NAING
184-412

ASSIGNMENT (29)

1(a) Batten

Battens are ex 500 x 25 oregon or soft pine. They are straight grained and well seasoned. Ceiling battens are usually fixed to the timber joists. In setting out battens, positions are set out to take cornice, joints mouldings and any parts which have definite positions. Flat headed 50mm gauge nails are used for fixing battens.

(b) Scrimming

Scrimming is one of the most important operations in fixing work. After panching has been completed, the plaster is gauged in a bracket and taken above the ceiling. Fibre of scrim is dipped into the plaster and then laid over the joints and rubbed on to the sheets or mouldings, on each side of the joint. This method is called scrimming.

To make good scrimming, at least a 25mm grip should be allowed on each side of the joint and should be the full length of the joint.

(c) Stopping

The objective of stopping is to fill up all holes and to leave a clean face to match the cast work.

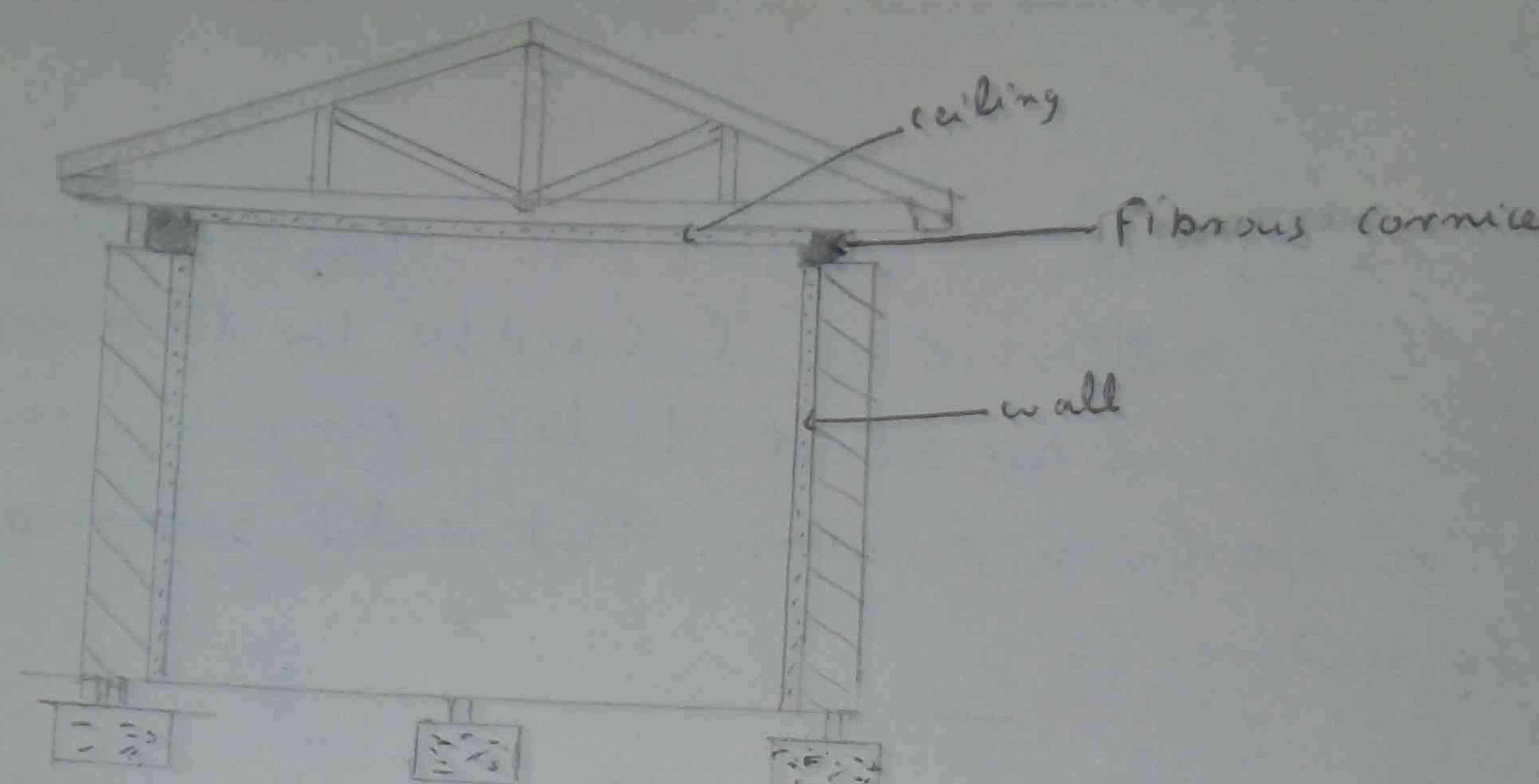
Joints and nail holes are stopped with neat plaster.

(d) Caulked joint

The edges of the sheets are hacked well with a sharp knife to expose a fair proportion of fibre.

Fibre is chopped into short length and mixed with plaster. It is then forced well up into the joints. So that it overlaps the top slightly and grips the exposed fibres in the sheets. This method is used sometimes when access to the top of the ceiling is not available.

2.



3 Before the fixing of fibrous plaster sheets, inspections should be made on structural timbers such as studs, joists and noggings are securely fixed. Inspection should also be made on electrician's conduits and wires and any services with in the walls are in positions before the sheets are fixed.

Very good

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Name MAUNG KYAW NAING

Address GPOBOX ...

its associated switchgear and other equipments, a...
adjacent to the building's own switch room. ...

412 BUILDING CONSTRUCTION

ASSIGNMENT (30)

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184-412

1/ Advantage of alternating current over direct current

Alternating current has many advantages over Direct current for power distribution. The big advantage is that voltage may readily be stepped up or stepped down by use of transformer

2/ (a) Substation

A substation is primarily housing for a heavy duty transformer and its associated switchgear and other equipments, and is usually located adjacent to the building's own switch room. Substation may be located outside or within the building as convenient.

It is planned, constructed and ventilated in accordance with the regulations of the local supply authority.

(b) Kilowatt

Kilowatt is commercial unit for electrical power ~~unit~~. It is equal to $\frac{\text{volt} \times \text{Amp}}{1000}$

(or) 1000 watts

(c) TRS

TRS is Tough Rubber Sheathed (rubber covered) wire

(d) Consumer's main

Consumer's main is the wiring between overhead cable from Electric Supply Authority's service and consumer's switch board which includes meter board, switch board and fuses for consumer's use.

(e) Earthing

The metal frames of all portable appliances are connected to the earth pin of standard 3 pin power plug. By this way, metal frames are connected to earth when the appliances are plugged in to the power socket. Earthing of metal work is a safety measure - ensuring that all exposed metal is at same potential.

Any short circuits or accidential contact of live wires with earthed metal box will result in the fuse being blown. Thus breaking the dangerous contact.

(f) Transformer

Transformer is to step up or step down the electrical voltage.

Transformer consists of an iron core on which are wound two insulated coils of each having many turns. Alternating current fed in to one of these coils will cause a corresponding varying magnetic field around the iron core which in turn induces an alternating current of similar frequency in the other coil.

The voltage induced across the second coil is approximately proportional to the ratio of the number of turns in that coil to the number in the first coil. Thus by adjusting the numbers of turns in the second coil, voltage can be adjusted ~~in~~ very wide range.

3/ Unit of electricity

Unit of electricity means that 1 kilowatt (kw) electrical power is consumed by electrical load for 1 hour (OR) 1 kwh.

Very good

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Subject Name: BUILDING CONSTRUCTION No. 412

Grading: Very good

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Name . MAUNG KYAW N...

twisted, and will ...

or drummy. After soaking under side of ...

with pure cement ...

412 - BUILDING CONSTRUCTION

MAUNG KYAW NAING

184 - 412

ASSIGNMENT (31)

1 (a) Quarry tiles

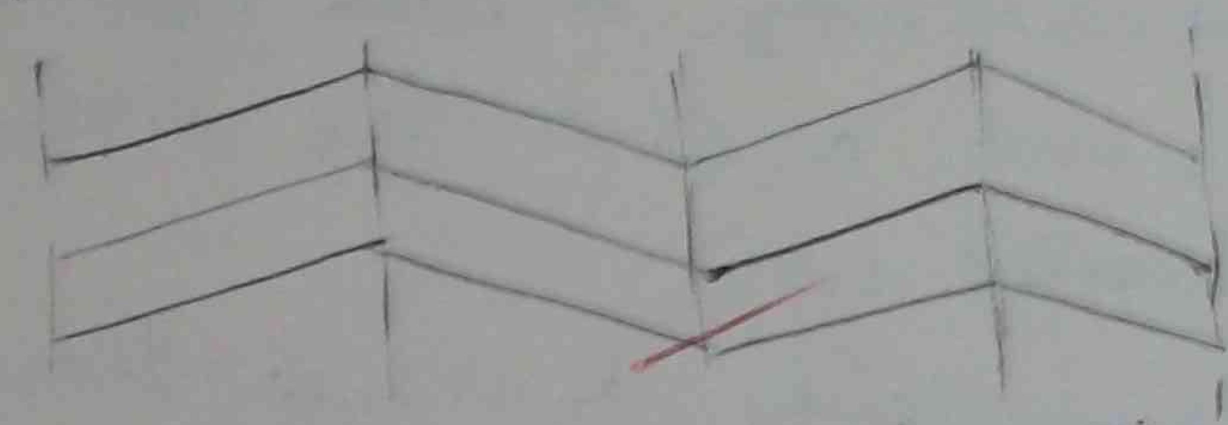
Quarries tiles are coarse in texture and are hard and dense. They are made from natural clays in red, black and cinnamon.

Quarry tiles are much more absorbent than most floor tiles. They are soaked before fixing. They usually are fixed with an open joint which is filled in and then pointed or ironed.

Special care is required in bedding quarry tiles as they are often twisted, and will arch over the bed, causing them to sound hollow or drummy. After soaking under side of the tiles is painted with pure cement.

1 (b) Herring bone pattern

Herring bone pattern is method to lay the tiles according to following diagram.



			Suitable Tile
2 (a)	Factory loading deck	–	Steel tile
(b)	Domestic kitchen	–	Linoleum
(c)	Office floor	–	vinyl
(d)	Bathroom floor	–	masonic

3 (a) Masonic Floor Tile

Laying

20×20mm, 24mm peppermint & 25mm hexagon vitreous ceramic masonic tiles are sheeted on brown paper before being sent to the job. The area to be tiled is accurately measured and sheets are usually supplied to fill a given area. The sheets vary in size. They are laid down carefully on the bed in the position they will occupy. moving of the sheet after they have been laid down causes the tiles to go out of alignment.

It is good policy to lay the border first. Extra care is required during screeding to obviate unnecessary bedding.

When a given strength of floor has been laid, the sheets are beaten down firmly. The paper is wetted so that after a time, it may be peeled off. At this stage, joints may be regulated and driers used judiciously to fill the joints. The final bedding and rubbing is given before grouting and cleaning off.

Grading

A gradual slope of approximately 1 in 150 looks better than steeper fall. If floor is required to carry water away, 1 in 75 grading is applied.

Cleaning

Tiles are cleaned off in the usual way. A clean wet rag which is damp rather than saturated is used, as it is less likely to cause the well grouted joints to be washed out.

The water should be changed regularly to reduce the white smear which invariably dries on the surface.

The floor is sometimes covered with damp sand. If this is left on for a few days and then swept off, a cleaner floor will result. Saw-dust is sometimes used to clean, the floors instead of a cloth. It has the effect of ensuring that joints remain well filled.

Very good

Builders' ESTIMATING simply explained

Metric Edition

by

JOHN A. MILNE FRICS AIQS Dip.Ed

Based on the Standard Method of Measurement of Building Works, 5th Edition (Metric) July 1968, the R.I.B.A. Conditions of Contract and the National Working Rules for the Building Industry.

Published by George Godwin Ltd, 4 Catherine Street, London WC2
(*A member of The Builder Group*)

Contract' and the National Joint Council for the Building Industries 'National Working Rules for the Building Industry'.

The labour constants used by building contracting firms are built up from experience but may also be obtained from books of constants prepared for this purpose and therefore long lists of them have not been provided. The rates of wages and the cost of materials will inevitably change, but this will in no way invalidate the principles of estimating as explained in this book.

I wish to express my thanks to friends and colleagues who have assisted me in the preparation of this book and also to the British Standards Institution and the National Joint Council for the Building Industry for permission to reproduce extracts from their publications.

J. A. MILNE

January 1971

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CHAPTER I

INTRODUCTION

In order to have an overall understanding of builders' estimating it is essential to have an outline knowledge of contract procedure. The normal parties concerned with the construction of a new building are the client, architect, quantity surveyor and the building contractor. First, we will look at each of these in more detail.

The client: He is the most important person in the operation as it is he or his company who are financing the project. He must feel sure that the building is designed to fulfil his requirements and will be built at an economical price.

The architect: He is the person who designs the building. This is usually done in collaboration with a team of specialists, i.e. quantity surveyor, structural, heating and electrical engineers. The architect must study the clients needs in order to produce a building which satisfies the functional requirements and is also aesthetically pleasing. The design is developed and working drawings are prepared. The working drawings are passed to the quantity surveyor for the production of a bill of quantities and later to the contractor to enable him to build to the architects design.

The quantity surveyor: He is responsible for ensuring that the architect receives realistic cost advice throughout the design stage. During the working drawings stage he commences preparing the bill of quantities. The bill of quantities together with the letter of tender is sent to a selected number of contractors for pricing in order to receive a competitive price for the works. The quantity surveyor reports to the architect on the tender costs and on costs generally throughout the construction.

The building contractor: He is responsible for the erection of the building in accordance with the architect's drawings. His tender would normally be the lowest received offering to execute the works. The tender figure would have been arrived at by the detailed pricing of the bill of quantities. The preparation of the tender figure requires considerable work to be done by the contractor's estimating department.

The Contract Documents

The documents which form the basis of most building contracts are the drawings of the proposed building, the conditions of contract applicable to the contract, the preambles and bill of quantities, a letter in the form of a formal tender from the contractor to the employer offering to carry out the work in accordance with the foregoing documents and the letter of acceptance from the employer to the builder.

In order to understand these documents more fully we will study each in more detail.

The drawings: Copies of the contract drawings must be available for the building contractor to inspect if he so desires, prior to him submitting his offer. It is better, however, if copies of small scale plans and elevations are sent to the contractor together with the bill of quantities when he is invited to tender. Copies of the contract drawings are signed by the parties to the contract to certify that they are the drawings relevant to the contract.

The conditions of contract: These are usually a standard form of contract conditions, the most usual being the R.I.B.A. form of conditions of contract (private and local authority editions) and the C.C.C. Works I, the form used by the Ministry of Public Building and Works. The parties to the

contract should sign the building contract (in Scotland) or the articles of agreement (in England and Wales).

The preambles and bill of quantities: The preambles give the type and standard of quality of materials and workmanship required to be used in the execution of the contract. The bill of quantities gives the description of each item of material and labour required to execute the work together with the quantity involved. The estimator is able to price each item in order to achieve a figure for carrying out the contract.

The following is an extract from a bill of quantities, the prices in the right-hand column being worked out by the estimator.

Bill of Quantities

		£	£
Excavations			
Excavate vegetable soil average 250 mm deep and spread on site average 100 m from excavation (m²)	73	0.43½	
Ditto basements starting from natural ground level and not exceeding 1.5 m deep (m³)	61	1.03½	
Ditto trenches to receive foundations, starting from 1 m below natural ground level and not exceed-exceeding 1.5 m deep (m³)	5	1.38	
Extra over basement excavations for breaking up rock (provisional quantity) (m³)	7	7.00	
Keep excavations free from general water	Sum	included	
Level and ram bottom of trench excavations to receive concrete foundations (m²)	30	0.12	
Surplus excavated material deposited on site in permanent spoil heaps average 50 m from excavations (m³)	63	0.34½	
Excavated material backfilled around foundations (m³)	3	0.86½	

BUILDERS' ESTIMATING SIMPLY EXPLAINED (METRIC EDITION)

		£	£
Plank and strut sides of basement excavations starting from natural ground level and average 1.5 m total depth (m²)	15	0.25	
Concrete Foundations			
Concrete in foundations not exceeding 150 mm thick (m³)	5	8.73½	
Sawn formwork to sides of concrete foundations at steps (m²)	2	1.50	

Letter of offer: This is in the form of a formal tender which is prepared by the quantity surveyor and sent to the contractor along with the bill of quantities. The contractor must use this tender form when submitting his offer.

The following is an example of a tender form:

TENDER

Address ....

....

Date ....

Messrs. A, B and C,
Architects,
Sirs,

I/We hereby offer to execute the Several Works of the proposed offices and flats at Greenacre Road, Newtown, all in accordance with drawings prepared by you and under your direction and superintendence and on the terms and to the extent of the Bill of Quantities signed by me/us as relative hereto and subject to the Conditions of Contract included in the relative Bill of Quantities and to your satisfaction for the sum of

....

....

I/We understand that the said works shall be completed and ready for use within .... months from the date on which I/We receive intimation from the Architects that the work can be proceeded with.

I/We understand that the Employers do not bind themselves to accept the lowest or any tender and I/We declare that this offer will be held open for acceptance for twenty-eight days from the date hereto.

Your acceptance of this offer will be binding on me/us.

Dated this .... day of 19

Name .... Signature ....

Address .... Witness ....

.... Witness ....

Letter of acceptance: This is a letter from the client, or from the architect on his behalf, to the contractor accepting his offer to execute the works. A formal contract may be signed if either of the parties so desires.

ARCHITECTS

Date ....

To Contractor.
Dear Sirs,

Proposed Offices and Flats at
Greenacre Road, Newtown

We are authorised to accept and do hereby accept your tender dated 6th February, 1970, offering to execute the Several Works of the above for the sum of *X* Thousand, *Y* Hundred and *Z* Pounds (£).

The Work will be commenced immediately on receipt of instructions to do so and will be carried out in accordance with drawings prepared by us and under our direction and superintendence and on the terms of the relative bill of quantities and will be subject to the conditions of contract included in the relative bill.

Kindly acknowledge receipt of this acceptance.

Yours faithfully,

General Information Required for Estimating

Before a contractor (or estimator) commences pricing the many items in a bill of quantities he must study the various documents and drawings that make up the contract. The points to be considered may be summarised as follows:

1. The Preliminaries Bill:
   - (*a*) Check that standard conditions of contract apply. Examine any amendments made to these conditions and see that they are fair and workable.
   - (*b*) Note the starting and completion dates.
   - (*c*) Check if there is a time limit for completion and whether there is a penalty for non-completion on time.
   - (*d*) Assess when the bulk of outside work will require to be done and consider the effect of this on guarantee time and completion dates.
   - (*e*) Check if the contract has to be executed in any particular order.
   - (*f*) Consider any requirements regarding special insurances in terms of the contract.
   - (*g*) Note the period of interim payments, when the final account will be certified and the limit of the retention fund.
   - (*h*) Check if the opportunity will be given to quote for any nominated sub-contractors work applicable to your firm.
   - (*i*) Note the location of the site: If in the country consider transport, roads, access and availability of labour. If in the town consider access, unloading and storing of materials.
   - (*j*) Note the length of the defects liability period.
   - (*k*) Check if contract is on a fixed price basis.

