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PRINCIPLES OF ENGINEERING MEASUREMENT TEACHING MATERIALS

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QUS 202 PRINCIPLES OF ENGINEERING MEASUREMENT

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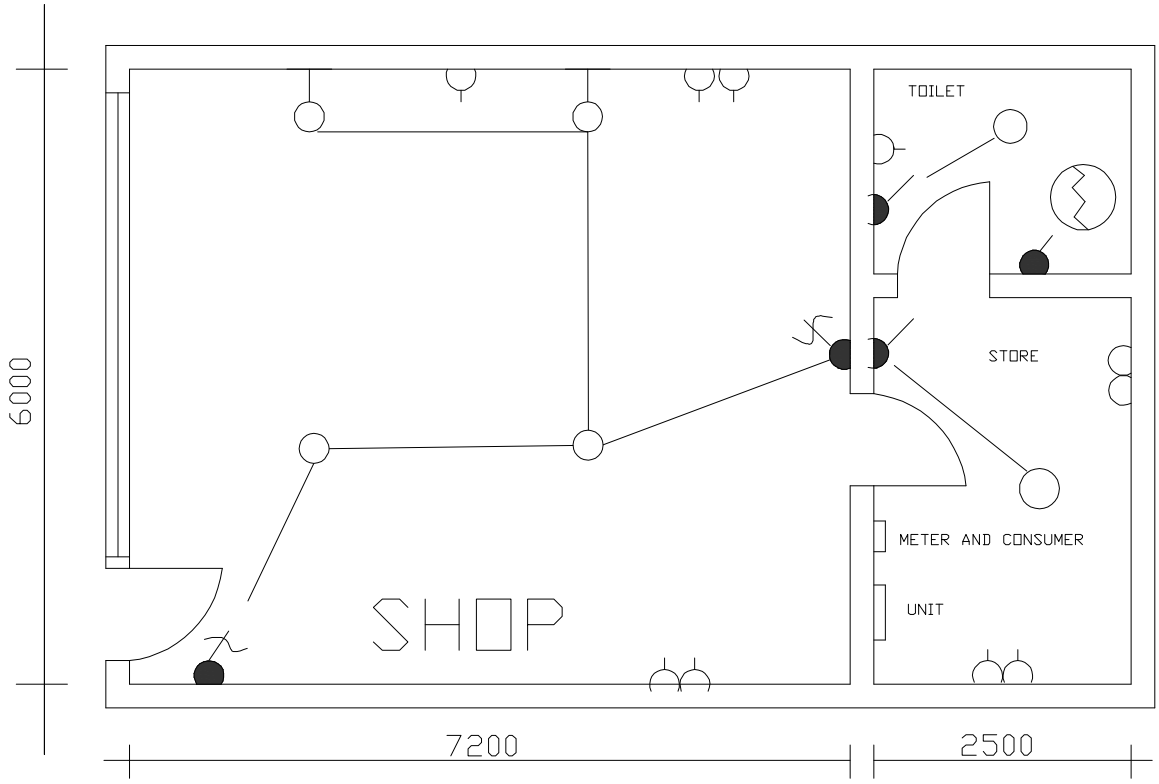


Fig 1

Construction

Walls	Brick and concrete block throughout.
Floors	Concrete with cement and sand screed
Roof	Timber joisted flat construction
Height	Finished floor to ceiling height ï 2700mm

Specification

The following represents a brief specification to indicate the general requirements for the installation but in order to price work in the commercial world a fully detailed specification would be prepared and issued with the Bill. Such a detailed document is beyond the scope of this book but referenced to a hypothetical full specification are made in some of the items in the worked example where this would happen in practice.

Voltage	230volts 50Hz AC mains provided by public electricity authority
Enclosure	Heavy gauged mild steel screwed conduit which acts as earth continuity.
Cable	PVC insulated single core cables drawn into conduit and clolour coded as appropriate.
Lighting	To be wired in two 5amp circuits in $1mm^2$ cables.
Power	To be wired in two 30amp ring circuits in $2.5mm^2$ cables.
Water Heater	To be wired in one 15amp radial circuit in $2.5mm^2$ cables.
Consumer Unit	Surface type metal clad with 60amp main swich and 6 ways (5 per distribution sheet and one spare way).
Main Cables	To be wired in $10mm^2$ cables protected by short length of trunking between meter and consumer unit.
Accessories	Switches, ceiling roses and power outlets to be white plastic pattern.
Regulations	The installations will comply with the latest IEE Regulations for Electrical installations: Regulations for the Electrical Equipment of Buildings.

Location	Lighting							Power			Water Heater		Remarks
	Circuit	Points		Switches		Lamps		Circ. no	13amp Single SSO	13amp Double SSO	Circ.no	15amp Spur	
		Type	Nr	One way	Two way	Nr	Watts						
Shop	1	Ceiling	2		2	2	60	3	2	2			Circular Fluorescent
		Wall	2			2	150						
Toilet	2	Ceiling	1	1		1	100	4	1		5	1	
Store	2	Ceiling	1	1		1	100	4		2			
Totals			6	2	2	6			1	4		1	

Fig. 2

General Background

The measurement of electrical services poses many of the same problems as the measurement of mechanical services. In fact the two are often grouped together and referred to as ómand e servicesô as a collective term. It is unusual, however, for the work to be carried out as separate contracts and to be designed by separate specialist engineers. It is quite common for the surveying duties within a quantity surveying or consulting engineerôs practice to be handled by separate specialist surveyors. There is a good deal of commonality in the approach to bill preparation.

A sound knowledge of electrical technology is required to understand the specification and to interpret the schematic drawings provided by the consulting engineer. A detailed knowledge of the lEE regulations for the electrical equipment of buildings and a knowledge of circuitry and wiring systems is essential so that trunking, tray and conduit runs can be plotted and the correct number of cables required measured for the two groups of services.

Measurement Procedures

The procedure for taking off electrical work is similar to that described for mechanical services (chapter 8) and therefore has not been repeated. A sound, systematic and logical approach with, possibly, the use of measurement schedules are the main requirements.

Where circuits are to be measured in detail, such as circuits other than lighting and small power, the route of the conduit and/or cable must be plotted on the plan or tracing overlay and the number of cables indicated. This sketch will then form a record of what is taken. An isometric sketch is often useful (as with pipework) to illustrate complex

runs. Conduit and/or cable runs should be plotted using a standard nomenclature to illustrate high Level, low level, rise, fall and number of cables. A suggested notation system is shown in the schedule overleaf.

When plotting conduit and cables it is usual to draw runs at right angles to each other rather than running diagonally. This is usually necessary because of the nature of the structure through which the conduits and cables are passing, as for example following joists or beams. Conduits and cables can sometimes be laid diagonally where running in floor screeds or in pitched roof spaces. Once the route has been plotted and the specification fully understood, the measurement is, as with mechanical services, relatively straightforward comprising basically enumerated items of equipment and final circuits and linear items of conduit, cable trunking, cable tray and cable, on more complex systems, all measured in accordance with the rules prescribed in SMM7.

Within the constraints of space in this book the worked example can only be an introduction to the subject although it introduces as many variations as possible. The main task facing the traditionally trained quantity surveyor is to develop his knowledge of technology as the measurement techniques involved are comparatively simple.

Before going into the procedures of measurement, let us briefly identify the items often contained in electrical installation in line with section 4 of the SMM which classified electrical work as follows:-

Incoming Services up to but Excluding Main Medium Voltage Switch Gear

This aspect of electrical installation includes linking the installations in the premises to the NEPA over or underground cable along the street or road. For domestic installation, this involves supplying load at 240V to the premises. This part of the installation whether domestic or industrial is generally undertaken by NEPA and the items involved are:-

Services cable- This is the conductor through which electric current is supplied to the electrical installation in the premises. The size of the cable depends on the power demand or load of the installation within the premises and it is the responsibility of the designer to determine it.