2. The Trade Preambles:
   - (*a*) Check that all the materials are available and that supplies will not interfere with completion dates.
   - (*b*) Check on any handling or storage difficulties that may be encountered if new materials are specified.

3. The Drawings
   - (*a*) Assess the likely requirements for mechanical plant and scaffolding.

   - (*b*) Check access and working space for plant and storage space for materials.
   - (*c*) Consider the requirements for huts, welfare facilities, toilets and temporary roads.
   - (*d*) Consider the supervisory staff requirements and the approximate size of the labour force.
   - (*e*) Consider security and the necessity for hoardings and/or watchmen.
   - (*f*) Check the position of boundaries, accesses and services. Consider the number and position of temporary water points.

4. The Site
   - (*a*) Check the actual position of the site in relation to adjoining property. Consider the access and the transport of plant and materials. Ensure that there are no obstacles to the transport of plant to the site such as narrow bridges or overhead cables. Assess problems due to traffic restrictions such as limited waiting and no parking and their effect on the unloading of materials.
   - (*b*) Determine the position of temporary roads, huts, toilets, hoardings and storage areas. Check on the suitability of the site for the use of plant.
   - (*c*) Consider the possibility of employing local labour or the availability of accommodation should men require to be housed in the area.
   - (*d*) Determine the type of ground to be excavated. This may be done by the inspection of trial holes. Enquire regarding the height of the water table and on the tendancy to flooding.
   - (*e*) Note the position, distance and time taken to travel to the nearest tip and the charge for its use, if excavated or other materials are required to be removed from the site.
   - (*f*) Check the position of water, drainage, electricity and telephone services for the provision of temporary supplies.
   - (*g*) Determine the general weather conditions for the area and consider its effect on guaranteed time allowances.
   - (*h*) Check on the availability of public transport to the site, the time taken for the journey and the distance from the yard.

(*i*) Check, in the case of alteration work, that unoccupied property is in fact empty property.

The building contractor, after having looked into the implications of the contract is now in a position to decide whether or not to submit an offer for the work.

The following points should be carefully considered:

1. How, in relation to present and likely future commitments, will this work fit into our overall building programme?
2. Will there be sufficient workmen available to complete the work within the time limit laid down by the client?
3. Will there be supervisory staff available at the time of the contract who are competent to handle this work?
4. Do we have plant and equipment necessary to complete this contract successfully or is it available for hire at realistic rates?
5. Will we have the necessary financial resources available for use on this contract?
6. Will the type of work involved make the best use of our labour force and are we competent to undertake such work?
7. Do we require the job in order to keep our workforce fully employed?
8. Is there sufficient time available to prepare an accurate tender?

Insufficient men, lack of proper plant and poor management hold up contracts, frustrate the architects and lose clients. The contractor must also consider the cash flow through the firm so that at any particular time he is not in a financial situation that could be detrimental to the future of the firm.

If the contractor decides to proceed and submit a tender he must obtain quotations for the following:

(i) The cost of all materials delivered to the site.

(ii) Estimates, on the same conditions as the main contract, for any portions of the work which he intends to sub-contract.

On receipt of the required quotations the estimator may proceed to build up rates for all the items in the bill of quantities.

The estimator must include for the following:

1. Materials:	The cost of materials delivered to the site. Labour unloading and storing. Waste; changes in bulk; consolidation.
2. Labour:	The cost of the men's wages plus the cost of all the other charges and allowances that must be paid by the employer. The performance standards of the men while carrying out the various elements of the work.
3. Plant:	The true cost of the plant to the contractor allowing for all standing charges and running costs. Transport, erection and dismantling charges and variable costs.
4. Temporary Works:	The cost of all temporary works necessary for the completion of the building works and for removal of same on completion of the contract.
5. Overheads:	A proportion of the cost of general supervision and oncosts necessarily incurred in running the business.
6. Profit:	A sum of money which is commensurate with the risk and effort involved in the organising and carrying out of the works.

The information available to the estimator will contain many uncertainties due to the fact that the work will take place some time in the future and at a site some distance from the builders head office or yard. In order to reduce the risk of error the estimate should be built up in a methodical manner and the estimator should stick to a strict routine.

CHAPTER II

OVERHEADS AND PROFITS

In order that a business may function properly and maintain its position in the industry it must earn enough money to cover the cost of all overheads and earn a profit for the shareholders and/or directors.

This money, which is additional to the cost of labour, plant and materials required for the execution of the contract, may be added either as a lump sum or as a percentage addition.

The sum of money allowed must cover the following:

Supervision: General supervision as given by the owner, manager or directors. The cost of supervision that is permanently on the site and can be directly attributed to that site is usually charged as a lump sum against the site. The cost of a travelling supervisor who is responsible for a number of sites is usually allowed for as an overhead.

Oncosts: The costs necessarily incurred in running the business, e.g. office and yard rent and rates, electricity, telephones, stationery, office salaries and expenses, car expenses, advertising; interest on borrowed capital, maintenance and depreciation of office and yard buildings and equipment, accountants fees, insurances not allowed for in labour costs, bad debts and the like.

Profit: The difference between the contract sum and that required to pay for overheads, site costs, labour, plant and materials to complete the contract.

The percentage addition for overheads and profit is important and must be determined before the unit rates can be fully calculated. The following example has been designed to illustrate the method of arriving at this percentage.

Example

The business under consideration is that of a general building contractor who has had successful trading over a period of years. The business is under the direction of two directors and employs an average annual total of 60 operatives. Records kept over a number of years show a relationship between the cash value of wages to the cash value of materials as being approximately 40:60.

Total Wage Bill

	£
32 tradesmen at £0.50 per h	*16.00*
7 apprentices at £0.35 per h	*2.45*
21 labourers at £0.45 per h	*9.45*
Per squad hours	*27.90*

The squad work a 40 h week	
Weekly wage bill: 40 × £27.90	*£1 116.00*
Annual wage bill: 50 × £1 116.00	*£55 800.00*

The cost of general indirect charges on labour must also be added to cover the following:

(*a*) *National Health contributions.*

(*b*) *Holiday with pay stamps.*

(*c*) *Graduated pensions.*

(*d*) *Redundancy payments.*

(*e*) *Construction industries training board levy.*

(*f*) *Selective employment tax.*

Records kept over a number of years indicate that these items amount to approximately 33⅓% of the gross wages bill, i.e. £18 600.00.

	£
Net wages	*55 800.00*
Percentage addition	*18 600.00*
Total wages bill	*£74 400.00*

Allowing for materials in the proportion of 60:40 (materials: labour) the gross annual turnover of work would be £186 000.00.

Overheads	Per annum £
1. Salaries of principals	
Directors salaries including compulsory contributions	6 500.00
2. Office salaries	
Office and general administrative staff at a combined salary of £3 000 including all compulsory contributions	3 000.00
3. Rent and Rates	
Office and yard. Rent— £300.00 per annum	
Local rates £1.25 per £1.0—375.00 per annum	
£675.00	675.00
4. Office expenses	
Printing, stationery, postages, telephones, electricity and fuel.	
Average total cost of £10.00 per week	
Cost per annum: 52 weeks at £10.00	520.00
5. Insurances	
Allow for all insurance policies not included in labour costs and site insurances. These insurances would include fire, theft, accident, etc.	1 000.00
6. Advertising	
The cost of advertising	75.00
7. Maintenance and depreciation	
Maintenance and depreciation of office and office equipment	200.00
8. Car expenses	
Allowing for three cars.	
Interest charges, annual running expenses, repairs and depreciation	1 200.00
9. Minor plant	
An allowance has been made for repair, maintenance and depreciation of minor tools, plant	
Carried forward	13 170.00

	£
Brought forward	13 170.00
and equipment which is supplied by the contractor and the cost of which is not readily allocated against individual contracts, i.e. trestles, battens, tools, shovels, barrows and scaffolding for work not exceeding 3.5 m high.	
Capital cost of equipment—(say) £1 000.00.	
Allow 5% for interest, 5% for repairs and 10% for depreciation.	
Cost to firm: 20% of £1 000.00	200.00
10. Interest on capital	
Under the conditions of contract (R.I.B.A.) the contractor will require to lie out of retention monies until the end of the maintenance period. In addition interim payments may not always be adequate and the final account may be delayed beyond the prescribed time limit.	
The limit of the retention fund is usually 5% of the contract value.	
By allowing 10% of £186 000 (i.e. £18 600.00) this covers the amount of retention monies and any necessary additional floating capital. If this money was available to the firm it could have been invested. Therefore the cost to the firm is 5% of £18 600.00	930.00
11. Professional fees	
The cost of accountant and other fees	150.00
	£14 450.00

The percentage of overheads to estimated annual turnover of work is

$$\frac{£14\,450.00}{£186\,000.00} \times 100 = 7\tfrac{3}{4}\% \text{ approx.}$$

This percentage does not allow for any of the following factors:

(*a*) Indirect labour charges, such as yard time, periods when on non-productive work, unemployed time etc., when the workmen are doing work which cannot be charged against a particular contract or job. This may be due to non-continuity of work for short periods through which the men are kept in employment.

(b) Reduction in work force due to illness or scarcity of work. This will reduce the value of work done by the contractor but the cost of the firms overheads will remain constant. Overheads charged on a percentage basis may not be fully recovered.

(c) The cost of minor remedial work done during the maintenance period. This may be allowed for under overheads or assessed and added as a lump sum in the preliminaries bill of each individual contract.

(d) The amounts of bad debts that are written off.

In order to cover for expenditure which may arise from these items the overheads percentage has been taken as 9%.

The percentage allowed for profit will vary and will depend on some or all of the following:

(i) The nature of the firms business. A firm of painters and decorators will require a larger profit percentage than a firm of general builders in order to achieve a comparable profit.

(ii) The size of the contract and whether it is mainly new work or work in alterations.

(iii) The area in which the work is required to be done.

(iv) The client and his professional advisers. An architect who does not prepare a complete set of drawings or issues excessive variation orders may so disrupt the contractor's programme that he requires to increase his profit margin. The same may be true if the surveyor is over meticulous or slow in finalising contracts.

(v) Whether the contractor requires the contract to give continuity of work.

In this example the profit percentage has been taken as 6%.

This gives a combined overheads and profit percentage of 15%. This percentage has been used throughout the book with the exception of the Electrical Installations section.

Note: The following refers to examples in the Electrical Installations Section only.

Using the figures from the above example the percentage addition for profit and oncosts allowed for in the Electrical section has been calculated as follows:

Overhead expenditure = £14 450.00

Annual labour costs = £74 400.00

$$\text{Percentage recovery} = \frac{£14\,450.00}{£74\,400.00} \times 100 = 19\tfrac{1}{2}\% \text{ approx.}$$

Allowing for additional items as previously described 20% has been added to labour costs to cover for overheads.

A profit of 6% on both materials and labour costs has also been allowed.

General

The percentage required for overheads and for profit varies between firms and between trades. The method used to recover overheads may also vary. The contractor must ensure that all costs that are not directly attributed to a particular job are in fact recovered over his years trading—or other such period that he uses for budgetary control.

The usual methods for recovery of overheads are:

(i) Overhead expenditure = £10 000.00

Overturn of firm = £143 000.00

$$\text{Percentage recovery} = \frac{£10\,000.00}{£143\,000.00} \times 100 = 7\% \text{ on job costs}$$

(ii) Overhead expenditure = £100 000.00

Annual labour costs = £65 000.00

$$\text{Percentage recovery} = \frac{£100\,000.00}{£65\,000.00} \times 100 = 15\tfrac{1}{2}\% \text{ on labour costs}$$

(iii) Overhead charges may also be calculated using the total productive hours.

Overheads are usually calculated on the most stable factor. In electrical contracting the cost of materials can fluctuate greatly while the labour costs remain comparatively stable. Different light fittings and specialised equipment can vary greatly in cost but the labour content involved for fixing in position may be similar. Because of this electrical contractors tend to recover overheads on their labour costs rather than on job costs. By analysing past records a contractor can determine the most appropriate method for the recovery of overheads.

Overheads and profit may be charged for as a percentage addition on each item in the bill of quantities or they may be charged for as a lump sum and inserted in the Preliminaries Bill. The method used can have an effect on the amount of the final account. If the contract is increased in value due to variations and the profit and oncosts have been added as a percentage on to each item then the contractor is bound to recover oncosts and profit for the additional work. If a lump sum had been charged then this may not have varied because of the increased amount of the contract. If the contract however had been decreased in value then the contractor would still have recovered the lump sum charged for profit and oncosts even although the amount of work was reduced. If the percentage had been added to the unit rates then the amount of money received by the contractor for profit and oncosts would have been reduced corresponding to the amendment of the quantities in the final measurement. Oncosts are an important factor in the cost to the contractor for carrying out a building contract. Not only must he ensure that the amount of labour, material, plant and temporary works charged for are appropriate to his needs he must ensure that the amount he receives for overheads is adequate. To do this he must budget for what his firm aims to attain over a given period of time (usually a year). The contractor must plan the anticipated expenditure and the value of work he proposes to undertake. As overheads are recovered on turnover it is essential that his assessment of turnover is realistic. The budget should consider the likelihood of expansion and

whether there is enough money available. The expansion and the running of the business should be planned. A flexible budget for the firms overheads should be prepared and used as a basis for determining the percentage to be charged.

The Distinction between an Estimate and a Tender

A tender is an offer made by a builder to actually carry out work at a price stated while an estimate only indicates the probable price of the work without offering to do it.

The estimate forms the basis on which the tender figure is derived. The object of the estimate is to predict the likely cost of the proposed works, while the object of the tender is to obtain the contract so as to earn maximum profit. The tender price that is submitted for a contract should be a management responsibility. Management must decide the amount of profit they require to carry out the contract and this may be added as a percentage or as a lump sum. Provided that the estimate is prepared in a logical manner from information on previous costs and known production outputs it is possible to consider the proposed contract in light of the market conditions at the time of the tender and the likely workload within the firm in relation to future commitments. These factors may influence the tender figure.

Feedback of Information

An estimator must know how his estimate of costs compared with the actual costs before he can act confidently and efficiently. Site information must be available to the estimator in such a form that he can analyse his labour performance standards and understand any major differences that may have arisen between his estimate and what actually took place. The estimate must form the basis of contract planning and cost control and must not be in isolation.

CHAPTER III

LABOUR COSTS

Introduction

In most unit rates the cost of labour is less than the cost of materials, yet it is the determination of the labour cost that calls for the most skill on the part of the estimator.

The labour element influences the unit cost in two ways:

(*a*) The various factors that the estimator adds to the basic wage rate to give the 'all in' labour rate.

(*b*) The amount of labour the estimator considers necessary to complete a set task.

The 'All-in' Labour Rate

This is the basic wage rate plus some or all of the following:

(i) Extra wages for tool money, dirt money, etc.
(ii) Overtime.
(iii) Travelling time and fares.
(iv) Lodging allowance.
(v) Holidays with pay.
(vi) National insurance and selective employment tax.
(vii) Guaranteed time due to inclement weather.
(viii) Supervision.
(ix) Redundancy and sundry costs.
(x) Graduated pension scheme.
(xi) Training board levy.
(xii) Insurances.

General

If the contract is firm in respect of labour the contractor may require to add an allowance to cover any increase in his labour rate, depending on the size and expected duration of the contract.

The wage rate is reviewed annually under the sliding scale agreement. Increases usually take effect from 1st February.

The actual rates of wages do not affect the method used to build up the unit rates. For this reason the rates of wages used in this chapter are:

Craftsmen	£0.50 per hour
Labourers	£0.45 per hour

The normal working week has been taken as 40 hours, which are worked in 5 days, 8 hours per day, Monday to Friday.

The National Joint Council for the Building Industry lay down the working rules for the industry. There are also statutory requirements for National Insurance, Graduated Pensions and the like which must be taken account of when determining the total labour costs. These rules and allowances vary from time to time but this will not invalidate the method used for calculating their effect on labour costs.

These rules and allowances will be considered in greater detail before proceeding to worked out labour rate examples incorporating the various points that have been discussed.

(i) Tool Money and Dirty Money

Allowances for tool money, dirty money and the like are laid down in the working rules agreement, e.g. carpenters and joiners providing and maintaining own tools receive £0.20 per week tool allowance, and extra payment for work in water or close contact with dirt or filth, £0.01½ per hour.

(ii) Overtime

Calculated on the basis of the working rule agreement.

Overtime is paid at the following rates for a 5-day week.

Mondays to Fridays:

First hour, time and a quarter; next 2 hours, time and a half; afterwards, until starting time next morning, double time.

Saturdays and Sundays:

Time worked from starting time on Saturday morning until 4 p.m., time and a half; from 4 p.m. on Saturday until normal starting time on Monday morning, double time.

(iii) Travelling Time and Fares

Calculated on the basis of the working rule agreement.

(iv) **Lodging Allowance**

Calculated on the basis of the working rule agreement. The allowance at present is £1.00 per night on which lodgings are required.

All men sent to job up to 32 km from the agreed boundary are allowed fares or conveyed to and from the job every week; if more than 32 km and up to 64 km every fortnight; from 64 to 96.5 km, every three weeks. Over 96.5 km is by negotiation.

(v) **Holidays With Pay**

There are two schemes in operation, one for annual holidays and one for public holidays.

The employers contribution at present is:

£0.65 per week for annual holidays
£0.39 per week for public holidays

£1.04 per week total

The contribution for the 'all in' rate has been taken as £1.10 per week total.

(vi) **National Insurance and Selective Employment Tax**

The current employers contributions are as follows:

	£
National Insurance	0.75
Industrial Injuries Insurance	0.05
National Health Service	0.033
Redundancy Payments Scheme	0.063
Selective Employment Tax	2.40
	£3.296

The employers contribution has been taken as £3.30.

(vii) **Guaranteed Time**

The employee is paid forty times the hourly wage rate applicable to him. *i.e.* the normal 40h week is fully guaranteed. The contractor therefore must allow for excessive stoppages due to inclement weather. The percentage allowed will depend on the type of work to be undertaken and the time of year. The percentage normally varies from nil to 10%.

(viii) **Supervision**

Generally all supervision which is permanently on the job is charged against the job. This may range from an agent with general foreman, time-keepers, etc., to a working foreman on the job. Supervision by a travelling foreman who is responsible for several jobs should be covered by the general overheads.

The total cost of supervision per week should be divided by the average weekly man-hours and included in the labour cost.

(ix) **Redundancy and Sundry Costs**

An allowance must be made to cover sickness benefit, severence pay, loss of production during notice, absenteeism and the like.

The allowance is normally made as a percentage of the wages paid and will vary according to the type and experience of the firm. Generally it is in the region of 1%.

(x) **Graduated Pension Scheme**

The contribution varies according to the employees earnings and is laid down in the National Insurance Act.

The employers contribution at present is equivalent to $4\frac{3}{4}$% of the employees wage bill, on wages £18.00 per week and under less £9.00 and $3\frac{1}{4}$% on the remainder over £18.00 up to £30.00.

(xi) **Training Board Levy**

The employer must pay a percentage of his wage bill to the Industrial Training Board to cover the cost of the apprenticeship training scheme. Money is refunded to the firm if their apprentices attend approved educational establishments.