Main Fuse (cut out)

This is used to effectively control the electricity supply into the premises in case of excess current or if serious earth fault occurs and for temporarily disconnecting power from consumers premises in case of default in payment of electrical bills.

Meter

This measure the extent of power used by the consumer on the basic of which NEPA prepares the consumer bills.

Statutorily, no person other than NEPA official is allowed to temper with the above stated items which are generally referred to as NEPA installations

(1) **Standby Equipment**

Standby equipments are mostly installed to function only when the existing power source fails or is shot down for maintenance or the like. Electricity generator set may only function when NEPA supply is off. There may be two of such generators with each working for a particular number of hours before the other takes off. An equipment such as transformer could also be two with one working continuously while the other is only put into use when the former has some fault. In most cases the standby equipments are completely installed and are differently from items kept in the store which are generally regarded as spares.

Mains Installation Excluding Final Subcircuit

The mains is a continuation of NEPA incoming upto and including a point where the first distribution is made. Thus, in a small domestic installation with only consumer unit or distribution board the mains is from the main switch upto and including the consumer unit or distribution board.

But for large installation with medium voltage (M.V). Boards which supplies say six distribution boards, the mains is from where the NEPA equipment stopped up to and include the M.V board. The distance from the M.V board (excluding the M.V board) up to and including the distribution boards are often referred to as submains. Hence for industrial or large electrical installation the basic items often contained within the mains and submains include:-

- High tension panel
- Transformers
- Medium voltage panels distribution boards
- Cables, cable tray, trunking or
- Busbas trunking

Please note that trunking is better ise for horizontal movement of large cables and also vertical movement where very limited number of cables is involved. The cable cable tray is mainly used for vertical movement of cables where large number of power cables are involved. The generator set, H.T panel and transformers usually require some solid support details of which are worked out by the structural engineer. Generally, what constitutes mains and submains depend to a large extent on the size and complexity of the electrical installation

Preparation of Schedule of Materials

More than not, clients, with particular reference to the private ones, do request for schedule of materials to enable them procure most of the materials (if not all) at the onset of electrical installation works to be executed by labour only contract. It will be absurd for a practicing Quantity Surveyor to say such work does not fall within his field or duties as a Quantity Surveyor. Hence, there is every need for the Quantity Surveyor to understand every bit of electrical installation drawings so that he can pick the quantities with ease and certainty. It may be necessary to state here, although briefly, that the routes of the conduit which is the same for cable is often not shown. This usually makes the exercise more difficult, leaving the taker off to use his experience. Hence if five engineers or Quantity Surveyors are given the same set of drawings, it is rare for them to come up with exactly the same quantity for each size of cable. The above not withstanding, there is a reasonable assumption that the routing which could result in good measurement. The items involved in powers final subcircuit are as follows:-

- **Conduit Including Boxes, Screws, Saddles, Couplers, Mole Bushes etc.**
- **Cables**
- **Socket**

The routes of the conduit is determined by, the circuit. All power outlets i.e. socket outlets having the same symbol number, belong to the same circuit and should be linked together with a conduit.The number of cables in a circuit as shown in the schematic drawing for the distribution board or consumer unit determines the number of cables to be combined in a conduit pipe.

Socket outlets represent points where electrical appliances are plugged. The type and make are usually specified. Note that socket outlets are usually 450mm average high above the floor level**.**

The conduit and cable make up the final subcircuit for power installation In other words power final suhcircuit covers the distance from the distribution board or consumer unit (excluding the D/B or C. U.) up to the socket outlet point but excluding the socket. The number of cables in circuit depends on the type of installation, whether surface or conduit. If conduit, the type- metal or PVC. In surface wiring, the cables are usually 3 core cables with one core being live, the second being neutral while the third serves as earth. The live; supplies current from the distribution board or consumer unit and it contains current at all times when the power source is on. The neutral is the return path fort the Current and it only contains current the circuit is on. The earth cable only conveys current to earth when there any leakage within the circuit. Such current is conveyed to earth to rninimise any damage that might be caused

If the installation is in conduit, then multi core cable is not used. Rather, single core cables are used**.** Three number of single core cable is used if PVC conduit is used. But if galvanized or any other metallic conduit is used, only two cables are used with the conduit acting as earth continuity conductor. The type of circuit may also determine the number of cables within **a** circuit. The circuit could be radial or ring mains. The radial circuit, depending on the type of wiring earlier discussed starts from the distribution board or consumer unit and serve all the socket outlet(s) within, the circuit**,** unlike the radical circuit, it does not terminate at the last or socket outlet in the circuit but returns to the distribution board or consumer unit there after**.** Ring circuit is commonly used for socket outlets**.** It is pertinent to state here that radial or ring circuit is usually not mentioned in the drawings but only Indicated in terms of the number of cables leaving the distribution board or consumer unit.

Lighting installation. Lighting Installation include: Conduits Cables Switches for Controlling the Lights Lighting Fittings

Like power final subcircuit, lighting final subcircuit covers the distance from distribution board or consumer unit (excluding the D/B or C.S.) up to the lighting stint but excluding the lighting fitting. The, number of Cables in a circuit also depends on the type of installation and circuit**.** Unlike, the power final subcircuit**,** lighting final subcircuit often contains two cables live and neutral. Earthing is usually restricted to heavy lighting fitting such as chandelier lighting fittings, sun lighting fittings etc

Radial circuit is mostly used for lighting fitting and lighting points are connected by looping-in many cable joints are only effected at in outlets or junction boxes**,** with connectors and not inside the conduit or along the length of surface wiring**.** The number of switches within a circuit depends on the function of the spaces to which the circuit is connected. For instance if there are four switches within a circuit, it should**,** be noted that the two cables from the distribution board or consumer unit will first stop at the nearest lighting point within the circuit, the live will be dropped at the switch controlling the light point(s) from where two cables will be taken up to the same lighting point. One of the ótwo cables contains live from the D/board while the other which is called ñbranchò is tapped from the former and it is *c*ontrolled by the switch**.** The latter is connected to all the lighting points that switch is to control while the former (the continuous one) is taken to the next switch. The same thing is repeated until the last switch which terminates the continuous line. The neutral does not come to the switch, rather, it is looped from one lighting point to another without any break in continuity.

Switches are described terms of rating the number of gangs and ways. The gang is the nob with which the switch is switched off or on. Some switches contain one, two, three or more gangs with each gand controlling different light(s). The ways define the ón position(s) of the switch**.** If light point(s) are controlled by a switch with just one ñonô position, such switch is regarded as one way switch**.** But if a set of Lights are controlled by two switches each with no fixed on position, such switches are called 2 way switches. If between the two way switches there is a third switch which controls the same set of light points, such

switch is called intermediate switch. Lighting fittings are often described in line with their support. For instance you have ceiling mounted fitting, wall mounted fitting, wall brackets etc.

1.5 Electric Heating Installation

A greater proportion of this aspect of installation is connected with mechanical installation. The area mainly concerned with electrical installation is the final subcirciut installation and connection to the electric boiler or heater pipe work and duct work (if required).

The pipes, duct work, boiler or heater more often than note are included under mechanical or plumbing measurement.

Electrical Appliances

Electrical appliances include among others cooker units, dish washing machine, laundry machine, etc.

Electrical Work Associated With Plumbing And Mechanical Engineering Installations

This aspect of the work include the connection of the following to electrical installation:-

Cold Water Pumps

Hose Reel Pumps

Air Conditioner Condensing Unit,

Air Handling Unit

Connection to Heavy Machines e.t.c

The connection of heavy equipments to electrical installation is usually done when conduit is already in position. Any adjustment for external distance not covered by initial conduit is usually made up with flexible conduit.

Thus, the items involved include:-

Conduit including flexible conduit

Cables

Control such as Staters.

Telephone Installations

The items under this section of work often include:

Conduit Coaxial Cables

Telephone Panels

Distribution Frames

Hand set and

Uninterrupted power supply (UPS) and Others.

The schematic for telephone usually shows the number of pairs of cables that serve each of the telephone equipment. The cable is often distributed using conduit or trunking sketing. The type specified should be carefully noted.

Clock Installation

The items involved include:

Conduit work if not surface

Wiring

Cables

Clocks

Uninterrupted Power Supply including charger.

The installation of the conduit and cable are similar to the ones stated earlier.

Sound distribution system

This involves the installation of public address systems such as loud speakers and microphones in churches and mosques.

The items include:-

Conduit Work if not surface

Wiring

Cables

Equipment

Unlike lighting or power installations most of the conduit and cable work under this section of the work are directed towards the equipment which produces the sound and they do not convey electricity.

Thus, the cables and conduit invoved do not fall under the final subcircuits stated under section S.21.2 of the NIQS SMM.

Alarms System Installation

This include fire alarm, the panel is connected to the various alarm bells and break glasses with cables commonly in conduits. Thus the item invoved in fire alarm which is the most alarm system include.

Conduit Work (if specified)

Cables

Break Glasses

Alarm Bell

Fire alarm panel. The panel contains some zones which are similar to the number of ways of the distribution board. The zoning system helps to indicate problems area within the premises for easy control. For instance, in high rise buildings say 14 storey office block, if there is fire in any of the floors, the moment the glass in that floor is broken, alarm is raised in the building with the panel showing the floor where such was detected. Smoke or heat detectors may also be incorporated into the alarm system. They trigger the moment heat or smoke is sensed in any of the zones.

The drawing may only indicate the location of the equipment, break glass, alarm bell, heat and smoke detectors but detailed description could be obtained from the specification and in case there is one, request to that effect should be sent the service engineer.

Earthing System

Installation

Earth (soil) offers least resistance to the flow of electricity. Each circuit within the distribution board, medium voltage panel including other distribution equipments are protected with circuit breaker. Each circuit breaker has a predetermined level of current it can carry and any excess current breaks the fuse thereby breaking the circuit which means stoppage of electricity flow. All the equipments are connected the earth cable or metal conduit which in turn is connected to the earth through earth rod or directly as the case may be. When there is any leakage, i.e. if the live wire is touching any undesired metal within the circuit and it gets in touch with the earth cable or galvanizes conduit, the

current flows at a faster rate into the earth. The flow could be such as to cause the fuse to break before much harm is done. Hence all electricity installations are always required to to be earthed as a safety device. The period within which the whole process happens could be few seconds or minutes. The items usually required include:

Earth rod

Test clamps

Conduit

Earth cables

Copper earth tape and other

Accessories

Lighting Prevention System

This is protective device against lighting. The installation contains:

Copper tape

Copper earth rod including test champs

Air termination points such as copper a pikes or radio- active type such as, p3, p4, etc. including accessories

The air terminal is mounted on the roof. Cable and conduit are not involved.

Special Services

These may include central antenna system and the like. Items of central antenna include:

Aerial

All channel amplifier

Current

Splitters

Television outlet

Aerial cables

Conduits.

Trunking ducting cable trays associated with more than one installation.

This often happen in large installation where cable for lighting, power, telephone equipment located at roof such as lift motor, chillers for central air-conditioning as well as air handling units are conveyed through the same trunking ducting and cable trays.

With the foregoing, perhaps it may be easier to understand the basic procedure for the measurement of electrical installation.

Procedure for the Measurement of Electrical Installation.

Like the main bills of quantities, the measurement of electrical installation could be base on trade or function of thee installation. Under trade system, all the cables require for installation are classified and grouped together. While under the function system similar to the elemental system, the measurement is carried out under sub-headings previously discussed. The advantage of the later is that the problem of cross checking under measurement often complained about by the services contractor as well as in term valuation are made easier in addition to others including material control on the part of the contract or labour only contract. The advantage of trade system is that it make it difficult for the client or any of his agents to discover any under or over measurement in such items as conduit and cables as quantities from different sections are lumped together. Hence the system is the most services engineers and in experienced quantity surveyors.

Our discussions shall be based on the SMM, which prefers measurement under the system similar to elemental system.

Sections S.I.

This deals with the basic information which prefers be provided and were previously discussed.

Plant

Under section S.2. The services sub-contractor is expected to allow for bringing to site as well as the removal from site the plant required for the work such as bending and dicing machine, and others. In to make valuation easier, the bringing to site and removal from site of all the plant required for the work could each be made an item. An item is also required to be allowed for maintenance on site with plant required for the work.

Incoming services up to but excluding switch gear

A earlier mentioned, all the items required for this section of work including the actual execution are the responsibility of NEPA although not without payment and such payment is often regarded as NEPA connected fee and it should be covered with provisional sum (section B, 11 and S.20) for such sum to be realistic, approximate quantity of the items required could be obtained and priced at current market prices including some adjustment for fluctuation in prices of materials.

Equipment and Controls

Under this sub-heading such items as generator set, H.T. panel. M.V. panel, transformer. Distribution Boards, etc, could be measured. The distribution of equipment is usually not difficult as it is based on the specification.

Where the specification for an item is too voluminous, a precise description of it including reference to the specification or manufacturer catosole in the bill of quantities could be adequate. The description M.V. panel and distribution boards should include the incoming and the outgoings. Fig1 shows schematic drawing for a distribution board.

The incomer to the distribution board in fig1 is 60 A300MA trip ELCB while the outgoing are:

4 No 10A TPEN MCB

3 No 15A TPEN MCB

3 No 20A TPEN MCB

2 No spares.

In addition, the description should include fixing of the D/Board to wall and the nature of the wall (see section S.6.).

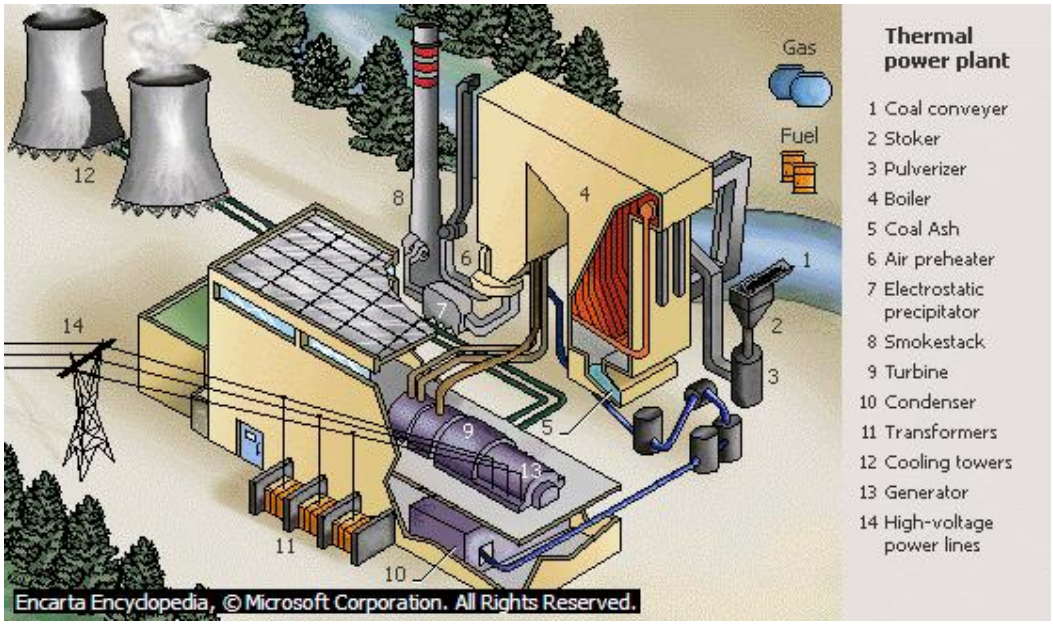
Having measured all the equipment including the distribution boards, the associated cables area then measured.