The cost to the firm will vary but will be in the region of 1% of wages paid. Alternatively this may be considered as an overhead and charged for as explained in Chapter II.

(xii) **Insurances for Employers Liability at Common Law**

Premium is generally calculated as a percentage of the wage bill. The amount would vary with the trade and type of work carried out by the firm.

Allow a premium of £1.00 or £1.25 per £100.00 of the total wage bill. In this calculation the amount paid as wages includes overtime and travelling time but does not include allowances for fares, etc., paid with wages.

Labour Rate Examples

1. To calculate the 'all-in' hourly labour rate for tradesmen and labourers working under normal conditions.

	Tradesman £	Labourer £
Wages for week of 40 h at £0.50 and £0.45	20.00	18.00
**Supervision: 40 h at £0.05 per h for working foreman: £2.00 divided by 11 men: £2.00 ÷ 11*	0.182	0.182
	20.182	18.182
National insurance contributions, S.E.T., etc.	3.30	3.30
Holidays with pay	1.10	1.10
Training Board Levy (C.I.T.B.) 1% on £20.182 and £18.182	0.202	0.182
Redundancy and Sundry costs 1% on £20.182 and £18.182	0.202	0.182
†Tool allowance	0.20	—
Graduated pension scheme	0.512	0.40
Employers liability insurance £1.00% on £20.182 and £18.182	0.202	0.182
	25.90	23.528
Guaranteed time 3%	0.777	0.706
	40)26.677	24.234
	£0.67	£0.60

Note: *These 'all in' labour rates of* £0.67 *for tradesmen and* £0.60 *for labourers have generally been used throughout this book for building up unit rates.*

* Supervision: An average gang size has been assumed which comprises a working foreman, 6 tradesmen and 4 labourers.

† The tool allowance varies with different trades. Amounts are laid down in the working rule agreement.

2. To calculate the 'all in' hourly labour rates for tradesmen and labourers working under normal conditions, but on a site 30 km from the boundary of the free area and with bus fares at £1.00 per week.

		Tradesman £	Labourer £
40	*Wage for week of 40 h*	20.00	18.00
	Travelling time 5 × ¾ h = 3¾ h		
3¾	*3¾ h at £0.50 and £0.45*	1.875	1.688
43¾	*Supervision: 43¾ h at £0.05 = £2.188 ÷ 11 men*	0.199	0.199
		22.074	19.887
	National insurance contributions, S.E.T., etc.	3.30	3.30
	Holidays with pay	1.10	1.10
	Training board levy 1% on £22.074 and £19.887	0.221	0.199
	Redundancy and sundry costs 1% on £22.074 and £19.887	0.221	0.199
	Fares	1.00	1.00
	Tool allowance	0.10	—
	Graduated pension scheme	0.575	0.512
	Employers liability insurance £1.00% on £22.074 and £19.887	0.221	0.199
		28.812	26.396
	Guaranteed time 5%	1.441	1.32
		40)30.253	27.716
		£0.75½	£0.69½

3. To calculate the 'all in' hourly labour rates for tradesmen and labourers working under normal conditions but the site is 12 km from the yard and transport is supplied by contractor.

Total number of working days per year = 52 weeks × 5 days

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Contractor to supply lorry to transport the men to the site, return to the yard for general use and return for men at night.

Morning run: 12 km out and 12 km back. 24 km in all and allowing for delay on site and for incidental delays, say 1 h.

Every run takes 1 h	
Lorry time 2 h per day	
5 days × 2 h = 10 h per week	
Cost of lorry (hire rate)	*£0.90 per h*
Driver (labourer rate + £0.02)	*£0.62 per h*
	£1.52 per h or £15.20 per week

With a gang of 11 men the cost would be £1.382 per man per week.

		Tradesman £	*Labourer* £
40	*Wage for week of 40 h*	20.00	18.00
	Travelling time 5 × ¼ h = 1¼ h		
1¼	*1¼ h at £0.50 and £0.45*	0.625	0.563
41¼	*Supervision: 41¼ h at £0.05 = £2.063 ÷ 11 men*	0.188	0.188
		20.813	18.751
	National insurance contributions, S.E.T., etc.	3.30	3.30
	Holidays with pay	1.10	1.10
	Training board levy 1% on £20.813 and £18.751	0.208	0.188
	Redundancy and sundry costs 1% on £20.813 and £18.751	0.208	0.188
	Cost of transport	1.382	1.382
	Tool allowance	0.20	—
	Graduated pensions scheme	0.538	0.47
	Employers liability insurance £1.00% on £20.813 and £18.751	0.208	0.188
	Carried forward	27.957	25.567

LABOUR COSTS

Brought forward	27.957	25.567
Guaranteed time 5%	1.398	1.278
	40)29.355	26.845
	£0.74	£0.67

4. To calculate the 'all in' hourly rates for tradesmen and labourers working under normal conditions. The men to work overtime 3 h per day from Monday to Thursday.

		Tradesman £	*Labourer* £
40	*Wage for week of 40 h*	20.00	18.00
	Overtime 1 h × 1¼ = 1¼ h		
	2 h × 1½ = 3 h		
	4¼ h		
17	*4¼ h × 4 days = 17 h at £0.50 and £0.45*	8.50	7.65
57	*Supervision: 57 h at £0.05 = £2.85 ÷ 11 men*	0.26	0.26
		28.76	25.91
	National insurance contributions, S.E.T., etc.	3.30	3.30
	Holidays with pay	1.10	1.10
	Training board levy 1% on £28.76 and £25.91	0.288	0.26
	Redundancy and sundry costs 1% on £28.76 and £25.91	0.288	0.26
	Tool allowance	0.10	—
	Graduated pension scheme	0.80	0.70
	Employers liability insurance	0.288	0.26
	Carried forward	34.924	31.79

Total number of working days per year = *52 weeks* × *5 days*
= *260 days*

Deduct

Annual holiday: 2 weeks × 5 days	= *10 days*	
Public holidays	= *5 days*	
Day release classes	= *44 days*	
		— *59 days*
		201 days

Actual number of hours worked = *201 days* × *8 h* = *1 608 h*

Cost per hour $= \frac{£883.133}{1\ 608} = £0.54$

General

It has been shown in the previous examples how to build up an 'all in' labour rate for specific jobs and how to make allowances for any requirements that are considered necessary. Most contractors however carry out contracts within certain limited areas and in roughly similar conditions. These contractors might find it more convenient to calculate a basic 'all in' labour rate which only includes for the basic wage, national insurance contributions including selective employment tax and holidays with pay. Additional indirect charges on wages such as guaranteed time, non-productive overtime, sickness, travelling time and expenses, C.I.T.B. levy and insurances can each be determined from past records and charged for as a percentage of the labour costs. Since these indirects are based on previous records and most contracts undertaken are similar in nature then the estimator has a greater control over the recovery of these monies. When pricing a contract which is different from the normal pattern of contracts undertaken then any peculiarities such as overtime or travelling time beyond the normal allowances must be ascertained. The anticipated additional expenditure for these items should be calculated and added as a percentage or as a lump sum to the contract.

The following is an example of this method:

Example

	Tradesman	*Labourer*
	£	£
Wage for week of 46 h at £0.50 and £0.45 per h	*23.00*	*20.70*
Supervision: 46 h at £0.05 per h for working foreman: £2.30 divided by 11 men	*0.209*	*0.209*
Tool allowance	*0.10*	—
National insurance contributions, S.E.T., etc.	*3.30*	*3.30*
Holidays with pay	*1.10*	*1.10*
	46)27.709	*25.309*
	£0.60	*£0.55*

The men are paid for a 40 h week but in addition they work 6 h overtime per week. This makes the number of hours worked per week 46 and the number of hours paid for 49. The non-productive overtime is allowed for as a percentage addition on labour in the additional indirects.

The cost of additional indirects on labour assessed from previous records.

	Percentage of £1.00 of labour costs
Guaranteed time	3.5
Non-productive overtime	5.2
Sickness	0.5
Travelling time and expenses	3.0
C.I.T.B. levy	0.8
Insurances	1.0
	14.0%

As previously mentioned unit rate build ups have been based on the labour rate example No. 1, for tradesmen and labourers

Brought forward	34.924	31.79
Guaranteed time 5%	1.746	1.589
Nett number of hours worked:	52)36.67	33.379
40 + (3 h × 4 days)	£0.70½	£0.64
40 + 12 = 52 h		

5. To calculate the 'all in' hourly labour rates for tradesmen and labourers for the following conditions. Site is 50 km from the agreed boundary and the men are paid lodging allowance. The majority of the work will be carried out in conditions unaffected by the weather.

Cost of return fare is £1.25.
Hours worked: 8 a.m. to 8 p.m. weekdays; 8 a.m. to 12 noon Saturdays.
Gang consists of 1 working foreman, 10 tradesmen and 10 labourers.

		Tradesman	Labourer
		£	£
40	Wage for week of 40 h	20.00	18.00
	Overtime		
	1 h × 1¼ = 1¼ h × 5 days = 6¼ h		
	2 h × 1½ = 3 h × 5 days = 15 h		
	4 h × 1½ = 6 h × 1 day = 6 h		
	27¼ h		
27¼	27¼ h at £0.50 and £0.45	13.625	12.263
¾	Travelling time 1½ h per fortnight, i.e. ¾ h per week at £0.50 and £0.45	0.375	0.338
68	Supervision: 68 h at £0.05 = £3.40 ÷ 21 men	0.162	0.162
	Carried forward	34.162	30.763

Brought forward	34.162	30.763
National insurance contributions, S.E.T., etc.	3.30	3.30
Holidays with pay	1.10	1.10
Training board levy 1% on £34.162 and £30.763	0.342	0.308
Redundancy and sundry costs 1% on £34.162 and £30.763	0.342	0.308
Lodging allowance: 7 nights at £1.00	7.00	7.00
Fares: £1.25 per fortnight (per week)	0.625	0.625
Tool allowance	0.10	—
Graduated pension scheme	0.82	0.82
Employers liability insurance £1.00% on £34.162 and £30.763	0.342	0.308
	59)48.133	44.532
Net number of hours worked: 40 + (3 × 5) + (4 × 1) 40 + 15 + 4 = 59 h	£0.81	£0.75

7. To calculate the 'all in' hourly labour rates for apprentices.
An apprentice trains for 4 yr.
A third year apprentice's rate has been taken as an average rate.
A third year apprentice's rate is two-thirds of a craftsman's rate.
Craftsman: 40 h at £0.50 £20.00 per week
A third year apprentice £13.333 per week

	£
Wage rate per year = 52 weeks at £13.333	693.316
National insurance contributions per year = 52 weeks at £3.30 (a third year apprentice is over 18 yr)	171.60
Graduated pensions per year = 52 weeks at £0.217	11.284
Employers liability insurance: £1.00% on £693.316	6.933
Cost of third year apprentice per year	£883.133

(irrespective of the type of tradesmen), the 'all in' rate for apprentices has been taken from example No. 6. An example using the alternative method of calculating labour rates is given in the Brickwork and Blockwork section example No. 2.

CHAPTER IV

PRELIMINARIES

The preliminaries section in a bill of quantities is one of the most important sections that require to be priced. In this section the contractor must allow for all matters affecting his costs that arise out of the conditions of contract, any special requirements of his clients or their professional advisers, and for all temporary works necessary to the carrying out of the contract.

The contractors tendering strategy will be reflected in the manner in which he prices the preliminaries. All precontract planning and tendering decisions require to be made before this section can be fully priced and it is therefore probable that the estimate will be completed prior to this section being priced and the tender figure agreed.

The following is an example of a preliminaries section of a bill of quantities with explanations on the method of pricing.

Page 1

Item No.	Preliminaries—Preliminary		Particulars £		
	Names of Parties		£		
1	Employer	The Directors, P.Q.R. Co. Ltd.			
2	Architect	Messrs. A.B.C., Chartered Architects			
3	Quantity Surveyor	Messrs. X.Y.Z., Chartered Surveyors			
	Description of Site				
4	The site is situated at the corner of Greenacre Road and Greenacre Terrace, Newtown and is coloured pink on site plan included with these Bills of Quantities.				
5	Access to the Site is by the route indicated on site layout				
6	The tenderer is recommended to visit the site and inspect any trial holes.				
		To collection £			

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Page 2

Item No.			£
7	**Drawings** The drawings used in the preparation of the Bills of Quantities can be seen, by appointment, or during usual office hours, at the office of the architect.		
8	**Description of the Works** The work comprises the demolition of part of the existing premises and the building of a new public house of about 25 m × 8 m and 5 m × 4 m plan sizes with extension of electrical services and relative external services. The single-storey building has a height of 3.10 m from finished floor level to underside of roof joists. The roof is of flat timber construction covered with bituminous felt roofing. A metal staircase and railing gives access to a roof drying area. The external walls are all cavity walling. The front elevation and return are dressed sandstone facework with horizontal weatherboarded parapet and all other walls are brick. Loadbearing partitions are concrete block or brick and w.c. partitions are breeze block. The floors are concrete with a tile finish in the entrance areas and toilets and a wood boarded finish in the bars. All natural light is by roof light and the cocktail bar has a timber barrel vaulted ceiling. The wall and ceiling finishes are generally plaster. The contractor, on acceptance of his offer, shall proceed immediately with the preparation of a programme or statement which shall clearly set forth the sequence of all operations and the time limits within which the contractor proposes that each operation shall be commenced and completed. The contractor, in the		
	To collection £		

Page 3

Item No.	Clause No.			£
		preparation of this programme shall be held to have co-ordinated the whole of the works embraced in this Contract including the work of nominated sub-contractors, where the necessary information is available to him. On agreement or negotiated amendment of the programme by the Architect, the Contractor shall be responsible for the execution of the works in conformity therewith.		
		Contract Particulars		
9		The works embraced in this Contract are to be carried out in accordance with the R.I.B.A. Schedule of Conditions of Building Contract (private edition with quantities) 1963 (July 1968 issue).		
10		Execution of the Building Contract shall be deemed to have taken place when letters of offer and acceptance have been exchanged between the parties.		
		Schedule of Clause Headings		
		Clause No. of 1963 R.I.B.A. Conditions (July 1968 issue).		
11	1	Contractor's obligations		
12	2	Architect's instructions		
13	3	Contract Documents. Clause 3(2)(*a*) is deleted.		
14	4	Statutory Obligations, Notices, Fees and Charges (items for rates on temporary buildings and water for the works are provided elsewhere).		
15	5	Levels and setting out the works.		
16	6	Materials, goods and workmanship to conform to description, testing and inspection.		
17	7	Royalties and Patent Rights.		
18	8	Foreman-in-Charge.		767
19	9	Access for Architect to the Works.		
		To collection £		767

Page 4

Item No.	Clause No.			£
20	10	Clerk of Works.		
21	11	Variations, provisional and prime cost sums.		
22	12	Contract Bills.		
23	13	Contract Sum.		
24	14	Materials and Goods Unfixed or Off-site.		
25	15	Practical completion and defects liability.		
26	16	Sectional completion.		
27	17	Assignment or Sub-letting.		
28	18	Injury to persons and property and Employers' Indemnity	See Summary	
29	19	Insurance against injury to persons and property. The contractor to allow for insurances against the matters referred to in Clause 19(1), sub-sections (*a*) and (*b*) in a minimum amount of £100 000 in respect of any one claim or series of claims arising out of any one event except that in respect of the liability of the Contractor for claims in respect of death or of personal injury to the Contractor's own employees arising out of or in the course of their employment the insurance shall be completely unlimited in amount.	See Summary	
		Clause 19(2) is not to apply.		
30	20	Insurance of Works against Fire, etc.	See Summary	
	20C	of the Schedule of Conditions shall apply.		
31	21	Possession, completion and postponement.		
32	22	Damages for non-completion. This clause is not applicable.		
33	23	Extension of Time. (Sub-Clause (*j*) is not to apply).		
34	24	Loss and expense caused by disturbance of regular progress of the work.		
35	25	Determination by Employer.		
36	26	Determination by Contractor.		
37	27	Nominated Sub-Contractors.		
38	28	Nominated Suppliers.		
39	29	Artists and Tradesmen.		
		To collection £		

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Item No.	Clause No.			£
40	30	Certificates and Payments.		
41	31	Fluctuations.		
		Clauses 31B, 31C and 31D shall apply.		
		The contractor is to enter in the list attached to Bill No. 1 the materials and goods to which Clause 31B(*b*) is to apply and the application thereof shall be restricted to the materials and goods so listed.		
42	32	Outbreak of hostilities.		
43	33	War Damage.		
44	34	Antiquities.		
45	35	Arbitration.		
		General Matters		
		Items not covered by the Schedule of Clause Headings:		
46		Plant, Tools and Vehicles.		
47		Safety, Health and Welfare of Workpeople (including those employed by Nominated Sub-Contractors) employed on the site.		
48		National Insurance and Pensions for workpeople	See Summary	
49		Annual and Public Holidays for Workpeople.	See Summary	
50		Transport for Workpeople.		
51		Safeguarding the works, materials and plant against damage and theft.		
52		Maintain public and private roads.		
53		Police Regulations.		
54		Where overtime is worked for a specified purpose at the written request of the Architect the Contractor shall be refunded in the 'non-productive' costs of overtime. Overtime will not be refunded unless the Architect gives written instructions to that effect.		
55		Water for the Works.	See Summary	
		To collection £		

BUILDERS' ESTIMATING SIMPLY EXPLAINED (METRIC EDITION)

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Item No.		£	
56	Temporary arrangements for storing and distributing about the site.		
57	Lighting and Power for the works.		
58	Temporary arrangements for distributing about the site and for lighting to hoardings and the like.		
59	The area available for the storage and working of materials is confined, and materials shall be brought onto the site only as required and prepared for incorporation in the buildings as far as possible. Materials shall be deposited only on such areas as allowed by the architect.		
60	The work shall be carried out so as to cause the minimum of interference with the occupants of the premises at which the work is being executed and with any persons using the premises.		
	Temporary Works		
61	Temporary roads, tracks, hardstandings, crossings and the like, including use by nominated Sub-Contractors.		
	Notes The building extension is on the boundary to the site at the rear of the pavement on Greenacre Road.		
62	Temporary sheds, offices, messrooms, sanitary accommodation and other temporary buildings for use of the Contractor.	290	—
63	Provide temporary dust proof screens about 30 m² where existing walls removed. Provide temporary lockfast doors and barricades to windows in order to ensure maximum security of the building at all times.	40	—
	To collection £	330	—

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Item No.		£
64	Rates on temporary buildings.	
65	Temporary fencing, hoardings, fans, planked footways, guard rails, gantries and the like for the proper execution of the work, for the protection of the Public and the Occupants of the adjoining premises and for meeting the requirements of any local or other authority.	
66	Temporary Scaffolding for the proper execution and completion of the Works.	
	Protecting, Drying and Cleaning the Works	
67	Protecting the works from inclement weather.	
68	Provisional Sum for providing temporary equipment, fuel and attendance for drying and controlling the humidity of the Works.	50
69	Provide for removing all rubbish and debris from the site and cleaning the works internally and externally. On completion, the works shall be cleaned which shall be deemed to include scrubbing floors, washing pavings, polishing glass inside and out; cleaning sanitary fittings; flushing drains and manholes; cleaning gutters and down pipes; leaving the whole of the new premises clean and ready for occupation.	
	To collection £	50