You should note the drop of the cable from the source of supply as well as the rise at the point of entering into the equipment or distribution board to which it is connected. Ensure that an allowance of 0.6m is added for each point of entering or leaving the equipment including distribution board (see section S.17.b). For external work requiring cable joined to make up the distance, such joints are enumerated stating the type and size of the cable including joint boxes, sealing boxes and the like required by the cable jointers. (See section S.174).

The cable termination glands used to ensure earthing continuity of the armoured cable at the point of entering the feeder pillar or busar chamber is numerated (see section S.17.6). It is usually one per feeder pillar or busbar chamber. Please note that it is the wire in the armored cable that is exposed and passed through the cable gland, which is fixed, to the cable entry or exit point in the casing. The three conductors in the armored cable are each connected to the bars in the feeder pillar or busbar chamber with the aid of line taps often called cable lugs. The line taps or cable lugs are enumerated stating the type and size of the cable including the shrouds. (Sections.17.5).

The conduit, Trunking and cable trays, like cable are measured in metres expects that there is no allowance at each equipment point. For trunking and cable trays, the finding such as extra over the trunking or cable trays in which they occur. Busbar trunking serves as a substitute for cable risers and it is measured in metres in line with section S. 13. 1 with the fittings such as the tap off boxes, tray feeder units and the like enumerated as extra over the busbar trunking in which they occur.

WEEK TWO:



2.0 Power Installation

Very often, all switches, socket out lets, Television outlets, T.V. outlet, water heater outlets, cooker control unit e.t.c. Are grouped together under switches and sockets and short coming of this system was explained earlier. Thus, for ease of understanding, power installation should include all the sockets outlet and should be measured in the following order:

Socket Outlets

Conduct

Cables

The socket conduit outlets are enumerated stating if single or twin. Single socket outlet has provision for one adaptor at a time while twin has provision for two adaptors.

As earlier mentioned, the conduit a cables from the distribution board or consumer unit to the socket outlets constitute final sub circuit and are enumerated stating the number of socket outlets points (section S.21.2e).

Thus, the description should include the type and size of conduit stating if concealed or surface, conduit boxes, type and size of cable including connectors, draw wire and other accessories.

But if cable required to be specially measured separately, the following steps should be taken:

Stating from the distribution board, take the horizontal measurements upto and including all including all socket outlets within the circuit.

Add the vertical measurement from the distribution board concrete slab often between 2.4-2.6m. Add the heights of the socket outlets from the concrete slab. A&B should give the net conduit required forte circuit, repeat same for all other circuit.

For cables, the same procedure used for conduit is adapted. As shown in figure 1 the schematic for distribution board shows the connection to the different socket outlets as well as the number of cables which is a reflection of the type of circuit. For instance, figure 1 shows 3xc2.mm2PVC Cu cable for F1-F2 meaning three number of single core 2.5mm2PVC copper cable. Thus, the measured distance the circuit covers is multiplied by three in order to arrive at the total quantity of 2.5mm2 single cable required. Note that you have to add allowance f 3x0.60 for the distribution board point and 3x0.30m for each socket outlet point.

The three with which all measurement are multiplied signifies that it is a ring circuit. i.e. live and neural plus the live that returns back to the D/B from the last socket outlets within the circuit. This again shows that there is no separate earthing meaning the circuit itself is serving as earthing. i.e. it is galvanized conduit or the like. If it were to be charged to PVC conduit, all measured lengths would have been multiplied by four as against three or the former quantity is divided by 3 to arrive at the quantity of earth cable.

Lightning Installation

The following order could be adopted;-

a) Lightning fittings
b) Switches
c) Conduit
d) Cables

The legend shows the type of lighting fittings details of which are given in the specification. The description of the lightening fittings should be very detailed including references to the catalogue of the manufacturer (s). Measurement of the conduit work under power installation earlier discussed. The final sub circuits are to be enumerated.

If otherwise is required as earlier discussed under power installation, the followings should be noted.

The conduit to lighting point leaves the distribution to the ceiling from where it is connected to all the lighting point within the circuit.

The conduit is dropped from one of the lighting points controlled by a switch to the switch outlets.

Thus, the measurement of conduit work includes taking all the horizontal measurements as well as the vertical one. The latter include the distance between the distribution board and the suspended floor or ceiling and the drop to the switches. Fig 1 shows 2xc 1.5mm2 PVC Cu cable meaning two number of single core PVC copper cable in the circuit live and neutral cables. Thus, all measurements including allowance are multiplied by two to arrive at the list switch within a circuit, al horizontal and vertical measurement to switches should be multiplied by three as against two.

The reason is that to the lighting point from where a cable (Live) is run to a switch, two cables are returned from the switch, one controlled by the switch while the other is not. The uncontrolled live with neutral is connected to a lighting point controlled by another switch as earlier discussed while the controlled one with neutral is connected to the various lighting point controlled by the switch. Be reminded that the neutral cable only connects all the lighting points and does not get to the switches.

Electric Heating Installation

The measurement of conduit and cable work under electric heating installation is similar to that under socket outlets.

Electrical Appliances

More often than no, the supply of electrical appliances as well as their installation is excluded from the bill of quantities. But where such are required to be measured,

the description should be based absolutely on the specification including the necessary preparations required for their installation.

Electrical Work Associated with Plumbing and Mechanical Engineering Installation

This aspect of work usually involve the installation of a final subcircuit to water pumps, fire pack where there is hose reel installation, float switch, borehole pump, heavy machine e.t.c. the items include conduit, cables Starter and others.

The conduit and cables are measured in inches. The starters and the like are enumerated stating the type and rating. For heavy machines, provision for flexible conduit may be necessary as earlier discussed and like other conduits, the flexible conduit is measured in meters. This may range from 0.50m to 1.50m per machine depending on the type of the machine.

Telephone Installation

The aspect of telephone installation that is included in the bill of quantities for electrical installation include the conduit work and telephone outlets. For high rise building constructed for commercial purposes, the exact telephone requirements of the potential tenants may not be known, thus by installation in that regard should be flexible. Hence the size of cable and telephone equipment are left at the description of the tenants. But where everything about telephone is required, the items required are as previously discussed.

The conduit is measured in metre and not as part of the final subcircuits which is required to be enumerated under section S.21.2. The description should be as previously discussed under power and lighting installation. The cables are measured metres stating the type and the number of pairs including if surface or drawn in conduit (section S.17.2) complete with all accessories.

The telephone outlets, panel distribution frames, hand sets, UPS and other are enumerated. Note that the description for each of the items must be based on the specification including reference to the specification and or manufacturer in the bill of quantities.

Clock Installation

The conduit and cable in the final subcircuit to clock installation are measured in meters except where such is connected to a socket outlet. The clock including other items required for the installation are enumerated. Again, the description should be based on the specification and where non is available, request to that effect should be communicated to the services engineer in charge.

Sound Distribution System

All the conduit and cables required for sound distribution system are measured in metres. The equipment including loud speakers, microphone, etc and enumerated. Again specification should be from the core of the description.