Schedule of Insertions

Defects Liability Period (Clauses 15, 16 and 30)	12 months
Percentage to cover Professional Fees (Clause 20A)	8½%
Date for Possession (Clause 21)	To be arranged
Date for Completion (Clause 21)	6 months from date of possession
Liquidate and Ascertained Damages (Clause 22)	Not applicable

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Period of Delay (Clause 26)	
(i) By reason of loss or damage caused by any one of the Contingencies referred to in Clause 20(A) 20(B)	3 months
(ii) For any other reason	1 month
Prime Cost Sums for which the Contractor desires to tender (Clause 27(g)). Any tender submitted by the Contractor shall for purposes of discount and profit, be treated as if it were submitted by a third party	To be arranged
Certificates (Clause 30)	
(1) Period of Interim Certificates	1 month
(2) Period for Honouring Certificates	21 days
(3) Percentage of certified value retained	10%
(4) Limit of Retention Fund	5% of contract sum
(5) Period of Final Measurement and Valuation	6 months from day named in the Certificate of Practical Completion of the works

Collection

Item No.		£	p
	Amount for Page 1		
	2		
	3	767	—
	4		
	5		
	6	330	—
	7	50	—
	Amount of Preliminaries carried to Summary £	1147	

Item No.	
1–10	Not priced. These items give general information (the names of the client and his professional advisers, a description of the works and the site and the conditions of contract applicable to the contract).
11–13	Not priced. These items give general contractual information.
14	Not priced unless there are special instructions for the contractor to include for this in his price.
15	Not generally priced. The contractor may allow for the setting out of the works in this item if the setting out is more complicated than normal.
16–17	A lump sum to cover the cost of any special testing that is asked for in the bill of quantities, and for the cost of royalties would be allowed for against these items. The lump sum would include for profit and oncosts.
18	Include for the total wages plus additional expenses (e.g. national insurance, holidays with pay etc.) of the foreman-in-charge and any other supervisory staff, clerks, time-keepers etc., who are wholly employed on this contract. The cost of a working foreman may be included in the 'all-in' labour rate as shown previously. The cost of a travelling foreman who is responsible for several contracts may be best allowed for as an overhead charge. We will assume a foreman-in-charge earning £25.00 per week for the period of the contract (i.e. 20 weeks). 20 weeks at £25 + $33\frac{1}{3}$% for additional expenses paid by the contractor + 15% for profit and oncosts.
19–24	Not normally priced. These items give general contractual information.
25	Not normally priced. The extent of the defects liability period will have an effect on the contractors costs. This may be priced in this item or alternatively the contractor may allow for his total annual costs for maintenance work on contracts as an overhead.
26	The contractor may include here for any additional expense that may occur because of the clients require-

BUILDERS' ESTIMATING SIMPLY EXPLAINED (METRIC EDITION)

Item No.	
	ment that the work has to be completed in a certain sequence.
27	Not normally priced as this item gives general contractual information.
28–30	See Summary. These items will be dealt with later.
31–36	Not priced in this example. If there had been a time limit and liquidated damages for non-completion on time then the contractor would have to consider his commitments fully in order to ascertain if he was capable of fulfilling this condition. In order to complete in time the contractor might require to work overtime and this would affect his overall price. The cost of overtime may be added in the 'all-in' labour rate as described previously or added as a lump sum in the preliminaries. If the contractor wished to tender and knew that he was unable to complete in the time stipulated he would then have to add to his tender price the cost of liquidated damages for the period he expected to over-run the contract period.
37–38	Not priced in the preliminaries. In the provisional and P.C. sums bill a percentage for profit should be added to the sum for nominated sub-contractors and suppliers.
39–40	Not priced in this example. If the payments were at different stages of the work or at long intervals then the contractor may charge for interest on the estimated value of the work done for the period it is retained by the client.
41	If the contract is on a firm price basis a sum may be included here to cover anticipated increase in labour and materials costs.
42–45	Not priced. These items give general contractual information.
46	Minor plant is usually allowed for when calculating the percentage addition for overheads. Items of plant that can be completely allocated against certain items of work in the bill of quantities may be allowed for in the unit rates for these items.

PRELIMINARIES

Item No.	
	Items of plant that perform general functions and cannot be allocated to specific items in the bill of quantities are normally allowed for here as lump sums. The lump sum would include for profit and oncosts.
47	Welfare hut, drying accommodation etc., usually included for under item 62. The cost of wellington boots or protective clothing for workmen may be included here if supplied by the contractor.
48–49	See Summary. These items will be dealt with later.
50	May be allowed for here as a lump sum or included for in the 'all-in' labour rate as shown previously.
51	This item may be priced for in a number of ways (i) By allowing for watchmen. The cost would be based on the number of shifts and length of period the watching was necessary plus the cost of accommodation for the watchman. (ii) By providing a barricade to protect buildings and or materials. (iii) By allowing a sum of money to cover the cost of any damage or theft from an assessment of past experience from work done in the same area.
52–53	Any anticipated expense may be allowed for here as a lump sum.
54	Not priced as this item gives general contractual information.
55	See Summary. These items will be dealt with later.
56	The cost would be allowed for as a lump sum which would be calculated on the basis of the following: (i) The number and position of the temporary draw off points required. (ii) The cost of cutting tracks and laying temporary piping including maintenance and removal. The cost of the materials would be less the credit value at removal. (iii) The cost of connecting the temporary supply to the nearest permanent water supply pipe.

Item No.

57–58 The cost would be allowed for as a lump sum and would include for the following:

(i) The estimated cost of electricity and electricity authorities charge for connection.

(ii) The cost of all labour and material necessary to provide the temporary supply, including maintenance and removal. The cost of materials would be less the credit value at removal.

59 A sum may be included here for any inconvenience caused and/or double handling required because of the restrictions of the site.

60 A sum may be included here for interference and in phasing the work so as to cause no inconvenience.

61 Reference should be made to the site and drawings to establish the amount of temporary work required.

62 The requirements for the contract may be calculated as follows:

Cost of storage shed

Initial cost		£150.00
Replacement—10 yr	10%	
Interest	5%	
Repairs	15%	
	30%	

Annual cost = 30% of £150.00 = £45.00

Used 45 weeks per year, therefore cost per week is £1.00.

	£
Transport to site	5.00
Erection costs	15.00
Used 20 weeks at £1.00	20.00
Dismantling costs	10.00
	50.00
Profit and oncosts 15%	7.50
	£57.50

Item No.

The cost of transport off the site would be charged for as the cost of transport to the site to which the shed is being transported.

Contract requirements for sheds etc.

	£
Shed (storage) 1	57.50
Office (foreman) 1	57.50
Messroom, including drying and dining facilities and first-aid	100.00
Sanitary accommodation	75.00
	£290.00

63 Allow sum to cover the work as described.

64 The cost of rates would be assessed and allowed for as a lump sum.

65 Reference should be made to the drawing and the site to determine the extent of this work.

66 The sum to be included for scaffolding must be carefully considered as scaffolding requirements vary considerably from one building to another. The drawings should be consulted to determine the extent of scaffolding required and whether putlog or independent scaffolding is necessary. If a large amount of scaffolding is required this would generally be sub-contracted to a specialist firm and an estimate of cost would be included under this item.

67–68 Not generally priced although a sum for protection may be included if the work involved is expected to be excessive.

68 Provisional sum for information only.

69 This may be allowed for in the unit rates or included here as a lump sum of the estimated cost.

Note: The amount of the preliminaries is usually approximately 5% to 10% of the contract figure.

Summary

The summary appears at the end of the bill of quantities and contains items referred to in the preliminaries. The following is an example of a summary with explanations of method of pricing.

Bill No.	Summary				
1.	Preliminaries	£			
2.	Provisional and P.C. sums	£			
3.	Excavations and earthwork	£			
4.	Etc.	£			
A.	Allow for insurance against injury to persons and employers indemnity as Clause 18	Sum			
B.	Ditto for insurance against injury to persons and property as Clause 19(1)(*a*)	Sum			
C.	Ditto for liability in respect to damage to property as Clause 19(1)(*b*)	Sum			
D.	Ditto for insurance of works fire, etc., as Clause 20(*a*)	Sum			
E.	Ditto for complying with the National Insurance Act (Health, Unemployment and Pensions for Workpeople)	Sum			
F.	Ditto for complying with holidays with pay and public holidays schemes for workpeople	Sum			
G.	Ditto for selective employment tax	Sum			
H.	Ditto for water for the works	Sum			
	Amount to tender	£			

Signed as relative to Tender of date...

Contractor's Signature...

Surveyor's address Measured from Plans and Calculated E.E.

Telephone No. (Sgnd) X.Y.Z.

(*Date*) *Chartered Quantity Surveyors.*

Method of Pricing Summary

Items A, B, E & F	Generally not priced in the summary. Item A is normally allowed for under the percentage addition for oncosts. Items B, E and F are normally allowed for in the build-up of the 'all-in' labour rate.
Items C & D	May be priced in the summary or covered in the general percentage addition for oncosts. Item C may be covered by a general insurance for all works to be executed by the contractor and would therefore be covered in the percentage addition for oncosts. Item D should be an insurance specific to the building under consideration and therefore priced for in the summary.
Item G	Not priced in the summary but included for in the 'all-in' labour rate.
Item H	This item would be priced in the summary on the basis of the water authorities charge for supplying water for building works. The water authorities charge is usually on the basis of a percentage of the overall cost of the works, or of the cost of the 'wet' trades portion of the works.

CHAPTER V

LABOUR CONSTANTS

The total quantity of labour required to perform a certain item of work is expressed as a labour constant. Labour constants for individual firms are calculated from experience built up over a long period. The time taken to perform the same item of work will vary from firm to firm, and from gang to gang, depending on the type of firm and the familiarity of the gang in performing the task.

The time taken to build a m² of brickwork, for example, should not be based on the time taken by a gang when working full out but must be based on the amount of brickwork built over the period of a week or from the time required to build a predetermined amount of brickwork. The labour constant would not be calculated using the best or poorest gang but on the performance of an average gang.

The labour constants are therefore based on the work a man can achieve in a set period of time, making allowances for wasted time, when he starts and stops, lunch time and during tea breaks.

More progressive firms are calculating labour constants by means of work study, but care must be taken in order to calculate constants over a long enough period to ensure that the constants are realistic.

The quantity of materials is accurately known from the bill of quantities and provided the contractor receives a good quotation from the merchant, the cost of materials should not vary significantly from that of the other contractors competing for the work. The cost of labour, however, is gauged from past experience and it is on this portion of the cost that the contract is largely won or lost, although something also depends on the factors of oncost and profit required by the competing contractors. This makes the accurate determination of the amount of labour required of major importance to the contractor.

The Use of Work Study

Work study may be used as a tool of estimating. One of the estimators main problems is the assessment of performance standards for his workmen for the many different items of work. A full time study on these items would require the employment of a work study officer and although this would lead to a more accurate assessment of performance standards it would also be expensive. Work study officers may not be considered as a viable proposition in other than the larger contracting organisations. A small builder may, however, use work study techniques to a limited extent so as to improve the efficiency of his estimating without incurring additional overheads. The use of work study concepts of rating and standard performance makes it possible to rationalise previous observations of performances into a systematic assessment of outputs. Standard performances which have been actively assessed are more likely to be accurate than information that is arrived at by the use of less stringent methods. The more accurate the information on labour outputs the less risk involved in the preparation of the estimate. Labour costs can be based on known performance standards.

Method studies may also be carried out to determine whether or not the most appropriate method is being used to perform an item of work. By carefully selecting items for method studies it may be possible to reduce the amount of labour hours required in some key items of work.

The following terms which are used in Work Study have been extracted from British Standard 3138: 1969 Glossary of Terms Used in Work Study, and are reproduced by permission of the British Standards Institution, 2 Park Street, London W1Y 4AA, from whom copies of the complete standard may be obtained.

Standard performance	The rate of output which qualified workers will naturally achieve without over-exertion as an average over the working day or shift provided they adhere to the specified method and provided they are motivated to apply themselves to their work. (It is recommended that this be denoted by 100 on the

BS scale, corresponding to the production of 1 standard hour of work per hour or 60 standard minutes per 60 minutes.)

Qualified worker One who is accepted as having the necessary physical attributes, who possesses the required intelligence and education and has acquired the necessary skill and knowledge to carry out the work in hand to satisfactory standards of safety, quantity and quality.

Rating The numerical value or symbol used to denote the rate of working.

Rating scale The series of numerical indices given to various rates of working. The scale is linear. The three most commonly used scales start at zero and take 80, 100 and 133 respectively as the numerical value of standard rating.

British Standard rating and performance scales 0/100, where 0 corresponds to no activity and 100 corresponds to 80 or 133 on the other common scales.

Standard rating The rating corresponds to the average rate at which qualified workers will naturally work at a job, provided they adhere to the specified method and provided they are motivated to apply themselves to their work. If the standard rating is maintained and the appropriate relaxation is taken, a worker will achieve standard performance over the working day or shift.

Basic time The time for carrying out an element of work at standard rating, i.e.:

$$\frac{\text{observed time} \times \text{observed rating}}{\text{standard rating}}$$

Relaxation allowance 'RA' An addition to the basic time intended to provide the worker with the opportunity to recover from the physiological and psychological effects of carrying out specified work under specified conditions and to allow

attention to personal needs. The amount of the allowance will depend on the nature of the job.

Fatigue allowance A subdivision of the relaxation allowance intended to cater for the physiological and psychological effects of carrying out specified work under specified conditions.

Personal needs allowance A subdivision of the relaxation allowance intended to cater for attention to personal needs.

Contingency allowance A small allowance of time which may be included in a standard time to meet legitimate and expected items of work or delays, the precise measurement of which may be uneconomical because of their infrequent or irregular occurrence.

Work content Basic time + relaxation allowance + any other allowance for additional work, e.g. work contingency allowance. Where it is required to indicate basic time plus relaxation allowance only, the term work content (basic) should be used expressed in standard units of work.

Standard time The total time in which a job should be completed at standard performance, i.e. work content (total), delay contingency allowance, unoccupied time and interference time, where applicable.

The rating of performance is not a scientific process but a measured judgement based on experience. A competent tradesman performing an item of work well in a steady, efficient manner under proper supervision would be given a 100 rating. A 100 rating is referred to as Standard Rating. Work done at Standard Rating plus appropriate allowances for relaxation, personal needs, etc., gives a performance which is referred to as Standard Performance. Few tradesmen work at Standard Performance or 100 rating unless adequately motivated to do so by an incentive scheme. A normal rating for a competent tradesman not working on bonus would be about 75 to 80. A rating of 60 could be described as very slow with the operative having little interest in his work, while a rating of 130 could be described as a fast, tradesmanlike performance of an operative working on bonus and still producing the desired standard of workmanship. It is important that the rating of operatives is carried out by a person who knows the work involved. An operative may appear to be working fast but because he is using the wrong method or tools he is not producing as much as another man who appears to be working more slowly but is using the correct method and/or the correct tools. The second man should be given the higher rating as he is the more competent tradesman and is providing the higher output.

Using standard ratings then Standard Times may be calculated as follows:

(*a*) A bricklayer laying 78 bricks per hour and rated at 120

$$\text{Standard Time} = \frac{\text{observed rating} \times \text{observed time}}{\text{standard rating}} = \frac{120 \times 60}{100}$$

$$= 72 \text{ minutes for 78 bricks or 65 bricks per hour.}$$

(*b*) A bricklayer laying 52 bricks per hour and rated at 80

$$\text{Standard Time} = \frac{80 \times 60}{100} = 48 \text{ minutes for 52 bricks or 65 bricks per hour}$$

If a building contractor is operating an incentive scheme then he could base his estimate on performance standards which corresponds to his labour working under financial motivation. This has been described as at 100 rating on the BS scale. The labour rate used for preparing the estimate would allow for the bonus earnings of the man (see chapter on Incentive Schemes). This would be the standard hour rate for the man working at 100 performance. The incentive would be a planned incentive.

$$\text{Standard Time} = \frac{\text{observed rating} \times \text{observed time}}{\text{standard rating}} + \text{allowances}$$

The allowances are an assessment of the time the men are not actually producing. They would include for time lost due to tea breaks, going to the toilet, general conversations, correcting mistakes, waiting for materials to arrive or for other trades, etc. These items are usually referred to as relaxation, fatigue, personal needs and contingency allowances. The percentage allowance is calculated by individual firms from their records. Provided the rating is done efficiently then the standard time should be the same but if a bonus scheme is being operated then the amount paid as bonus to the various workmen would be different. (i.e. their ratings are different therefore their bonus earnings are different.) Instead of the men being described as slow, average or fast a rating may be given to their performance. In this example ratings of 80, 100, 125 respectively have been given and an allowance of 25% has been added to cover the various items listed above. Although the mens times varied the standard time calculated is constant.

Fast man

$$\frac{125 \times 16 \text{ minutes}}{100} = 20 \text{ minutes} + 25\% = 25 \text{ minutes}$$

Average man

$$\frac{100 \times 20 \text{ minutes}}{100} = 20 \text{ minutes} + 25\% = 25 \text{ minutes}$$

Slow man

$$\frac{80 \times 25 \text{ minutes}}{100} = 20 \text{ minutes} + 25\% = 25 \text{ minutes}$$

The appreciation of the value of work study and the use of standard performances as a means of determining the labour content for items of work should lead to more accurate estimating. Rating and standard performances may be used in estimating irrespective of whether or not an incentive scheme is being operated. An example of their application to estimating is given in the chapter on Incentive Schemes.

CHAPTER VI

MATERIALS

The cost of materials must include the following:

(a) The cost delivered to the site. The contractor must ensure that where materials are quoted Ex works etc. he includes for all necessary additional costs to bring the materials on to the site.

(b) The cost of unloading and storing. The contractor must allow for any double handling that may be necessary due to the nature of the site, conditions of contracts, or for his own convenience in prefabricating parts of the work off the site. Due to lack of access or congestion on a site materials may be required to be unloaded and wheeled to the site. Joinery fitments are usually made in the joiners workshop, split into sections for transport, re-assembled and erected in position on site.

Storage huts for materials are usually charged for in the preliminaries bill.

(c) Waste and pilfering. Waste should be allowed on all materials and is due to the following:

(i) Breakages, e.g. lavatory basins get cracked, drain pipes, glass, etc. get broken.

(ii) Cuttings, e.g. rainwater pipes and gutters are manufactured in standard lengths and because of position of fittings, etc. whole lengths may not always be used. Plywood and other sheet materials come in standard sizes that may not correspond to the dimensions required on the site, and so necessitate cutting and waste.

(iii) Depreciation due to bad storage, e.g. Cement in bags if stored in damp conditions will go hard. Plasterboard deteriorates if damp and may become unusable.

(d) The cost of returning empty cases. If expensive cases are used to transport materials then there is usually a credit value in the case provided that it is returned.

(e) Compaction and loss of bulk. Some materials reduce in bulk when placed in position, e.g.:

(i) Hardcore when compacted loses about 25% in volume, and

(ii) there is a reduction in volume between the dry ingredients for concrete and the wet mixed concrete. The percentage reduction varies with the concrete mix specified.

(f) Increase in volume. Excavated materials increase in volume on excavation and this has an effect on the cost of removal.