Alarm System

The conduit work as well as the cables are measured in metres. All other items including the equipment are enumerated. In the case of fire alarm system, the description for alarm bell and a break glass should include the manufacturer. Same goes for the fire alarm panel which number of zones must be stated.

Earthing System

Earthing cables and conduit including copper tapes are given in metres stating the type and size as well as other accessories in the description (section S22.2). the connection of copper tapes (conductor) to the equipment and earth rod including junctions are enumerated separately stating the type and size of the conductor (section S.22.2).

Test clamps, earth electrode (earth rod) are enumerated stating type and size including method of connection where necessary. Radius bend and in the wide dimensions of tape conductors are enumerated as extra over the conductor in which they occur.

Lighting Prevention System

The copper tape is measured in meters. The earth rod, test-clamps and air termination points are enumerated separately. Connection of the copper tape to

the air terminal and earth rod including junctions are enumerated. Radius bend and bend in wide dimensions of tape conductors are enumerated separately as extra over the conductor in which they occur. The air termination once again, is located at the roof top.

Central Antenna System

All the conduit and cables are measured in meters stating type and size, nature of background etc in the description as previously described. The channel amplifier, power source, splitters and television outlets are enumerated separately stating the type and size. Specification should be strictly adhered to as previously explained.

Trunking, Ducting and Cable Trays Associated with more than one Installation

All the trunking, ducting and cable trays associated with more than one installation are measured in metres stating the type and size in the description. The fittings such as tees, bends and the likes are enumerated as extra over the trunking, ducting and cable trays in which they occur.

Preliminaries

This aspect of the write up was deliberately kept until this point otherwise, it supposed to have been the first item in the bill of quantities. It was so term because of the general nature of the items which come under it. The items to be allowed by the contractor under preliminaries includes:

(a). Bring to site all plant requires for the work as earlier mentioned (section R.2.1)

(b). Removal from site ditto

(c). Maintaining on site all plant required for this section of the work (section R.2.2)

(d). Provision of working/shop drawing by the services subcontractor (this should be an amendment to the SMM to reflect what prevails in our environment)

(e). Provision of performance bond

(f). Provision of all necessary insurance covers stipulated in the contract conditions

(g). Preparation of ñas installed drawingsò (usually four sets) section S. 25.6

(h). Marking the position of holes, mortices, chases and the like in the structure (section R.37.2.), this is similar to setting out which is carried cut by the main contractor.

(i). Testing each aspect of installation as may be requested by the services Engineers or Architects during construction and at practical completion stages (section R 37. 5.) the preliminaries should from the first part of the bill of quantities.

External Works

For small residential installation, external works comprises security lighting fittings including the associated cables and conduit. For installations such as electrical installation in an industrial or residential estate, external work may include equipment such as H.T. panel, transformers, cables, etc. all external work should be clearly defined (section S. 5.b).

It is common practice to prepare a bill of quantities under the sub sections earlier mentioned including a subsection for external works, in this case, all sections with the exception of external work are deemed to be internal work. It is better to specifically indicate if the subsection is internal or external.

Builder's Work

It should be remembered that such work as the provision of scaffolding, storage area, hoisting, lighting for the work etc are not given under builderôs work as they are covered by attendance on the nominated subcontractor work in the main bill of quantities for the project (section B9.2-4). Builderôs work comprises the aspect of actual execution of electrical installation that concerns the builder and such include:

(a). Excavation of trenches for large cables usually between power source such as

plant/machine room located outside the building and the main building. The

measurement is as stated under section S.27.1.

(b). Cables covers in trenches often called cable tiles are measured in metres stating the type and size (Section S.27.2.)

(c). Inspection chambers may be located at a point along the running length of

external cable, where the earth rods for earthing and lighting prevention

systems are driven into the ground etc. the measurement is as stated in (section S.27.3.)

(d). Equipment supports and or bedding are usually not given details design until at the post contract stage when the necessary information on weight and size could be supplied to the structural engineer by the Services subcontractor. Plate work and supporting steel work are measured in accordance with section S.6.6. Bedding and pointing components are enumerated stating the size, composition and mix of the bedding material. (section S.27.4)

(e). Pylons, poles, hut-posts, wall brackets, pole stays and the like are enumerated separately stating the size, the method of fixing and the nature of the structure. (section S.27.8)

(f). Any other work involving the cutting of the structure such as cutting and printing ends of supports for equipment, fittings, trunking, tray and the like are enumerated stating the size of the support and the nature of the structure (section S.27.5)

(g). Allowance for cutting away and making good after the electrician on new structures is enumerated as electrical points stating the type of conduits or cable and whether concealed or exposed. Details of the measurement is as indicated under section S.27.6.

i. Boring or excavating holes in ground for poles and stay are enumerated stating the depth, the nature of filling and treatment of surplus soil (section S.27.9)

ii. Excavating pits and forming concrete bases for pylons are measured in line with section and F of the SMM (section S.27.10)

(h). Catenary cables are given in metres stating the type and size, Eye bolts, shackles and straining screws are given in the description stating the method of fixing.

Further explanation of the builderôs work stated above is not given much attention because the S.M.M section in that regard seems simplified enough until otherwise is proved.

Protection

Protecting the work in this section should be given as an item (section S.28.) Thus from the foregoing, a typical bill of quantities could be summarized as follows:

- Preliminaries
- Equipment and Controls
- Power Installation
- Lighting
- Electrical heating installation (if any)
- Electrical appliances (if required)
- Telephone installation
- Clock installation (if any)
- Sound distribution installation (if required)
- Alarm system installation (if required)
- Earthing system installation (if required)
- Lighting prevention installation (if required)

Electrical work associated with plumbing and mechanical engineering installation.

Special services such as central antenna system and the like.

Trunking, ducting cable trays associated with more than one installation.

Having discussed the basic information required for electrical installation, the various classes of work therein as well as the procedure for measurement, our next topic shall be measurement of plumbing installation in addition to responses to any request for clarification emanating from this write up.