(g) Delivery of materials as and when required. The contractor when buying materials should not only be looking for the cheapest price but also for good service. If a supplier can deliver materials to the site as and when required then this helps the contractor to adhere to his programme of work and lessen the possible sources of delay. Provided the service is good it may be cheaper for the contractor in the long run to deal with this supplier in preference to a supplier with cheaper quotations but a poor service.

Unloading Materials

Many materials quoted to be delivered on site require to be unloaded. The contractor therefore requires to allow in his estimate for the labour unloading and storing these materials. This may be done by adding the cost of this labour to the unit rates or by assessing the total labour costs and allowing for these as a lump sum in the preliminaries. Materials such as sand, aggregates and sometimes common bricks may be tipped off the lorries and no charge made for labour unloading. Facing bricks, timber, cement in bags and the like require unloading and stacking. In the case of timber it may be easier to assess the number of loads required and the total time to unload and stack and to allow for this as a lump sum in the preliminaries. With facing bricks and cement however it may be easier to allow for this by adjusting the material quotation to include for unloading e.g.

tradesman not working on bonus would be about 75 to 80. A rating of 60 could be described as very slow with the operative having little interest in his work, while a rating of 130 could be described as a fast, tradesmanlike performance of an operative working on bonus and still producing the desired standard of workmanship. It is important that the rating of operatives is carried out by a person who knows the work involved. An operative may appear to be working fast but because he is using the wrong method or tools he is not producing as much as another man who appears to be working more slowly but is using the correct method and/or the correct tools. The second man should be given the higher rating as he is the more competent tradesman and is providing the higher output.

Using standard ratings then Standard Times may be calculated as follows:

(*a*) A bricklayer laying 78 bricks per hour and rated at 120

$$\text{Standard Time} = \frac{\text{observed rating} \times \text{observed time}}{\text{standard rating}} = \frac{120 \times 60}{100}$$

= 72 minutes for 78 bricks or 65 bricks per hour.

(*b*) A bricklayer laying 52 bricks per hour and rated at 80

$$\text{Standard Time} = \frac{80 \times 60}{100} = \text{48 minutes for 52 bricks or 65 bricks per hour}$$

If a building contractor is operating an incentive scheme then he could base his estimate on performance standards which corresponds to his labour working under financial motivation. This has been described as at 100 rating on the BS scale. The labour rate used for preparing the estimate would allow for the bonus earnings of the man (see chapter on Incentive Schemes). This would be the standard hour rate for the man working at 100 performance. The incentive would be a planned incentive.

$$\text{Standard Time} = \frac{\text{observed rating} \times \text{observed time}}{\text{standard rating}} + \text{allowances}$$

The allowances are an assessment of the time the men are not actually producing. They would include for time lost due to tea breaks, going to the toilet, general conversations, correcting mistakes, waiting for materials to arrive or for other trades, etc. These items are usually referred to as relaxation, fatigue, personal needs and contingency allowances. The percentage allowance is calculated by individual firms from their records. Provided the rating is done efficiently then the standard time should be the same but if a bonus scheme is being operated then the amount paid as bonus to the various workmen would be different. (i.e. their ratings are different therefore their bonus earnings are different.) Instead of the men being described as slow, average or fast a rating may be given to their performance. In this example ratings of 80, 100, 125 respectively have been given and an allowance of 25% has been added to cover the various items listed above. Although the mens times varied the standard time calculated is constant.

Fast man

$$\frac{125 \times 16 \text{ minutes}}{100} = 20 \text{ minutes} + 25\% = 25 \text{ minutes}$$

Average man

$$\frac{100 \times 20 \text{ minutes}}{100} = 20 \text{ minutes} + 25\% = 25 \text{ minutes}$$

Slow man

$$\frac{80 \times 25 \text{ minutes}}{100} = 20 \text{ minutes} + 25\% = 25 \text{ minutes}$$

The appreciation of the value of work study and the use of standard performances as a means of determining the labour content for items of work should lead to more accurate estimating. Rating and standard performances may be used in estimating irrespective of whether or not an incentive scheme is being operated. An example of their application to estimating is given in the chapter on Incentive Schemes.

Cost of cement d/d	£8.00 per tonne
Unload and store	
0.75 h labourer at £0.60	£0.45
	£8.45 per tonne delivered on site and unloaded

On contracts requiring large quantities of concrete, the cement is usually delivered in bulk containers and transferred to cement silos on the site. In this case no unloading charge is necessary. It is also becoming more common practice for bricks to be delivered in bundles held together by wire. These bundles may be unloaded by crane and the cost of unloading would be covered for in the lump sum cost of the crane.

The time taken to unload may be added to the labour constant as shown under bar reinforcement on page 82 or may be added to the labour section of the unit rate build up as shown in slating example No. 2 in the Roofing section.

In estimating the method used would at all times be the one that gives the most accurate result for the type of material being considered.

Unloaded materials require to be stored on the site in positions convenient for distribution and incorporation in the building. Careful storage can achieve savings due to a reduction in handling costs and loss through accidental damage.

Approximate times taken to unload materials by hand:

Material	*1 Labourer*
Cement or plaster (in bags)	0.75 h per tonne
Bricks	2.5 h per thousand
Timber (carcessing)	1.0 h per m³
Slates	2.25 h per thousand
Copper tubing (28 to 42 mm)	1.0 h per 150 m
Drain pipes	3.25 h per thousand

Discounts

Material prices are generally subject to reduction due to trade and cash discounts. Some contractors, due to the amount of materials purchased through a merchant, may receive a

preferential discount. Trade discounts are generally in the order of 10% to 60% and cash discounts are generally 2½% or 5%.

The price of materials used in the build up of material costs should be trade prices (i.e. the retail price less the trade discount). The cash discount is not deducted at this stage for unless the merchants accounts are paid within the required period (usually one month) the cash discount is not allowed. Cash discounts, however, may be considerable and if not deducted they form a hidden profit. Management often require the total of the cash discounts to be assessed so that they can ascertain the actual anticipated profit from the works. Provided that management considers it feasible to pay the accounts within the time limit and that the money from discounts is relatively safe then they may make a lump sum adjustment on the estimate so as to arrive at a tender figure. The consideration of factors such as this help management to submit tenders for contracts based on known facts in relation to their current needs.

Trade Terms in Common Use

c & f	Cost of freight included in price.
c.i.f.	Cost, insurance and freight included in price.
C.O.D.	Cash on delivery.
D/d site	The cost of materials includes for delivering them to the site. The contractor is responsible for the unloading of materials on their arrival at the site.
E. & O.E.	Errors and omissions excepted.
Ex works	The cost of materials is at the manufacturer's works. The contractor must pay for transport from works to the site or yard. The manufacturer loads the lorries at the works. The cost of delivering and unloading is met by the contractor.
F.O.B.	Free on board (ship). Manufacturer pays for loading and cartage of materials to nearest port. The contractor pays for the unloading of the ship (done by others) and for transporting materials to yard or site. The contractor is also responsible for any harbour dues.
F.O.Q.	Free on Quay. Generally as last but manufacturer

pays for unloading materials and landing charges. The contractor pays for loading and transporting materials to site or yard.

F.O.R. Free on rail. Manufacturer pays for loading and cartage of materials to the nearest railway station. The contractor unloads the rail containers and transports materials to site or yard. The contractor is also responsible for any demurrage charges (i.e. railway charges for not unloading within a limited set down period—usually 24 hours).

Nett cost This is the final cost after all deductions (i.e. trade and cash) have been deducted. It is the nett price to the builder.

Prime cost This is the cost after the trade discount has been deducted but before the cash discount is deducted. If there is no cash discount then the nett price and prime cost will be the same.

	£
e.g. To supplying 1 tile fireplace and hearth	80.00
Trade discount 20%	16.00
Prime cost	64.00
Cash discount 5%	3.20
Nett cost	£60.80

Pro rata In proportion.

CHAPTER VII

MOTOR TRANSPORT

Labour and materials moved by the contractor is usually by (*a*) private road hauler or (*b*) his own lorries.

If motor transport is only required for short intermittent periods it is usually more economical for a contractor to use hired transport than to keep his own lorries. It is usually found convenient to own and use one, or a small fleet of, lorries, depending on size and type of work undertaken, but for any additional demands for such service the work would be carried out by hiring.

Cost of Operating Builder's Own Lorry

Cost per hour, excluding normal business overheads and garaging, based on the following:

800 km per week.

Capital cost of £2 000.00 with residue value of £300.00 after 5 yr.

5 km per litre of petrol.

New tyres every 40 000 km. Tyres cost £150.00 per set.

Major overhaul every 80 000 km. Overhaul costs approx. £200.00.

General maintenance, oil and renewals approx. £200.00 per annum.

Standing Charge per Week

		£
*Driver's wages, 40 h at £0.62		24.80
	£	
Capital expenditure	2 000.00	
†Less residue value	300.00	
	£1 700.00	
	Carried forward	*24.80*

* A driver is paid £0.02 more than a labourer. If lorry driver is also a labourer then he would not be included in the standing charges if the lorry was not in use.

† The residue value need not be deducted. See note on replacement of mechanical plant in next chapter.

		Brought forward	24.80
Annual sinking fund—20% of £1 700.00 ÷ 50 weeks			6.80
Interest on capital—5% of £2 000.00 ÷ 50 weeks			2.00
	£		
Annual road tax	42.50		
Annual insurance	60.00		
	£102.50 ÷ 50 weeks		2.05
Running Costs per Week			
Petrol, 800 km ÷ 5 km at £0.06 per litre			9.60
Tyres, £150.00 every 40 000 km, i.e. £150 per yr ÷ 50 weeks			3.00
Overhaul, £200.00 every 80 000 km, i.e. £100 per yr ÷ 50 weeks			2.00
General maintenance, £200.00 per yr ÷ 50 weeks			4.00
Standing charges and running costs per week based on 800 km			£54.25

$$\text{Cost per h} = \frac{£54.25}{40} = £1.37$$

Capacity of Motor Lorries

Load capacities are somewhat nominal and vary considerably, depending on the manufacture of the lorry.

The load to be carried may be restricted by the weight capacity or by the size of the box. If the capacity is in doubt it is best to calculate the box capacity and convert the cubic capacity into kg, bricks, etc.

The box sizes of typical lorries are approximately:

2 740 × 1 830 × 450 mm

2 450 × 2 130 × 450 mm

3 350 × 2 130 × 600 mm

Examples

1. Calculate the cost of removing excavations to a tip 1 km distant using contractor's own lorry.

Lorry operating cost = £1.37 per h (from previous example).

	m^3
Box size 3.35 × 2.13 × 0.60	4.28
Add for load being above lorry sides (say) 20%	0.84
	5.12

A 5.12 m^3 capacity of loose soil would correspond to 5.12 m^3 less 25% for soil before excavating. 5.12 m^3 — 25% = 5.12 — 1.28 = 3.84 m^3. Allow 3.75 m^3.

	h
Lorry time to load	
Three labourers loading	0.75
Travelling and tipping	0.50
	1.25

	£
Lorry costs, 1.25 h at £1.37	1.713
Labour costs, 2.25 h at £0.60	1.350
	£3.063

Cost of removing excavations

$$\text{per } m^3 = \frac{£3.063}{3.75m^3} = £0.80$$

2. Calculate the cost of transporting bricks per 1 000 from the contractor's yard to site 25 km distant. Hire charge of lorry, including driver, is £1.00 per h.

Assume lorry will carry bricks to site and return empty.

	m^3
Capacity of lorry, 2.45 × 2.13 × 0.45	2.35
Add for lorry being stacked up higher than sides of box (say) 25%	0.59
	2.94

1 m³ contains approx. 500 bricks (theoretical maximum) 2.94 m³ contain 2.94 × 500 = 1 470 bricks (theoretical capacity of lorry).

The actual capacity would vary according to how the lorry was loaded, the weight it was capable of pulling, and the type of roads or site over which it had to travel. Assume the actual capacity as 1 200 bricks.

Lorry time

	h
Waiting while bricks are loaded	0.35
Travelling to site	0.85
Unloading (tipping)	0.15
Returning empty from site	0.75
	2.10

	£
Cost of lorry transporting, 1 200 bricks = 2.1 h × £1.00	2.10
Labour costs, 4 labourers 0.35 h each = 1.4 h × £0.60	0.84
Cost of lorry and labour transporting 1 200 bricks	£2.94

Cost of transporting 1 000 bricks = £2.45

Facing bricks would require labour for unloading at the site as they should not be tipped.

3. Calculate the cost of transporting slates per 1 000 from the railway station to the site 15 km distant. Hire charge of 6 tonne lorry, including driver, is £1.25 per h. The slates weigh 150.0 kg per 1 000.

The number of slates per load = 4 000.

Lorry time

	h
Travel to station	0.5
Load lorry: 4 labourers 2 h	2.0
Travel to site	0.75
Unload and stack	2.0
	5.25 h

	£
Cost of lorry transporting 4 000 slates = 5.25 h × £1.25	6.56
Labour costs, 4 labourers 2 h = 8 h × £0.60	4.80
Cost of lorry and labour transporting 4 000 slates	£11.36

Cost of transporting 1 000 slates = £2.84

CHAPTER VIII

MECHANICAL PLANT

Introduction

There are two main classifications of plant: (*a*) plant used on the site and (*b*) plant used in the workshop. The type of plant dealt with here is the plant used on the site and the general notes that follow are applicable to excavator equipment, concrete mixing plant, etc.

Plant used in the workshop is static, housed in good conditions and generally used to produce standard or similar items. It is not affected by site and weather conditions. The most usual types are joiners machinery for making doors, etc., and equipment for the manufacturer of precast concrete units.

Generally plant is employed on a building site in order to save money, labour or time or a combination of all three. In many circumstances it is cheaper to use machines for certain operations than to use the corresponding amount of labour, e.g. large site excavations. With the scarcity of building labour the contractor must become more mechanised in order to cut down on the amount of labour required. In certain circumstances he may require to do this irrespective of cost. In contracts where time is an important factor the contractor may require to use certain plant in order to speed up the work and get it completed within the required time.

For pricing purposes plant used on the site can be sub-divided into (*a*) plant performing specific items of work and (*b*) plant which performs many different tasks.

Cost of Plant

The cost of plant can be considered under the main headings of (*a*) standing charges, (*b*) running costs and (*c*) variable costs. These headings can be further detailed as follows:

1. Capital outlay
2. Replacement
3. Maintenance and repairs

} Standing charges.

4. Labour operating and attending
5. Fuel

} Running costs.

6. Transport
7. Temporary site work

} Variable costs.

All these items must be considered and broken down into the cost per unit of measurement which is required to be priced or into the cost per week in order to arrive at a total charge for the contract.

Standing Charges

The standing charges are irrespective of the cost of running the machine and the more the machine is used the less these charges influence the daily or hourly cost of operating the machine. The actual working time per annum is estimated and the charge per hour calculated in order to recover the cost of the standing charges in the rate charged. The points to be considered in each item are as follows:

Capital Outlay

The purchase of a machine should be considered as an investment. Interest on the capital outlay would therefore be expected. An interest charge compatible to other similar investments would be in the region of 5% to 10%.

Replacement

The machine requires to earn sufficient money to buy a similar machine at the end of its useful working life. The two main points to be considered are: (*a*) the useful life of the machine and (*b*) the expected cost of the replacement machine. The useful life depends on the type of machine and use to which it is put. An excavator would be expected to have a shorter life than a crane. If a machine has a useful life of 5 yr then a 20% return on capital cost would be required. For a life of 10 yr a 10% return would be required. The expected cost of the replacement machine may be greater than the cost of the machine it is replacing. This is, however, balanced to some extent by the market or scrap value of the machine to be replaced and can generally be discounted.

Maintenance and Repairs

This item only deals with the labour and material costs of periodic services and replacement of worn parts. It does not take into account any time lost due to these services or breakdowns. The cost involved depends on the type of equipment and can vary from about 5% to 50%. The actual percentage is calculated from previous records kept by the individual contracting firms.

Running Costs

Running costs are only incurred when the machine is actually being used. As with the standing charges, the actual work time per annum is estimated and the charge per hour calculated. The points to be considered in each item are as follows:

Labour Operating and Attending

This item must cover the cost of all labour necessary for operating the machine. In the case of a concrete mixer this would be the driver and the attendant labourers for aggregate and cement and for excavators and cranes, drivers and banksmen would be required. The labour removing the concrete to the required position would not be included in this item as this is over and above the mixing which the machine is expected to perform.

Fuel

This item covers the cost of all fuel, oil, etc. required for the efficient running of the machine.

Variable Costs

The total of the standing charges and running costs make up the basic cost of operating the machine. These costs are independent of the site and remain constant. Costs which vary from site to site must be considered separately and are as follows:

Transport

The cost of transporting the machine on and off the site must be considered. Generally the cost of transport to the site is

charged against the contract and the cost of transport off the site is charged against the contract at which the machine is required. The cost of transport is usually calculated as a lump sum and charged for under the preliminaries bill.

Temporary Site Works

Any additional work which is required due to the site conditions is charged for under this heading. For example, an opening may be required to give access to the site for the machine which would have to be made good at completion or a hardstanding may be required to be built for the concreting plant which would have to be removed at completion of the contract. This would also be calculated as a lump sum and charged for under the preliminaries bill.

Calculation of Time Worked by Machine

The machine will not work every day throughout the year and it is therefore necessary to calculate the actual number of possible working days:

		days
Days not worked:	Week-ends	104
	Annual holidays	10
	Public holidays (approx.)	6
		120

Time will also be lost in transporting equipment from site to site and in idle time while waiting to be transported. This may account for a further 30 to 40 days of non-productive time.

In addition, time is also lost due to overhauls and repairs. The amount of time wasted is influenced by the type and use of the machine and may account for another 10 to 20 days of non-productive time.

This gives a total of about 160 or 180 non-productive days or 185 or 205 productive days.

It must also be considered that during the normal working day there are delays and stoppages and that it is impracticable to work continuously throughout the whole day.

Examples

1. Cost of excavations per m³ using D6 tractor and scraper of 4.5 m³ capacity which belongs to the contractor.

This type of plant consists of two units: the tractor and the scraper.

It provides a cheap form of excavating if the haul does not exceed 450 m. Beyond this distance the mechanical excavation plant should be used in conjunction with vehicular transport. This type of machine is most suited for large road contracts or site levelling work. The scraper acts as a container in which the excavated material is hauled.

As the scraper is pulled by the tractor it excavates the ground with its cutting edge and the material enters the scraper which when full is raised above the ground and hauled to the tip by the tractor for off loading.

As mentioned in the introduction to this chapter a major consideration to be determined before purchasing a machine is its capacity. This is not what it can achieve in one hour but what it can achieve in one year, allowing for the weather, repairs, holidays, waiting time between jobs and time lost in transporting from job to job.

Cost of machine

		£
Capital cost		4 000.00
Replacement—5 yr	20%	
Interest	10%	
Repairs	25%	
	55%	

∴ Total annual cost = £2 200.00

Use 150 days = £14.67 per day or £1.83½ per h.

Cost of using the machine to excavate and remove to spoil heaps not exceeding 100 m.

	£
Cost of tractor and scraper per h	1.835
Carried forward	1.835

			£
		Brought forward	1.835
Labour operating and attending		£	
	Driver (1)	0.62	
	Banksman (1)	0.61	
	Labourers (2)	1.20	2.43
Fuel	*Petrol (start)*	0.01	
	Diesel, 15 litre at £0.05	0.75	
	Oil and grease	0.15	0.91
			£5.175

Productive Rate

4.5 m³ scraper at 100 m haul would give 5 turns per h.

∴ 22.5 m³ excavated and deposited.

	£
Cost per m³ $= \frac{£5.175}{22.5m^3} =$	0.21
Profit and oncost 15%	0.035
	£0.265 m³

Cost per m³—£0.26½

Plant Hiring

As mentioned previously, if the contractor cannot find continuous use for mechanical plant and it is likely to stand idle for long periods, then it is more economical for him to hire the plant for the specific job or operation.

Large contracting organisations usually have a plant pool and a separate plant department which hires to the contracting departments or other contractors, if it is not required by its own organisation, at rates similar to that normally charged by plant-hiring firms.

The advantage of hiring is that the contractor can use the money he would have spent on the machine to expand his business, pay wages to employ more men and increase turnover or pay invoices more quickly so as to get better discounts.

The advantage of owning is that the machine is available when required and this may assist in contract planning.

2. In example 1, if instead of owning the D6 tractor and scraper, the contractor hired one for the excavations, the build up of rate would have been as follows:

In this case the (1) capital outlay (2) replacement and (3) maintenance costs are all covered by the hire charge.

Cost of machine

		£
Hire charge		2.00

Labour operating and attending

	£	
Driver (1)	0.62	
Banksman (1)	0.61	
Labourers (2)	1.20	
		2.43

Fuel

	£	
Petrol (start)	0.01	
Diesel, 15 litre at £0.05	0.75	
Oil and grease	0.15	
		0.91
		£5.34

Productive Rate

As before 22.5 m³ excavated and deposited.

$$\text{Cost per m}^3 = \frac{£5.34}{22.5\ \text{m}^3} = £0.235$$

Profit and oncost 15%	0.035
	£0.27 m³

Although in this example it is dearer to hire, this is only true if the equipment owned is used to its full capacity. If the equipment and operator have long periods of idleness there is a loss of interest on capital.

Transport of Machinery

The transport of the machine to the site has not been included. This is because it is best allowed for as a sum in the preliminaries bill. If the plant is owned by the contractor the cost of taking it on to the job would be charged against that job and the cost of removing it against the job it is being transported to. If hired, the cost to and from the job are both charged to that job.

If equipment has a high hire charge and it is not possible to arrange for an unbroken period of use, it may be cheaper to return the plant to the hirer and bring it back to the site at a later date, thus paying double delivery charges rather than pay hire charge for equipment standing idle.

3. Cost of excavating trenches not exceeding 1.5 m deep, including removing excavations off site to a tip found by contractor—m³.

Excavations done by backacter owned by contractor and removed by dumpers hired from plant hire firm.

		£
Cost of machine		3 000.00
Standing charges		
Replacement—5 yr	20%	
Interest	10%	
Repairs	20%	
	50%	
∴ Total annual cost		£1 500.00

Use 180 days = £8.333 per day or £1.042 per hour

	£
Standing charges per h	1.042

Labour operating and attending

	£	
Driver (1)	0.62	
Labourers (2)	1.20	
		1.82
Carried forward		2.862

		£
Brought forward		2.862

Fuel

	£	
Petrol (start)	0.01	
Diesel, 15 litre at £0.05	0.75	
Oil and grease	0.15	
		0.91
		£3.772

Productive Rate

0.4 m³ capacity bucket at 40 shovels per h.

$40 \times 0.4\ m^3 = 16\ m^3$ *per h.*

Cost of excavating per m³ $= \frac{£3.772}{16\ m^3} = £0.234$

16 m³ excavations required to be removed to a tip 0.5 km distant.

Use two 4 m³ dumpers at a hire rate of £1.00 per h each.

		£
	Hire charge, two at £1.00 per h	2.00 per h
Labour operating	*Drivers (2) a £0.62 per h*	1.24 per h
Fuel	*Diesel 2 × 2.5 litres = 5 litres at £0.05*	0.25 per h
		£3.49 per h

Charge for tip—assume free.

∴ Cost of transport per m³ $= \frac{£3.49}{16\ m^3} = £0.218$

Allow for standing time waiting to be loaded 10%	= 0.022
	£0.24

	£
Cost of excavating	0.234
Cost of transport	0.24
	0.474
Profit and oncost 15%	0.071
	£0.545 m³

Cost of excavating and carting £0.54½ per m³

It has been assumed that the dumper has a 4 m³ 'struck' capacity and that the amount of the additional material loaded compensates for the 'bulking' of the excavated material.

Dumpers are suitable for short journeys up to ½ km. They are capable of doing two ½ km journeys per h if filled by a mechanical excavator.

4. Cost of mixing concrete per m³ using a 10/7 mixer owned by the contractor.

			£
Cost of mixer			1 000.00
	Replacement—10 yr	10%	
	Interest	5%	
	Repairs	15%	
		30%	
	∴ Total annual cost = £300.00		
	Use 200 days = £1.50 per day.		

		£	£
Cost of mixer per day			1.50
Labour operating		£	
	Mixer driver	0.61	
	Cement man	0.60	
	Aggregate men (3)	1.80	
	per hour	£3.01	
	per day	24.08	24.08
	Carried forward		25.58

	£
Brought forward	25.58
* *Mixer driver ½ h overtime per day*	0.31

Fuel

	£	
Petrol 7 litres at £0.07	0.49	
Oil (0.25 litres)	0.075	
Waste	0.025 *per day*	0.59
	per day	26.48

Output

Normal day 8 h. Allow 3 min per batch and this gives 160 batches per day.

	160 batches
Less 10%	*16 for breakdowns*
	144
	0.2† m³ per batch
	28.8 m³ per day

$$\textit{Cost of mixing per } m^3 = \frac{£26.48}{28.8\ m^3} = £0.92$$

As this is only a stage in the build up of a unit rate for concrete the profit and oncost percentage will not be added here but at the end of the complete build up of price.

* The mixer driver is allowed ½ h overtime for cleaning and preparing the mixer (working rule 3F).

† The 10/7 concrete mixer has a drum of 7 ft³ capacity which is equivalent to 0.2 m³.

5. Calculate the cost of mixing concrete per m³ using a 10/7 mixer hired from a plant hire firm.

	£
Cost of mixer	
Hire charge, per day	2.75
**Idle time, say 10%*	0.275
Labour operating	
As Example 4	24.39
Fuel	
As Example 4	0.59
	£28.005 per day

Output

As Example 4—28.8 m³ per day.

$$\textit{Cost of mixing per } m^3 = \frac{£28.005}{28.8\ m^3} = £0.98$$

In the previous two examples the cost of mixing concrete has been broken down into a cost per m³. This cost may be added to the unit rate build up for concrete and therefore gives the cost of concrete including mixing. Alternatively the cost of mixing may be excluded from the unit rate and allowed for as a lump sum in the preliminaries bill. The period the concrete mixer will be required on site can be determined from the contractors programme of work in relation to the quantities of concrete involved and the times that they are required. This tends to be the best method as an accurate lump sum cost of the mixer can be calculated for the contract. In calculating the cost of mixing per m³ however to a certain extent the non-productive periods of the concrete mixer on site can be charged for by an accurate assessment of working days per annum in the case of the contractors own plant, or by a realistic assessment of idle time, in the case of hired plant. This method should give

* Idle time has been added in this example as for this type of plant the hire cost is not heavy. It is therefore better to keep the mixer on the site over its useful period even although there are non-productive periods rather than to increase the transport charges.

a rate for mixing per m³ that is comparable with the lump sum charge.

6. Calculate the cost of mixing mortar per m³ using a 10/7 mixer hired from a plant hire firm.

		£	£
Cost of mixer			
	Hire charge, per day		*2.75*
	Idle time, say 10%		*0.275*
Labour operating			
	**1 operator at £0.60 per h*		*4.80 per day*
Fuel			
	Petrol, 4.5 litres at £0.07	*0.315*	
	Oil and waste (say)	*0.055*	
			0.37
			£8.195 per day

Output

Normal day, 8 h less ½ h for cleaning and preparation, i.e. 7½ h running time. Allow 6 batches per h or 45 batches per 7½ h running time.

	45 batches
Less 2½%	*1 for breakdowns*
	44
	0.2 m³ per batch
	8.8

$$\textit{Cost of mixing per } m^3 = \frac{£8.195}{8.8\ m^3} = £0.93$$

In a similar manner as for mixing concrete the cost of the mixer could be charged for on a lump sum in the preliminaries bill on the basis of time the mixer will be required on the site.

* This mortar mixer will be serving more than one gang of bricklayers and additional labour will be available in the form of labourers which are charged for as members of the bricklaying gang.

Cranes, Hoists, etc.

The cost of cranes, hoists and similar equipment which perform many tasks cannot be broken down and allocated to individual unit rates. The estimator must assess the length of time this type of equipment will be required on the site and the total cost is allowed for as a lump sum in the preliminaries bill.

This lump sum will include for profit and overheads.

Example

Calculate the cost of a rail mounted tower crane required on the site for a period of 40 weeks.

	£
Transport to site	*50.00*
Erection costs	
Crane	*200.00*
Track	*75.00*
Hire charges	
Crane: 40 weeks at £150.00 per week	*6 000.00*
Track: 60 m at £0.35 per week = £21.00 per week × 40 weeks	*840.00*
Electrical power	
40 weeks at £2.00 per week	*80.00*
Operatives	
1 crane driver (full-time) and 1 banksman (part-time) allow 40 weeks at £38.00 per week	*1 520.00*
Temporary base for track including removal and reinstatement of ground, 150 m² at £5.00	*750.00*
Dismantling costs	
Crane	*200.00*
Track	*75.00*
	9 790.00
Profit and oncost 15%	*1 468.50*
Lump sum cost of tower crane for period of contract	*£11 258.50*

CHAPTER IX

EXCAVATIONS AND EARTHWORKS

Labour Constants

Excavating by Hand

Approximate Time per m³ for Excavating in Average Soils.
Excavations thrown and filled into barrows (not exceeding 1.5 m)

	hours
Area	1.0 to 1.75
Trenches	1.75 to 2.25
Pipe tracks	2.5 to 3.25

Allied Operations

	hours
Excavate from spoil heaps	0.75 to 1.0
Refill and ram trenches and tracks	1.0 to 1.5
Throw out only (1.5 m stages)	1.25
Wheel 50 m, deposit and return	0.5
Every additional 25 m	0.25
Spread and level	0.4 to 0.75

Note: (i) Excavating for isolated piers etc. not exceeding 0.5 m² add 25% to trench excavations.
(ii) Excavated materials increase in bulk and this must therefore be allowed for when pricing for carting away.

The constants for excavating to be adjusted by the following percentages depending on the nature of the soil:
Loose soil, −20%; Clay or heavy soil, +50%; Rock, +200% to 300%.

Breaking Up Existing Surfaces

Breaking up macadam surface 150 mm thick, by hand	1.25 man h per m²
Ditto concrete surface 150 mm thick, ditto	2.5 man h per m²

Planking and Strutting

Close Sheeting	
Not exceeding 1.5 m deep	1.25 m² per man per h
Exceeding 1.5 m deep and not exceeding 3.0 m deep	0.75 m² per man per h
Poling Boards, Waling and Struts at 2.0 m centres	
Not exceeding 1.5 m deep	2.5 m² per man per h

Hand Excavations

An excavator digs a trench to a depth of 1.5 m deep and throws out the excavated soil to the surface for this depth. He may throw the soil to one or both sides and another man may clear away the soil from the edge of the trench. When digging the next 1.5 m in depth the excavator cannot throw the soil to the surface so a platform is provided at the first 1.5 m depth level. He digs and throws the soil onto this platform and another man lifts and throws it to the surface.

For each additional 1.5 m depth the same procedure is carried out.

Examples

1. *Excavate vegetable soil average 250 mm deep and spread on site average 100 m from excavation—m².*

	hour
Excavate and get out	*1.0*
Wheel average 100 m, deposit and return	*1.0*
Spread and level	*0.5*
	2.5
Labourer 2.5 h at £0.60	*£1.50*
Profit and oncost 15%	*0.225*
	£1.725 per m³

£1.725 per m³—therefore 250 mm deep = ¼ of £1.725
= £0.43½ per m²

2. Excavate basements starting from natural ground level and not exceeding 1.5 m deep—m³.

Excavate and get out	*1.5 h*
Labourer 1.5 h at £0.60	*£0.90*
Profit and oncost 15%	*0.135*
	£1.035 per m³

Cost per m³ = £1.03½

3. Excavate trenches to receive foundations, starting from 1 m below natural ground level and not exceeding 1.5 m deep—m³.

Excavate and get out	*2.0 h*
Labourer, 2 h at £0.60	*£1.20*
Profit and oncost 15%	*0.18*
	£1.38 per m³

4. Excavate trenches to receive foundations, starting from 1 m below natural ground level, and over 1.5 m but not exceeding 3 m deep—m³.

Excavate and get out	*2.25 h*
Throw one stage	*1.25 h*
	3.5 h
Labourer, 3.5 h at £0.60	*£2.10*
Profit and oncost 15%	*0.315*
	£2.41½ per m³

5. Surplus excavated material deposited on site in permanent spoil heaps average 50 m from excavation—m³.

Wheel not exceeding 50 m	*0.5 h*
Labourer 0.5 h at £0.60	*£0.30*
Profit and oncost 15%	*0.045*
	£0.34½ per m³

6. Excavated material backfilled around foundations—m³.

Return, fill in and ram	*1.25 h*
Labourer, 1.25 h at £0.60	*£0.75*
Profit and oncost 15%	*0.113*
	£0.86½ per m³

7. Plank and strut sides of basement excavations starting from natural ground level and average 1.5 m total depth—m².
Timber, £30.00 m³, delivered site.
Calculate on length of excavation 2 m long and 1.5 m deep.

Material	m³	£
Waling 180 mm × 40 mm × 2.0 m	*0.0144*	
Poling 6/180 mm × 40 mm × 1.5 m	*0.0648*	
Struts 2/100 mm × 100 mm × 1.4 m	*0.0280*	
	0.1072 at £30.00 =	*3.216*
Nails (say)		*0.05*
		£3.266

Allow for using 5 times $= \frac{£3.266}{5} =$ *£0.653 per 3 m²*

	£
Materials cost per m²	*0.218*
Carried forward	*0.218*

	Brought forward	0.218
Labour		
1 labourer 2.5 m² per h		
£0.61½ for 2.5 m²—1m²*		0.246
		0.464
Profit and oncost 15%		0.07
		£0.53½† per m²

8. Hardcore filling in making up levels over 300 mm thick, deposited and compacted in layers—m³.

	£	£
Material		
Hardcore per m³	0.80	
Allow for shrinkage due to compaction and waste 25%	0.20	1.00
Labour		
Labourer 1.5 h per m³, 1.5h at £0.60		0.90
		1.90
Profit and oncost 15%		0.285
		£2.18½ per m³

For examples on excavations using mechanical plant see Chapter VII.

* A timberman gets £0.01½ per h more than a labourer's wage.

† Planking and strutting is measured for all excavations but it is not always required. It is the risk that is being priced more than the labour and materials involved. A rate calculated from experience of about £0.25 per m² would be more realistic depending, of course, on the nature of the soil.

CHAPTER X

CONCRETE WORK

Depositing and Compacting Concrete per m³

Position	*Not reinforced* *Hours one labourer*	*Reinforced* *Hours one labourer*
In trenches for foundations not exceeding 300 mm thick	1.25	1.75
Beds exceeding 150 mm thick but not exceeding 300 mm thick	5.00	6.0
Suspended floors, roofs and the like not exceeding 150 mm thick	5.75	7.0
Ditto, ditto exceeding 150 mm thick but not exceeding 300 mm thick	5.25	6.5
Walls not exceeding 150 mm thick	6.25	7.75
Ditto exceeding 150 mm thick but not exceeding 300 mm thick	5.25	6.25
Columns not exceeding 0.05 m² sectional areas	10.5	11.5
Ditto exceeding 0.05 m² but not exceeding 0.10 m² sectional area	7.75	9.0
Ditto exceeding 0.10 m² sectional area	6.5	7.75
Beams not exceeding 0.05 m² sectional area	9.0	10.5
Ditto exceeding 0.05 m² but not exceeding 0.10 m² sectional area	6.5	7.75
Ditto exceeding 0.10 m² sectional area	~~5.5~~ 6.25	6.5

Reinforcement

Bar Reinforcement for Reinforced Concrete

Mild Steel Reinforcing Bars

Diameter of bar	*6 mm*	*10 mm*	*12 mm*	*16 mm*	*20 mm*	*25 mm*
Weight per kg/m	0.222	0.617	0.888	1.58	2.47	3.86

Labour Constants

Diameter of bar	20 mm	12 mm	6 mm
	Hours 1 labourer per tonne		
Unload and stack on site	5	5	5
Cut to length	5	7.5	10
Bending to shape	20	30	Bent *in situ*
Fixing	30	37.5	60
Total per tonne	60	80	75

Formwork

Formwork to horizontal soffits of suspended floors and roofs per m².

Erect and remove (allowing 1 carpenter and 1 labourer one strut per 1.25 m²)	*h*
Up to 3.50 m high	0.70
3.50 m to 5.0 m high	0.85
5.0 m to 6.5 m high	0.95

Multipliers to be used in conjunction with above

Formwork, per use	
One use	1.0
Two uses	0.85
Three uses	0.80
Four uses	0.75
Five uses	0.70
Formwork to sloping soffits	
Not exceeding 15° from horizontal	1.15
Exceeding 15° from horizontal	1.25

Formwork to curved surfaces

Small radius	2.15
Large radius	1.50
Struts, two per m²	1.15

Nails

For first use allow 0.5 kg per m² and for each additional re-use allow 0.13 kg per m².

Concrete

Composed of cement, sand and aggregate in various proportions. Cement weighs 1 440 kg/m³ (B.S.S. for ordinary Portland cement). Sand weighs 1 600 kg/m³ when dry and approximately 1 280 kg/m³ when damp.

Aggregate weighs 1 280 kg to 1 770 kg/m³, depending on type.

Cost per m³

Rates built up in three sections:

(i) Cost of materials.

(ii) Cost of mixing.

(iii) Cost of placing and compacting.

(*a*) *Cost of Materials*

Cement, £8.25 per tonne; Sand, £0.60 per tonne; Aggregate, £1.50 per tonne delivered site.

1:2:4 Nominal mix. The actual mix using damp sand would be 1:2½:4.

Materials

		£
Cement	1 part × 1 440 kg = 1 440 kg	
	at £8.25 per tonne =	11.88
Sand	2 parts × 1 600 kg = 3 200 kg	
	at £0.60 per tonne =	1.92
Aggregate	4 parts × 1 650 kg = 6 600 kg	
	at £1.50 per tonne =	9.90
	7	£23.70
Deduct	2.8 shrinkage 40%	
	4.2	
	0.2 waste 5%	
	4.0	

$$\text{Cost of materials per m}^3 = \frac{£23.70}{4.0} = £5.925$$

(*b*) *Cost of mixing*

Hand mixing

Light aggregate concrete: 1 labourer 4 h per m³.