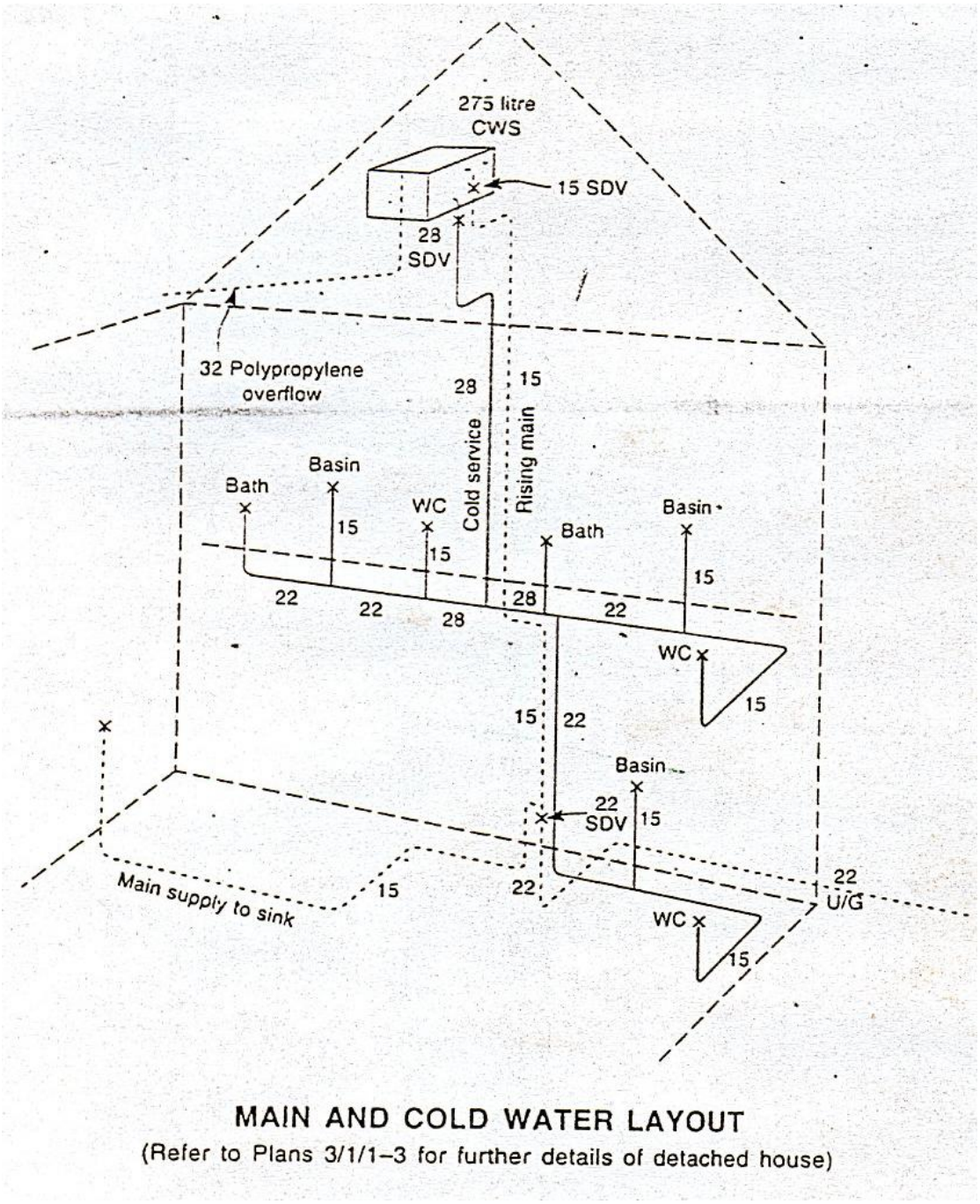
ITEM NO.	DESCRIPTION	UNIT	QTY
`	**BC coiled filament pearl lamps**		
	100 watt Store/toilet	nr	2
	150 watt Shop	nr	2
	Accessories 5 amp single pole silent action white plastic plate switches, include steel conduit box plugged and screwed to masonry.		
	One way Store/toilet	nr	2
	Two way Shop	nr	2
	General LV power		

	Cables and conduits in final circuits		
	<u>Final circuits in heavy guage MS conduit with single core 2.5mm² PVC insulated and colour coded cables, generally concealed in backgrounds comprising plastered masonry walls and screeded concrete floors.</u>	nr	2
	Switch sockets 230 volt 30 amp ring circuit	nr	1
	Immersion heater 230 volt 15 amp single outlet radical circuit. (toilet)	nr	1
	Flexible cable connection between control switch and connection box on 3000watt unit water heater, comprising three core 50/0.25mm² butyl rubber insulated and sheated flexible, length not exceeding 1.00m.		
	ACCESSORIES		
	13 amp switched single socket outlets white plastic plate pattern, include appropriate steel conduit box plugged and screwed to masonry having 1mm² copper earth connector with PVC colour coded sleeve between box and outlet.	nr	3
	13 amp switched double socket outlets otherwise as item 4/4 above	nr	4
		item	1

	Water heater control switch double pole 15 amp rating white plastic plate pattern embossed õWATER HEATERô with warning neon and outlet for flexible cord, include, conduit box with earth connector as described in item 4/4 above.	item	6
	Testing		7
	Identification and sundries N.B. items in this section of the bill refer to the whole of the foregoing installation.	nr	1
			1
	Additional bonding to extraneous metal in accordance with the IEE regulations to be priced on a lump sum basis to cover the bonding required for the plumbing and heating installations and the roller shutter to the shop front.	item	
	Marking position of holes, mortices and chases,in the structure.		
	Identification diagram of circuit system drawn in ink on paper on hardboard about 300x200mm coated in clear varnish plugged and screwed to masonry.		
	Testing and commissioning the whole installation in accordance with the IEE regulations as specification.	nr	
	Holes and chases for electrical installation	nr	
	N.B items in this section of the bill refer to the whole of the forgoing installation.	nr	
	<u>Cutting or forming holes, mortrices, sinkings and chases for electrical installation comprising concealed MS conduits and make good.</u>	nr	

	Luminaire points Socket outlet points Fitting outlet point Control gear point		

WEEK 3: 3.0 INTRODUCTION TO MEASURMENT OF PLUMBING AND MECHANICAL SERVICES



MAIN AND COLD WATER LAYOUT

(Refer to Plans 3/1/1–3 for further details of detached house)

Fig. 1

WORKED EXAMPLE 4/1 – DETACHED HOUSE
Abstract Sheets for SMM7 Section S – Piped Supply Systems

Main Supply
Note: 22 mm Underground main billed direct without an abstract as straightforward take off.

ABSTRACT NR 1 – Main supply – 15 mm copper with saddle clips; compression fittings; timber background

Location	Pipe	Made Bends	Made Offsets	Fittings 2 ends	Special Connections female bent	SDV
Roofspace Under GF 1F	2.60 4.50 1.40	1 2 2	1 1	2 1 2	1	1
Totals	8.50	5	2	5	1	1

ABSTRACT NR 2 – Main supply – copper with pipe rings: compression fittings; masonry background

Location	Pipe		Made Bends 15	Made Offsets 15	Fittings 2 ends 15	Fittings 3 ends 22	Special Connections female straight 15
	22	15					
GF Toilet GF Branch 1F Cupb. GF Sink	0.25	2.40 0.40 2.50 1.00	2 2 2	1 1 2	1	1	1
Totals	0.25	6.30	6	4	1	1	1

Commentary: Abstract Nr 1 is only concerned with one size of pipe and thus sizes can be omitted from table.
The 'Fittings 2 ends' are bent couplings and the 'Fitting 3 ends' is a tee piece 22 × 15 × 15 mm.

Fig.2

General Background

The measurement of mechanical services installations requires a detailed knowledge of technology. The drawings from which the quantity surveyor must work are those that are prepared by the consulting services engineer. Consulting engineers are required by their scale of charges to prepare drawings and specifications ósufficient to obtain tendersô. The drawings are schematic only, as it is trade practice for the contractor to prepare all necessary working drawings and to include in his tender for a complete working installation. The exact routeing of pipework and ductwork is often left to the craft operatives doing the work and the contractor will have in mind such factors as the location of other services, restrictions on space and the ease of maintenance of the completed work. In essence, the quantity surveyor must put himself in the position of the operative and include in the bill of quantities all items necessary for the complete installation. A good practical knowledge of the technology of services installations is therefore essential.

Many quantity surveying practices employ engineers within their organizations either to give advice to the taker off or to take off the quantities themselves. It is, however, generally believed that the traditionally trained quantity surveyor can acquire the necessary additional knowledge of technology by private study, attending courses, observing site installations and taking measurements on site and is then competent to prepare accurate bills of quantities for mechanical services.

Measurement Procedures

The first task in taking off, as with any other work section, is fully to study and understand the drawings and specifications provided. A study of these documents will inevitably lead to queries. These queries must first be scrutinised by the in-house engineer and/or the appropriate partner to eliminate any obvious discrepancies and must then be submitted to the consulting services engineer in the usual way. The query/answer procedure is essential for the preparation of good bills. The consulting services engineer may not be very familiar with the process and may regard the completion of the query sheets as an additional burden for which he receives no payment. Skill, tact and diplomacy are needed to limit the number and frequency of queries and to stress their benefits to the engineer, namely, that they help to remove anomalies that could cause future problems on site.

The taker off will need to make sensible approximations on occasions, where the method of working is left to the operative on site. Two examples of such approximations are firstly

whether to measure made bends or fittings and secondly what allowance to make for co-ordination of services. In the first instance one approach in practice is to measure bends only in the bill of quantities and to insert a suitable preamble to the effect that the contractor must allow in his prices for the provision of made bends or fittings as required. Another option is to state in the preambles the proportion of made bends to fittings for different classes of pipework and that the contractor must allow in his prices for any additional fittings required. The consulting services engineer should be consulted in the preparation of this schedule, and/or be requested to give guidance on likely requirements.

With regard to co-ordination it is difficult to give specific guidance. Where co-ordinated drawings are provided by the engineer the exception rather than the rule many of the problems will have been resolved and a minimal inclusion of additional pipework and bends/fittings will be sufficient. Where no co-ordinated drawings are available, however, and where services run in congested areas, the problems of co-ordination may be such that services may need to be substantially diverted requiring additional pipe- work and possibly additional builderôs work. Each scheme must be judged on its merits and, in consultation with the engineer, suitable provision should be made. Co-ordination items are best included in the hills either as approximate quantities or provisional sums in accordance with SMM General Rules 10.1 and 3.

Approach to Measurement

Having acquired adequate information and a full understanding of the scheme, taking off can begin. Firstly, the drawings should be coloured up using a suitable colour code to illustrate the various services to be measured. The drawings are mainly in the form of floor plans and it is often helpful to draw a sketch of complicated sections of the work to he taken off in isometric projection to illustrate the full extent of the work involved. These sketches provide a valuable record of the work measured and are often useful for final account purposes.

A good workmanlike method of booking dimensions and striking through work on the drawings is essential to make sure that nothing is missed. Since the work is of a repetitive nature, a schedule approach is often favoured with the items listed across the top of a sheet of abstract-sized paper and with location information given on the left-hand side. The use of schedules however has the disadvantage that the dimensions are less easy to follow and read. The traditional quantity surveying approach tends to produce reams of paper and to be time-

consuming. A sensible compromise used by some practices is to take off on traditional dimensions paper with abbreviated descriptions and to use a cut and shuffle abstract system which will cope effectively with the constant repetition of items.

A good library of reference information is absolutely essential. This will include textbooks on technology, trade literature, relevant British Standards and Codes of Practice, the current edition of the IHVE (Chartered Institute of Building Services) guide and the current edition of the Heating and Ventilating Contractorsô Associationõs Specification for Sheet Metal Ductwork.

The process of measurement is relatively straightforward, comprising enumerated items of plant at the source, a connecting network of pipework or ducting measured linearly, with enumerated fittings taken as extra over pipes and ducting, enumerated ancillaries, and finally enumerated items for the emission plant and equipment. Special supports and sleeves for pipes and ducting each generate further enumerated items. Assuming that the installation to be measured is fully understood and sufficient specification information is available, no great difficulty should be experienced provided a methodical approach is adopted throughout.

Work in plant rooms is identified separately because of the restricted working conditions (SMM *Y10120/30.M2).* Everything necessary for jointing is deemed to be included (SMM Y10/20/30.C1), and full requirements of materials shall be given as prescribed in SMM Y10/20/30.S1ð 6. Thermal insulation to pipelines and ducting is measured in metres giving the nominal size of the pipeline or ducting, while insulation to equipment is enumerated giving the overall size or measured in m2 (SMM Y50.1.1, 3 & 4.1.0).

Section Y of SMM7 must be read in conjunction with the appropriate sections of the *Code of Procedure.* The *Code of Procedure* gives examples of items which are not included in the text of SMM7. For instance, Y1O/1 1:2.4 in the Code states that examples of pipe fittings would include bends, springs, offsets, swan necks, Y-junctions, double Y-junctions, blank flanges, puddle flanges, bushes, reducers, elbows, twin elbows, tees, crosses and unions. The special significance of this item is that pipe fittings 65 mm diameter are grouped together irrespective of type, sting the number of ends. With larger fittings the type is stated (5MM Y10.2.3ð 4.2ð 6.1ð 2). In section Y10:8.1, the Code gives examples of pipework ancillaries which include draw-off taps, stop valves, control valves, regulating valves, safety valves, reducing valves, non-return valves, drain cocks, stop cocks, air cocks, mixing valves, steam traps, strainers, gauges and thermometers, and automatic controls.

The worked example in this chapter provides a fully annotated take off covering the measurement of services for a particular project, selected to give a good range of different features. Care must be taken not to apply the descriptions and other data to another project, without careful reference to the particular specification and engineering requirements of the scheme in hand.

Work Sections

The rules for the measurement of mechanical services given in Work Group Y arc billed under separate work sections as listed in Appendix B of SMM7. the requisite work sections are as follows: R Disposal systems, which include sewage pumping and refuse chutes. S. Piped supply systems, which include cold water, hot water, steam fire hose reels, dry risers, wet risers and sprinklers. T Mechanical heating/cooling/refrigeration systems which includes gas /oil fried boilers, coal fried boilers, heat pumps, solar collectors, warm air heating and central refrigeration plant. U Ventilation/air conditioning systems, which include toilet and kitchen extracts, smoke extract/smoke control and various form of air conditioning.

WEEK 4: 4.0

TAKING OFF BILLING IN RESPECT OF MECHANICAL/PLUMBING SERVICES

Pipework Generally

Pipes are classified under appropriate headings, such as hot water supply (S11 in Appendix B of SMM7 and the Common Arrangement), and measured over all fittings and branches in meters, stating the type, nominal size, method of jointing and type, spacing and method of fixing supports and distinguishing between straight and curved pipes (SMM Y10.1.1.1.0 and Y 10.MB). Pipes are deemed to include joints in their running lengths (SMM Y 10. CB), and the provision of every thing necessary for jointing (SMM Y 10. C1), without the need for specific mention. The type of background to which the pipe supports are fixed will be classified in the categories listed in SMM General Rule 8.3

Details of the kind of kind and quality of materials used in the pipes, gauge and other relevant particulars listed in SMM Y.10.S1-6, are likely to be included in preamble clause or a project specification.

Made bends, special joints and connections and fittings such as Y-junctions, reducers, elbows, tees and crosses, are all enumerated as items extra over the pipes in which they occur (SMM Y 10.2.1-4). In the case of special joints, the type and method of jointing is to be stated and they comprise joints which differ from those generally occurring in the running length or are connections to pipes of a different profile or material, connections to existing pipes of a different profile or material, connections to existing pipes or to equipment, appliances or ends of flue pipes (SMM Y10. D2).

Pipe fittings Ò65mm diameter are classified according to the number of ends, while those of larger diameter are described. The method of jointing is stated where different from the pipe in which the fitting occurs.

Valves and pipes are classified as pipe work ancillaries and are enumerated stating the type, nominal size method of jointing, type, number and method of fixing support and type of pipe to be connected (SMM Y.11.8.1.1.0). Those located in ducts and trenches are each kept separate and so described.

Cutting holes through the structure for pipes and making good surfaces are enumerated, stating the nature and thickness of the structure and the shape of the hole, and classifying the pipes as to size in accordance with SMM P 31.20.2.1-3.2 & 4; for example pipes Ò55mm nominal size, 55 -110mm and > 110mm. the cutting of holes for pipes is best picked up when the various lengths of pipe work are taken off, rather than leaving all the holes to be taken off after the pipe work has been measured complete. By contrast, painting of pipes may often, with advantage, be left to the end of the taking off.