Heavy aggregate concrete: 1 labourer 5.25 h per m³.

In hand mixing a finer mix may require more time, e.g. a 1:3:6 mix may take 4.75 h and a 1:2:4 mix may take 5.25 h. This is not a factor in machine mixing.

Hand mixing per m³ = 5.25 h at £0.60 = £3.15.

Machine mixing

The calculation for machine mixing is shown in the chapter on mechanical plant.

Machine mixing per m³ = £0.92.

(c) *Cost of Placing*

After the materials are mixed the concrete is transported and deposited where required. Mixing plant should be positioned in a place convenient to the point of deposit so the distances involved are as short as possible. Where long distances are involved dumpers may be used to transport the concrete. In contracts where the concrete requires hoisting a mobile or tower crane and hoppers may be used.

Ready Mix Concrete

Ready mix concrete is gaining in popularity and is very suitable for congested sites where it is impracticable for the contractor to set up his own concrete mixing plant or where only small quantities of concrete are required. By calculating the cost of the mixing plant for the period that it is required on the site and the cost of materials it is possible for the contractor to compare the cost of his own mixed concrete with that of ready mix concrete. Where large quantities of concrete are required or where the contractor's own plant would otherwise be lying idle it may be cheaper for the contractor to mix his own concrete.

Examples

1. Concrete (1:2:4) in foundations not exceeding 150 mm thick—m³.

	£
Materials	5.925
Mixing	0.92
Carried forward	6.845

	£
Brought forward	6.845
Placing	
1 labourer, 1.25 h at £0.60	0.75
	7.595
Profit and oncost 15%	1.14
	£8.73½ m³

2. Concrete (1:2:4) in beds 150 mm thick—m².

	£
Materials	5.925
Mixing	0.92
Placing	
1 labourer, 5.25 h at £0.60	3.15
	9.995
Profit and oncost 15%	1.499
	£11.494 m³

Cost per m² 150 mm thick = £1.71½

3. Reinforced concrete (1:2:4) in beam exceeding 0.10 m² sectional area—m³.

	£
Materials	5.925
Mixing	0.92
Placing	
1 labourer, 6.25 h at £0.60	3.75
	£10.595
Profit and oncost 15%	1.589
	£12.18½ m³

BUILDERS' ESTIMATING SIMPLY EXPLAINED (METRIC EDITION)

Reinforcement

4. Mild steel bars 12mm diameter for reinforcing concrete including bends, hooks, tying wire, distance blocks and ordinary spacers—kg.

Quote: steel £60.00 per tonne delivered site.

		£
Materials		
	Steel, per tonne	60.00
	Waste and rolling margin 5%	3.00
	Spacers (say)	3.00
	Steel tying wire 13.5 kg per tonne of 12 mm rods at £0.10 per kg	1.35
Labour		
	Steel bender, 80 h at £0.62 (qualified benders and fixers paid £0.02 per h more than labourers)	49.60
		116.95
	Profit and oncost 15%	17.54
		£134.49 tonne

Cost per kg = £0.13½

5. Steel wire mesh fabric weighing 2.22 kg per m², overlapped 90 mm all joinings, including tying wire and distance blocks—m².

		£
Materials		
	Steel fabric 1 m²	0.20
	Spacers and tying wire (say)	0.025
		0.225
	Waste and laps 7½%	0.017
Labour		
	Steel fixer, 0.2 h per m², 0.2 h at £0.62	0.124
	Carried forward	0.366

	£
Brought forward	0.366
Profit and oncost 15%	0.054
	£0.42 m²

Formwork

6. Formwork to horizontal soffits of floors including supports and afterwards removing—m².

		£
Materials (per 10 m²)		
	9 mm plywood, 10 m² at £0.75	7.50
	100 mm × 100 mm struts, 0.2 m³ at £30.00	6.00
	Battens etc., 0.18 m³ at £30.00	5.40
		18.90
	Waste 7%	1.323
	Cost per 10 m²	*£20.223*

Cost per m² = £2.022

Allowing for 1 use

	£
Material cost, per m²	2.022
Less re-usable value, say 60%	1.213
Actual cost of timber per m²	0.809
Nails 0.5 kg at £0.12½	0.063
Material cost per m² allowing for 1 use only	0.872

Allowing for edge joints not being tight: say 17 m².

Allowing for 5 uses

	£
Material cost, per m²	2.022
Nails:	
1st use, 0.5 kg at £0.12½	0.063
4 re-uses (allow 0.13 kg per m² for each re-use) 4 × 0.13 kg = 0.52 kg at £0.12½	0.065
Cost per m² allowing for 5 re-uses	£2.15

$$\text{Cost per m}^2 = \frac{£2.15}{5} = £0.43$$

Labour (*allowing for 1 use*)

1 tradesman and 1 labourer = 0.7 h per m².
0.7 h at £1.27 = £0.889 per m².

	£
Materials	0.872
Labour	0.889
	1.761
Profit and oncost 15%	0.264
	£2.02½ m²

Labour (*allowing for 5 uses*)

1 tradesman and 1 labourer = 0.49 h per m².
0.49 h at £1.28 = £0.627 per m².*

	£
Materials	0.43
Labour	0.627
	1.057
Profit and oncost 15%	0.159
	£1.21½ m²

* Allow extra wages for reusing old materials as per working rule.

7. Precast concrete lintols 110 × 230 mm over opening, reinforced with one 12 mm diameter mild steel bar—linear m.

Mould

No top or bottom required. Calculate on a 1 m lintol.

Material

	£
110 × 32 mm timber 2.5 m at £0.32	0.80
Nails, 0.1 kg at £0.12½	0.013
Bolts, 4 at £0.05	0.20
	£1.013
Allow for 25 reuses: £1.013 ÷ 25	£0.041

Labour

Mould 0.4 h labourer; 0.4 h at £0.60	0.24
	£0.281

Reinforcement

Cost of material and fixing £0.13½ per kg as example 4: 1.15 m at £0.13½ kg	£0.13

Concrete

Cost of material (1:2:4), £5.925 m³ as calculated before: 0.03 m³ at £5.925	0.178
Labour placing 10 h labourer per m³: 0.03 m³ at £6.00 m³	0.18
	£0.358

Hoisting and Setting

8 h bricklayer and 16 h labourer per m³.

	£
8 h at £0.67	5.36
Carried forward	5.36

Allowing for edge joints not being tight: say 17 m².

		£
	Brought forward	*5.36*
16 h at £0.60		*9.60*
		£14.96 m³

0.03 m³ at £14.96 = £0.449

	£
Mould	*0.281*
Reinforcement	*0.13*
Concrete	*0.358*
Hoisting and Setting	*0.449*
	1.218
Profit and oncost 15%	*0.182*
	£1.40 m

CHAPTER XI

BRICKWORK AND BLOCKWORK

Bricks and Mortar per Square Metre Half Brick Thick

Imperial brick sizes converted to metric:
219 mm × 105 mm × 67 mm (8⅝″ × 4⅛″ × 2⅝″) and 219 mm × 105 mm × 73 mm (8⅝″ × 4⅛″ × 2⅞″).

Metric brick sizes:
Clay bricks—215 mm × 102.5 mm × 65 mm: Concrete bricks —200 mm × 100 mm × 75 mm.

To calculate the Number of Bricks required per Square Metre

65 mm bricks with 10 mm beds and joints.

Brick size	215.0	65.0
Bed and joint	10.0	10.0
	225.0	75.0

225.0 × 75.0 = 16 875 mm²
= 60 bricks per m²

Mortar requirements per Square Metre

	Single frog (*m³*)	*Double frog* (*m³*)
9.5 mm beds and joints		
67 mm bricks	0.03	0.035
73 mm bricks	0.02	0.025
10 mm beds and joints		
65 mm bricks	0.035	0.04
75 mm bricks	0.025	0.03

Number of Facing Bricks required per Square Metre

Bond	*Brick size* 219 × 105 × 67 mm	219 × 105 × 73 mm	215 × 102·5 × 65 mm	200 × 100 × 75 mm
Stretcher	58	53	60	56
English	87	80	90	84
Flemish	77	71	80	75
English garden wall	73	66	75	70

BUILDERS' ESTIMATING SIMPLY EXPLAINED (METRIC EDITION)

Gang Size

There is generally 1 labourer to every 2 bricklayers. This may be varied due to circumstances, type or position of work under consideration.

Brickwork

Cost of Brickwork

The price must include for the following:

(i) The cost, delivered to site, of bricks, cement, lime and sand.

(ii) The labour for mixing mortar and building bricks, including labour depositing bricks and mortar at the required positions.

(iii) Labour erecting and removing scaffolding as required.

(iv) Cost of water.

Items (i) and (ii) are included in the unit rate for brickwork.

Items (iii) and (iv) are included in the preliminaries bill as a lump sum.

Factors Affecting the Cost of Brickwork

(*a*) The size of the bricks, i.e. 65 mm, 67 mm, or 75 mm thick. This affects the number to be laid per m².

(*b*) Whether the bricks have frogs and the position of the frog, affects the amount of mortar required for building.

(*c*) The mortar mix and the thickness of the beds and joints.

(*d*) The bond.

Cost of Mortar

Cement Mortar (1:3)

Cement 1 part × 1 440 kg = 1 440 kg at £8.25 per tonne = £11.88

Sand 3 parts × 1 600 kg = 4 800 kg at £0.60 per tonne = 2.90

4 *Carried forward* £14.78

4 *Brought forward*

Deduct 0.8 Shrinkage 20%

3.2

0.2 Waste 5%

3.0

$\therefore$ Cost of mortar (materials only) $= \dfrac{£14.78}{3} = £4.93$ m³

Cement Lime Mortar (1:2:8)

Cement 1 part × 1 440 kg = 1 440 kg at £8.25 per tonne = £11.88

Lime 2 parts × 510 kg = 1 020 kg at £8.50 per tonne = 8.67

Sand 8 parts × 1 600 kg = 12 800 kg at £0.60 per tonne = 7.68

11 £28.23

Deduct 2.2 Shrinkage 20%

8.8

0.4 Waste 5%

8.4

$\therefore$ Cost of mortar (materials only) $= \dfrac{£28.23}{8.4} = £3.36$ m³

Cost of mortar, including mixing = £3.36 + £0.93 = £4.29 m³.
(mixing calculated under mechanical plant section)

Examples

1. Half brick walls built in cement lime mortar with 10 mm beds and joints—m².
Quote: 65 mm clay bricks at £11.00 per thousand delivered site.

Material	£
Bricks, 60 at £11.00 per thousand	0.66
Carried forward	0.66

	£
Brought forward	*0.66*
Waste 5%	*0.033*
Mortar, 0.035 m³ at £4.29 m³	*0.15*

Labour

Bricklayers lay on average between 40 and 100 bricks per h.

Assume an output of 60 bricks per h.

Using a gang of 4 bricklayers and 2 labourers, a total of 240 bricks would be laid per h.

	£
Bricklayers 4 at £0.67	*2.68*
Labourers 2 at £0.60	*1.20*
	£3.88 per 240 bricks

Cost of laying 60 bricks $= \frac{£3.88}{240} \times 60 =$ *0.97*

	1.813
Profit and oncost 15%	*0.272*
	£2.08½ m²

Brickwork is generally priced in proportion, e.g.

Half brick wall	*£2.08½ m²*
One brick wall	*£4.17 m²*
One-and-a-half brick wall	*£6.25½ m²*

Brickwork in chimney breasts and chimney stacks is generally priced in proportion as the extra labour and height will be compensated by the over-measurement due to the flues not being deducted.

Walls built to radius should be priced more expensive due to increased labour costs.

Walls built to 10 m radius—labour costs increased by 50%.

Walls built to 1.5 m radius—labour costs increased by 100%.

Reduced brickwork in projections generally takes longer to

build. The rate would be adjusted by reducing the number of bricks laid per hour.

2. Half brick wall, in skin of hollow wall, built in cement lime mortar with 10 mm beds and joints—m².

Quote: 75 mm concrete bricks at £12.00 per thousand delivered site.

	£
Material	
Bricks, 56 at £12.00 per 1 000	*0.672*
Waste 5%	*0.034*
Mortar 0.025 m³ at £4.29	*0.107*

Labour

Bricklayers laying 60 bricks per h.

Using a gang of 5 bricklayers and 3 labourers a total of 300 bricks will be laid per h.

	£
*Bricklayers 5 at £0.60**	*3.00*
*Labourers 3 at £0.55**	*1.65*
	4.65
**Additional indirects 14%*	*0.65*
	£5.30 for 300 bricks

Cost of lay 56 $= \frac{£5.30}{300} \times 56$ *0.989*

	1.802
Profit and oncost 15%	*0.270*
	£2.072 m²

Cost per m² = £2.07

* The labour rates in example 2 have been based on the example on page 29 of the Labour Costs section.

3. *Form 50 mm cavity of hollow walls, including three wall ties per Square metre—m².*
Quote: £14.00 per 1 000. wall ties

	£
3 No. at £14.00 per 1 000	0.042
Waste 10%	0.004
	0.046
Profit and oncost 15%	0.007
	£0.05 m²

4. *Close 50 mm cavity of hollow walls with brickwork—m.*

Material
Allow 5 bricks per metre which includes for waste.

	£
Bricks, 5 at £11.00 per thousand	0.055
Mortar (say)	0.015
Labour	
1 bricklayer with attendant labourer will do 1 m in 0.2 h. Gang as before, 2 bricklayers and 1 labourer	
Bricklayer 0.2 h at £0.67	0.134
Labourer 0.1 h at £0.60	0.06
	0.264
Profit and oncost 15%	0.04
	£0.304 m

Cost per m = £0.30½

5. *Rough cutting brickwork—m².*
Materials
Allow 12 bricks per m² for waste (i.e. 20% of 60 bricks)

	£
Bricks, 12 at £11.00 per thousand	0.132
Carried forward	0.132

	£
Brought forward	0.132
Labour	
1 bricklayer with attendant labourer will do 1 m² in 2.25 h. Gang as before, 2 bricklayers and 1 labourer.	
Bricklayer 2.25 h at £0.67	1.507
Labourer 1.13 h at £0.60	0.678
	2.317
Profit and oncost 15%	0.348
	£2.665 m²

Cost per m² = £2.66½

Note: *Although a labourer is not required for rough cutting he will still be in attendance on the gang and although possibly idle he will require to be charged against the operation.*

6. *Extra over common brickwork for facing brickwork, key pointed as the work proceeds—m².*
Preambles state all walling to be built in English bond.
Quote: Bricks £17.50 per thousand delivered site.

No. of bricks required per m²

Bricks (all stretchers) as calculated before	60
Add for headers, i.e. double number of bricks every second course = ½ of 60	30
	90

	£
Material	
Bricks, 90 at £17.50 per thousand	1.575
Waste 5%	0.079
Mortar 0.04 m³ at £4.29 m³	0.172
Labour	
2 labourers and 4 bricklayers each laying 50 bricks per h, including pointing: 200 bricks per h	
Carried forward	1.826

		£
	Brought forward	*1.826*
Bricklayers	£	
4 at £0.67	*2.68*	
Labourers		
2 at £0.60	*1.20*	
	£3.88 per 200 bricks	
Cost of laying 90 $= \frac{£3.88}{200} \times 90 =$		*1.746*
		3.572
Profit and oncost 15%		*0.536*
		£4.108
Deduct		
Common brickwork allowing for extra headers, $1\frac{1}{2} \times £2.08\frac{1}{2}$		*3.127*
		£0.981 m²

Cost per m² = £0.98

7. Extra over common brickwork for facing brickwork, key pointed at a later date—m².

Preambles state that all walling to be built in Flemish bond.

Quote: Bricks £17.50 per thousand delivered site.

No. of bricks required per m²

Bricks (all stretchers) as calculated before	*60*
Add for headers (alternate headers and stretchers) approx. $\frac{1}{3}$ *of 60*	*20*
	80

Material

	£
Bricks, 80 at £17.50 per thousand	*1.40*
Waste 5%	*0.07*
Mortar, 0.035 m³ for building	
0.005 m³ for pointing	
0.04 m³ at £4.29 m³	*0.172*
Carried forward	*1.642*

		£
	Brought forward	*1.642*

Labour

Laying

2 labourers and 4 bricklayers each laying 55 bricks per h = 220 bricks per h

Bricklayers	£	
4 at £0.67	*2.68*	
Labourers		
2 at £0.60	*1.20*	
	£3.88 per 220 bricks	
Cost of laying 80 bricks $= \frac{£3.88}{220} \times 80$		*1.411*

Pointing

1 bricklayer will point 1.75 m² per h.
1 labourer and 4 bricklayers will point 7 m² per h.

Bricklayers	£	
4 at £0.67	*2.68*	
Labourer		
1 at £0.60	*0.60*	
	£3.28 per 7 m²	
Cost per m² $= \frac{£3.28}{7} =$		*0.468*
		3.521
Profit and oncost 15%		*0.528*
		£4.049
Deduct		
Common brickwork allowing for extra headers, $1\frac{1}{3} \times £2.08\frac{1}{2}$		*2.78*
		£1.27 m²

8. Half brick walls in skins of hollow walling in multi-colour facing bricks (P.C. £15.00 per thousand delivered site) in stretcher bond, including flush pointing as the work proceeds—m².

	£
Material	
Bricks, 60 at £15.00 per thousand	0.90
Waste 5%	0.045
Mortar, 0.04 m³ at £4.29 m³	0.172
Labour	
2 labourers and 4 bricklayers each laying 50 bricks per h including pointing = 200 bricks per h.	
Bricklayers £	
4 at £0.67 2.68	
Labourers	
2 at £0.60 1.20	
£3.88 per 200 bricks	
Cost of laying 60 $= \frac{£3.88}{200} \times 60 =$	1.164
	2.281
Profit and oncost 15%	0.342
	£2.623 m²

Cost per m² = £2.62½

9. 100 mm concrete block partition built in cement lime mortar—m².

Quote: 400 × 200 × 100 mm blocks—£0.75 per m².

	£
Material	
100 mm partition blocks, 1 m²	0.75
Waste 5%	0.038
Mortar, 0.015 m³ at £4.29 m³	0.064
Labour	
Bricklayers 0.7 h and labourer 0.35 h per m².	
Bricklayers 0.7 h at £0.67	0.469
Labourer 0.35 h at £0.60	0.21
	1.531
Profit and oncost 15%	0.23
	£1.76 m²

10. Rough cutting 100 mm concrete block partition against soffit—m.

	£
Material	
Allow ½ block per m for waste	
½ block at £0.06 per block	0.03
Mortar (say)	0.02
Labour	
1 bricklayer and attendant labourer will do 9 m per h	
9 m cost £0.67 + ½ of £0.60 = £0.97: 1 m	0.108
	0.158
Profit and oncost 15%	0.024
	£0.182 m

Cost per m = £0.18

11. Hessian base bituminous sheeting damp proof course bedded in cement mortar on brick walls overlapped 75 mm at all joinings—m².

	£
Material	
Damp proof course, 1 m²	0.30
Cement mortar, 0.01 m³ at £4.29m³	0.042
	0.342
Waste and laps 7½%	0.026
Labour	
1 h bricklayer and 0.5 h labourer per 4.25 m².	
£0.97 per 4.25 m²: 1 m²	0.228
	0.596
Profit and oncost 15%	0.089
	£0.685 m²

Cost per m² = £0.68½

CHAPTER XII

RUBBLE WALLING AND MASONRY

The following are the weights of various building stones:

	Approx. weight kg/m³
Sandstones:	
Forest of Dean, Gloucestershire	2 435
Mansfield, Nottinghamshire	2 259
Limestones:	
Ancaster, Lincolnshire	2 499
Bath, Somerset	2 082
Granites:	
Rubislaw, Aberdeen	2 643
Peterhead, Aberdeenshire	2 643

One m³ of rubble walling requires approximately 0.9 m³ of stone.

Generally a cement lime mortar is used for building masonry walls.

Approximately 0.2 m³ of mortar is required per m³ of rubble walling.

Labour Required

Allow 3 labourers for every 2 masons for building rubble walling.

Each mason will build 1 m³ in 4 hours.

Cement Lime Mortar (1:2:8)

Calculated in brickwork and blockwork section.

Cost of mortar = £4.29 per m³.

Examples

Rubble Walling

1. 500 mm random rubble wall built in cement lime mortar—m².

Quote: limestone £22.00 m³ delivered site.

		£
Material		
Stone 0.45 m³ at £22.00		9.90
Mortar 0.1 m³ at £4.29		0.429
	£	
Labour		
2 masons 4 h = 8 h at £0.67	5.36	
3 labourers 4 h = 12 h at £0.60	7.20	
	12.56	
£12.56 for 2 m³		
1 m², 500 mm thick		3.14
		13.469
Profit and oncost 15%		2.02
		£15.49 m²

Masonry

2. Granite ashlar 250 mm thick in courses 300 mm high built in cement lime mortar with 10 mm beds and joints, including pare pointing in cement mortar at a later date—m².

Quote: granite ashlar dressed at quarry £12.00 per m² delivered site.

	£
Material	
Stone, 1 m²	12.00
Mortar	
Building 0.06 m³	
Pointing 0.006 m³	
0.066 m³ at £4.29	0.283
Labour	
Building	
2.4 h 1 mason and 1 labourer per m²	
2.4 h at £1.27	3.048
Carried forward	15.331

		£
	Brought forward	*15.331*
Pointing		
0.2 h 2 masons and 1 labourer per m²		
0.2 h at £1.94		*0.388*
		15.719
Profit and oncost 15%		*2.358*
		£18.08 m²

CHAPTER XIII

ROOFING

Slate and Tile Roofing

To Calculate the Number of Slates Required

For head-nailed slates: $\text{Gauge} = \frac{(\text{Length} - 25\text{ mm}) - \text{Lap}}{2}$

For centre-nailed slates: $\text{Gauge} = \frac{\text{Length} - \text{Lap}}{2}$

For plain tiles: $\text{Gauge} = \frac{\text{Length of tile} - \text{Lap}}{2}$

The gauge is equal to the length of slate visible to the eye. The effective covering area of each slate is therefore the slate width × gauge.

In the case of 406 × 254 mm Welsh slates laid to a 76 mm lap and head nailed the calculation would be as follows:

$$\text{Gauge} = \frac{(406 - 25\text{ mm}) - 76\text{ mm}}{2} = 152.5\text{ mm}$$

$$\text{Area covered} = 254 \times 152.5\text{ mm} = 38\,735\text{ mm}^2$$

$$\text{Number of slates per m}^2 = \frac{1\,000\,000}{38\,735} = 26$$

$$\text{Number of m}^2 \text{ per } 1\,000 = \frac{1\,000}{26} = 38.5$$

Allowing for rough edges, etc. say 40 m²

Slate nails

38 mm copper or galvanised slate nails weigh 3.18 kg per 1 000, i.e. 320 nails to 1 kg.

Labour Constants

2 slaters and 1 labourer will fix 6 no. 10 m² rolls of felt per h.
2 slaters and 1 labourer will lay 6.75 m² of slating per h (using 406 × 254 mm slates).
1 labourer will unload and stack 1 000 slates in 2 h.
1 slater will double hole 1 000 slates in 4 h.
1 slater and 1 labourer will sort and double hole 1 000 slates in 4 h.

2 tilers and 1 labourer will fix 250 plain tiles double nailed per h; 335 plain tiles single nailed per h; 500 plain tiles hung only per h.

Tile Battens

Calculate the length of timber fixed at centres required per m² as follows:

$$\frac{1\,000 \text{ mm}}{\text{centres}}$$

e.g. battens at 101.5 mm gauge $= \frac{1\,000}{101.5} = 10$ m.

Allow 1 nail to every 445 mm of timber.

Labour required

2 slaters and 1 labourer will fix 8.5 m² of battens per h at 101.5 mm centres.

Examples

1. Cover sarking with underslating felt—m².

Preambles: The underslating felt to be impregnated bituminous felt weighing 13.5 kg per roll of 10 m² to conform to BS747. The felt to be overlapped 75 mm at all joinings and fixed with galvanised nails.

Quote: £0.80 per roll of felt; nails £0.15 per kg; all delivered site. Roll size: 11.0 m × 0.9 m.

Actual area covered. Assume three end laps which will reduce the length by 225 mm and one side lap which will reduce width by 75 mm. Area covered = 10.775 × 0.825 = 9 m².

		£
Materials		
	Roll of felt	0.80
	**Nails, 0.15 kg at £0.15*	0.023
		0.823
	Waste 2½%	0.02
	Carried forward	0.843

		£
	Brought forward	0.843
Labour	*2 slaters and 1 labourer will fix 6 rolls per h*	
	£1.94 per 6 rolls: 1 roll	0.323
		1.166
	Profit and oncost 15%	0.175
		£1.341 per 9 m²

Cost per m² = £0.15

* Felt is not usually fixed securely as it will be held firmly in position by slate nails when the slates are laid.

2. Slate roof with 406 × 254 mm Welsh slates—m².

Preambles: All slates to be machine drilled, double holed and double head nailed to sarking with 38 mm galvanised nails and laid to a 76 mm lap.

Quote: Slates £60 per 1 000; nails £0.15 per kg; all delivered site. Number of m² per 1 000 slates as previously calculated: 40.

		£
Material		
	Slate cost per m² $= \frac{£60.00}{40}$	1.50
	Nails (320 per kg)	
	26 slates per m² = 52 nails	
	0.2 kg at £0.15	0.03
		1.53
	Waste 5%	0.077
Labour	*Unloading and stacking: 1 labourer 2 h.*	
	2 h at £0.60 per h = £1.20 per 1 000: 26 =	0.03
	Carried forward	1.637

Brought forward		1.637
Holing: 1 slater 4 h. 4 h at £0.67 per h = £2.68 per 1 000: 26 =		0.069
Laying: 2 slaters and 1 labourer 6.75 m² per h. 6.75 m² cost £1.94: 1 m²		0.287
		1.993
Profit and oncost 15%		0.298
		£2.291 m²

Cost per m² = £2.29

3. Form double eaves course—m.

		£
Material		
5 slates per m, including waste		
5 slates at £60.00 per 1 000		0.30
Labour		
0.75 h tradesman and 0.38 h labourer per m	£	
0.75 h at £0.67	0.503	
0.38 h at £0.60	0.228	
		0.731
		1.031
Profit and oncost 15%		0.154
		£1.185 m

Cost per m = £1.18½

4. Square cutting slating round openings—m.

	£
Material	
Additional waste of about 30 slates per 50 m	
30 slates at £60.00 per 1 000	1.80
Carried forward	1.80

		£
Brought forward		1.80
Labour		
20 h slater and 10 h labourer per 50 m	£	
20 h at £0.67	13.40	
10 h at £0.60	6.00	
		19.40
		21.20
Profit and oncost 15%		3.18
		£24.38 per 50 m

Cost per m = £0.49

5. Tile roof with 267 × 165 mm concrete plain roofing tiles laid with a 64 mm lap, each tile double nailed with 38 mm steel wire nails and hung on and including 38 × 19 mm softwood tiling battens—m².

Quote: Tiles £15.00 per 1 000; nails £0.15 per kg; battens £0.07½ per m, all delivered site.

Length of battens required per m², as previously calculated: 10 m.

No. of tiles required:

$$\text{Gauge} = \frac{\text{length of tile} - \text{lap}}{2} = \frac{267 - 64}{2} = 101.5 \text{ mm}$$

Area covered per tile = 165 × 101.5 mm = 16 748 mm².

$$\text{Number of tiles per m}^2 = \frac{1\,000\,000}{16\,748} = 60$$

$$\text{Number of m}^2 \text{ per } 1\,000 = \frac{1\,000}{60} = 16.67 \text{ m}^2.$$

Allowing for edge joints not being tight: say 17 m².

		£	£
Materials			
Battens			
	Battens, 10 m at £0.07½ per m	0.75	
	Nails, 30 nails, 0.1 kg at £0.15	0.015	
		0.765	
	Waste 2½%	0.019	
			0.784
Tiles			
	Tiles per m² = $\frac{£15.00}{17}$ =	0.883	
	Nails (320 per kg) 60 tiles per m² = 120 nails 0.4 kg at £0.15	0.06	
		0.943	
	Waste 5%	0.047	
			0.990
Labour			
Battens			
	2 slaters and 1 labourer 8.5 m² per h £1.94 per 8.5 m²: 1 m²		0.228
Tiles			
	Unloading and stacking 1 labourer 2 h per 1 000 2 h at £0.60 = £1.20 per 1 000: 60		0.070
	Laying: 2 slaters and 1 labourer 250 plain tiles per h £1.94 per 250 tiles: 60		0.474
			2.546
	Profit and oncost 15%		0.381
			£2.927 m²

Cost per m² = £2.93

6. Tile roof with 413 × 330 mm concrete interlocking roofing tiles laid with a 76 mm lap, each tile single nailed with 38 mm steel wire nails and hung on and including 38 × 19 mm softwood tiling battens—m².

Quote: Tiles £80.00 per 1 000; nails £0.15 per kg; battens £0.07½ per m; all delivered site.

Length of battens required per m² $= \frac{1\,000}{337} = 3$ *m.*

No. of tiles required

Gauge = length of tile — lap = 413 mm — 76 mm = 337 mm*

Area covered per tile = 337 × 292 mm† = 98 404 mm²

Number of tiles per m² $= \frac{1\,000\,000}{98\,404} = 10.2$

Number of m² per 1 000 $= \frac{1\,000}{10.2} = 98$

		£	£
Materials			
Battens			
	Battens 3 m at £0.07½	0.225	
	Nails (allow)	0.005	
		0.230	
	Waste 2½%	0.006	
			0.236
Tiles			
	Tiles per m² = $\frac{£80.00}{98}$	0.816	
	Nails (320 per kg) 10 nails at £0.15 per kg	0.005	
		0.821	
	Waste 5%	0.041	
			0.862
	Carried forward		1.098

* Interlocking tiles are single lap tiles.

† Width of tile — side lap, i.e. 330 mm — 38 mm = 292 mm.

Brought forward 1.098

Labour

Battens

2 slaters and 1 labourer 28 m² per h

£1.94 per 28 m²: 1 m² 0.069

Tiles

Unloading and stacking

1 labourer 2.25 h per 1 000

2.25 h at £0.60 = £1.35: 10.2 0.014

Laying

2 slaters and 1 labourer 160 tiles per h

£1.94 per 160 tiles: 10.2 0.124

1.305

Profit and oncost 15% 0.196

£1.501 m²

Cost per m² = £1.50

7. Black tile ridge bedded and pointed in cement mortar—m.

Quote: 500 mm length—£0.25 each delivered site.

	£
Material	
1 length	0.25
Mortar and waste (say)	0.05
Labour	
2 slaters and 1 labourer lay 30 lengths per h	
30 lengths cost £1.94: 1 length	0.065
	0.365
Profit and oncost 15%	0.054
	£0.419 per 500 mm length

Cost per m = £0.84

8. Standard asbestos cement corrugated sheeting to pitched roof fixed with 8 mm galvanised hook bolts and nuts with lead cupped and asbestos washers to steel angle purlins—m².

Quote: Asbestos cement sheets £0.50 per m²; 8 mm galvanised hook bolts and nuts £2.00 per 100; lead cupped washers £0.50 per 100; asbestos washers £0.15 per 100.

Calculated on sheet size of 3.00 × 0.762 and 950 mm purlin spacing.

Allow for 115 mm side laps and 150 mm end laps.

Actual size: 3.00 × 0.762 2.286

Actual area cover: 2.850 × 0.647 1.844

0.442 = 20% for laps.

	£
Materials	
Sheeting, 1 m²	0.50
Allow for laps and waste 25%	0.125
Bolts, 3 per m² including waste at £2.65 per 100	0.08
Labour	
0.3 h tradesman and labourer per m²	
0.3 h at £1.27	0.381
	1.086
Profit and oncost 15%	0.163
	£1.249 m²

Cost per m² = £1.25

Roof Lead Work

Labour Constants

	Plumber and apprentice per m²	
	2.57 mm thick	*2.16 mm thick*
Lead flat	*2.5 h*	*2.25 h*
Lead gutter	*2.75 h*	*2.5 h*
	Plumber and apprentice per m	
Lead flashings	*0.65 h*	
Lead wedging	*0.1 h*	
Copper nailing	*0.15 h*	

9. 2.57 mm Sheet lead covering wood flat roof—m².

Quote: 2.57 mm sheet lead £4.80 per m², delivered site.

	£
Material	
Lead 1 m²	4.80
Waste 2½%	0.12
Labour	
2.5 h 1 plumber and 1 apprentice	
2.5 h at £1.21	3.025
	7.945
Profit and oncost 15%	1.192
	£9.13½ m²

10. 2.16 mm sheet lead flashing 150 mm wide and with 150 mm laps, including clips—m.

Quote: 2.16 mm Sheet lead £3.80 per m², delivered site.

	£
Material	
Lead 1 m 150 mm wide at £3.80 per m²	0.57
Allow for laps and clips 5%	0.029
Waste 2½%	0.014
Labour	
0.65 h 1 plumber and 1 apprentice	
0.65 h at £1.21	0.787
	1.40
Profit and oncost 15%	0.21
	£1.61 m

CHAPTER XIV

CARPENTRY

Labour and Material Constants

	Per m³		Per 10 m	
	Nails kg	*1 carpenter* h	*Nails* kg	*1 carpenter* h
Plates	1.6	8.75	0.05	0.25
Floor and roof joists (100 mm × 50 mm to 150 mm × 50 mm)	3.2	14.0	0.20	0.80
Floor and roof joists (200 mm × 44 mm to 200 mm × 50 mm)	1.6	10.5	0.15	0.90
Floor and roof joists (175 mm × 63 mm to 300 mm × 50 mm)	1.6	8.75	0.20	1.10
Standard partitions (75 mm × 50 mm, 100 mm × 50 mm)	3.2	15.75	0.15	0.70
Ceiling joists and collars	3.2	17.5	0.15	0.90
Rafters	3.2	17.5	0.15	0.90
Purlins, ceiling beams and struts	3.2	14.0	0.25	1.10

	Nails kg	*1 carpenter* h
Per m²		
Sarking	0.3	0.45
Grounds	0.1	0.35
Per m		
Herring bone strutting	0.2	0.50
Solid strutting	0.1	0.25
Tilting fillets (50 mm × 40 mm)	0.3	0.15
Raking cutting sarking	—	0.15
Per Number		
Joints in joisting	—	0.25

Examples

1. *100 × 25 mm Red pine wallplate—m.*

Quote: Timber £30.00 per m³ delivered site.

	£
Materials	
Timber, per m³	30.00
Waste 5%	1.50
Labour	
8.75 h carpenter at £0.67	5.862
	37.362
Profit and oncost 15%	5.604
	£42.966

Cost per m $= \frac{2.500}{1\,000.000} \times$ £42.966 = £0.11

2. *150 × 50 mm White pine floor joists—m.*

	£
Materials	
Timber, per m³	30.00
Nails, 3.2 kg at £0.12½ per kg	0.40
	30.40
Waste 5%	1.52
Labour	
14 h carpenter at £0.67	9.38
	41.30
Profit and oncost 15%	6.195
	£47.495

Cost per m $= \frac{7.500}{1\,000.000} \times$ £47.495 = £0.35½

3. *200 × 63 mm White pine floor and roof joists—m.*

Quote: 250 × 50 mm W.P. joists—£0.37½ per m delivered site.

	£
Materials	
Timber, 10 m at £0.37½ per m	3.75
Nails 0.2 kg at £0.12½ per kg	0.025
	3.775
Waste 5%	0.189
Labour	
1.10 h carpenter at £0.67	0.737
	4.701
Profit and oncost 15%	0.705
	£5.406 per 10 m

Cost per m = £0.54

4. *Labour trimming 150 × 50 mm floor joists to chimney breast and hearth 1.5 × 1.2 m overall—No.*

Allow for 5 joints.

	£
Labour	
1.25 h carpenter at £0.67	0.838
Profit and oncost 15%	0.126
	£0.96 No.

5. *100 × 50 mm White pine rafters—m.*

	£
Materials	
Timber, per m³	30.00
Nails, 3.2 kg at £0.12½ per kg	0.40
Carried forward	30.40

	£
Brought forward	30.40
Waste 5%	1.52
Labour	
17.5 h carpenter at £0.67	11.725
	43.645
Profit and oncost 15%	6.547
	£50.192

$$\text{Cost per m} = \frac{5.000}{1\,000.000} \times £50.192 = £0.25$$

6. *200 × 50 mm White pine valley rafters including cutting and fitting ends of rafters to same—linear m.*

	£
Material	
Timber, per m³	30.00
Nails, 3.2 kg at £0.12½ per kg	0.40
	30.40
Waste 2½%	0.76
Labour	
31.5 h carpenter at £0.67	21.105
	52.265
Profit and oncost 15%	7.84
	£60.105

$$\text{Cost per m} = \frac{10.000}{1\,000.000} \times £60.105 = £0.60$$

7. *230 × 25 mm White pine ridge board including cutting and fitting ends of rafters to same—m.*

Cost per m³ as rafters = £50.192

$$\text{Cost per m} = \frac{5.750}{1\,000.000} \times £50.192 = £0.29$$

8. *16 mm White pine sarking in batten widths nailed to rafters—m².*

	£
Material	
Timber, per m³	30.00
Waste 2½%	0.75
	£30.75 per m³

	£
Material cost per m² 16 mm thick =	
$\frac{16}{1.000} \times £30.75 =$	0.492
Nails 0.3 kg at £0.12½ per kg	0.038
Labour	
.45 h carpenter at £0.67	0.302
	0.832
Profit and oncost 15%	0.125
	£0.95½ m²

9. *38 × 25 mm White pine open spaced grounds at 400 mm centres plugged to brick walls—m².*

Allow for plugs at 600 mm centres.

A 2 500 mm length at 400 mm centres covers—2 500 × 400 = 1 m².

A length of ground 2.5 m long has 5 plugs.

	£
Material	
Ground 2 500 mm at £0.04 per m	0.10
Plugs (say) 5 at £0.01½	0.075
Nails 0.1 kg at £0.12½ per kg	0.013
	0.188
Waste and slips 5%	0.01
Carried forward	0.198