Adequacy of Measurement

It is quite usually for parallel flow and return pipes to be shown by a single line on the engineer schematic drawings and annotated F and R with a note of dissimilar sizes that often occur. When measuring, adequate allowance must be made for bends, circumventing obstructions, and even for cold feed vent and air release pipes, plant room drains and pump by-passes, where not shown in the detail.

Equipment

When measuring mechanical equipments, such details as type, size and pattern, rated duty, capacity, loading as appropriate and method of fixing are stated. Specification cross references are often inserted from mechanical equipments as provided for in SMM Y 20/40 .1.1.1.0. How ever, the excessive use of cross references to the specification can be inconvenient to the estimator and fuller descriptions in the bill may sometimes form the better approach, although this runs contrary to the wider use of project specifications. Where insufficient data are available, the work can be covered by PC or provisional sums or bill of approximate quantities may be prepared.

Examples of equipment are listed in the *code of procedure* and include boilers, generators, water treatment and pressurization plant, tanks, cylinders, calorifiers, pumps, compressors, fans, filters, humidifiers, and refrigeration units.

Air Ductlines

Ducting is classified as to whether straight, curved stating radil or flexible, and giving the type, shape, size, method of jointing and spacing and method of fixing supports, and background, and is measured in meters as SMMY30.1.1.5.1.1. Like pipes, it is measured over all fittings and branches (SMMY30.M3), and is deemed to include joints in running lengths and stiffeners (SMMY30.C3).

Items measured extra over the ducting in which they occur include the following:

1. Lining ducting internally in meters, stating the type and thickness of lining material and internal size, ducting (SMMY30.2.1.1.0).
2. Special joints and connections, as described in SMMy30.D2, enumerated, stating the type, size, ducting size and method of jointing (SMMY30.2.2.1.1.);
3. Fittings, such as stop ends, bends, offsets, diminishing pieces, change of section pieces and junction places access opening and covers and doors; and test holes and covers are each enumerated, stating the type as SMM Y30.3-6.1.1.

Ancillaries to deducting, such as grelles, diffusers, dampers, shutters, cowls, terminals, root ventilators, attenuators and anti-vermin screens, are enumerated giving the information prescribed in SMM Y30.4.1.1.1.0,while breaking into existing ducting is given as an item, stating the type, size and location of duct and purpose of breaking in (SMM Y30.5.1.1.1-4).

Ducting sleeves are enumerated and classified and described as for pipes (SMM Y30.71-2.1.1.2).

Pipe and Deduction Supports

Pipes and deduction supports which differ from the given with pipes and ductlines are separately enumerated, giving details of the nominal size of pipe or shape and size of duct, type and size of support, method of fixing pipe or duct support and nature of background (SMM Y10.9.0.1.3 and Y30.6.0.1.3).

Builder's Work in Connection with Mechanical Installation

Builderôs work in connection with mechanical installation is identified under an appropriate heading (SMM P31.M2). Unless identified in SMM work section P30 and P31.all other items of builders work associated with mechanical installation are given in accordance with the appropriate work sections (SMM P31.M1). Where a hot water and heating installation is to be carried out by a nominated sub contractor, items will be provided to cover any specific items of special attendance required in accordance with SMM A51.1.3.1 8.1 2 classified as either fixed or time related charges. General attendance on nominated sub-contractors is measured in accordance with SMM A42.1.16.

WORKED EXAMPLE

The worked example covers the element of low-pressure hot water heating and ventilation system as illustrated on drawing 13 and described in the following extract from the specification of the engineering works, which the student is advised to study carefully.

The drawing shows more work than it is actually measured in this example, but it is considered that this provides a more realistic approach and will give the students practice in identifying specific parts of the work. In like manner extracts from an convector and grille schedules have been Inserted to illustrate their usual format even though one item is actually taken from each to avoid considerable repetition of similar items.

Extract from the Specification of Engineering Works for the

Treatment Block

1 Drawing and Document.

The contractor shall be responsible for the preparation and supply of all detail drawings for builders work, wiring diagrams and drawings of work done by other trades, require for the purpose of the installation and cost of these must be included in tender.

Within ten days of certified practical completion of the contract, the contractor shall supply to the engineer, two complete sets of as installed drawings on heavy quality lined or tracing firm and one-set of half-plate photograph negatives indicating the exact position of all plant, equipment and pipe runs as actually installed.

ITEM NO	DESCRIPTION	UNIT	QTY
	TAKING-OFF IN PRESPECT OF A SERVICE PLUMBING WORK; IN ACCORDANCE WITH SMM7.		
	COLD WATER INSTALLATION MAINS SUPPLY – INTERNAL.		
	Pipeline and pipe line Ancillaries		
1/1	Copper tubing to BS 2871 Part 1 ï table x Pipes, straight. 15mm diameter jointed with brass compression couplings, fixed to timber background with copper suddle clips at centres as specified.	m	9
½	Pipes, straight. 15mm diameter jointed as above, fixed to masonry background with brass pipe rings plugged and screwed at centres as specified.	m	6
1/3	Pipes, straight. 22mm diameter jointed as above, not fixed.		1
	Copper tubling to BS 2871 a.b.d items extra over		

	copper pipes in which they occur.		
2/1	Made bends 15mm pipe	nr.	11
2/2	Made offsets 15mm pipe	nr.	6
2/3	Fittings 15mm diameter brass compression pattern, three ends.	nr.	6
2/4	Fitting 22mm diameter brass compression pattern, three ends.	nr.	1
2/5	Special connection between 15mm pipe and male threaded equipment with brass compression, female straight connection.	nr.	1
2/6	Special joint between 15mm pipe and male threaded equipment with brass compression female bent connection.	nr.	1
2/7	Pipe work Ancillaries Brass screw down value 15mm diameter with compression joints to copper pipes.	nr.	1

ITEM NO	DESCRIPTION	UNIT	QTY
	GENERAL PIPE LINE EQUIPMENT		
3/1	Cold water storage as tern comprising 275 litre actual capacity plastic cisform made and model as specified complete with plastic lid, holed for and provided with 13mm diameter brass ballwalve with male tail, jam nuts and in se back plate 350mm brass shank and 175mm plastic standing waste overflow with plastic screwed outlet, 28mm diameter brass make outlet bosses with jam nuts support shelf by others.	nr.	1
	Policy Propylene overflow pipework focuted with push fit "O" ring couplings.		
4/1	Pipes, straight, 3.2 mm diameter fixed with plastic pipe clips screwed at centres as specified.	m	5
	Items extra over propylene pipes in which they occur.		
4/2	Neat cut beveled end 32, pipe (eaves) (roofsplice)	nr.	1
4/3	Fittings 32mm dismeter ñOò ring pattern two ends (Elbow)	nr.	1
4/4	Special connection between 32mm pipe and male threaded equipment with óOò ring female straight connection.(to cistern).	nr.	1

WEEK 5: 5.0 **INTRODUCTION TO CIVIL ENGINEERING WORKS**

Worked examples :-

Excavation and Filling

Introduction

The worked example above covers the measurement of excavation and filling to cerate a level playing field 72 x 36m within an area of slopping ground. The work involves creating stopping sites banks to the excavations and the filling to suit the contours, with the banks specified to be set to a slope of 1 in 2.5. Side bankings compound with naturally sloping ground create a problem in accessing the horizontal component of the banks. To make the task more straight forward, the existing ground is assumed to slope evenly throughout.

The excavation is reduced to formation datum 150.00 with the whole of the level area and the banks being top soiled 150mm deep, thus the level playing surface will finish at datum 150:150

There is just sufficient fill material resulting from the excavation to complete the filling work but there is an overall short fall of top soil requiring some importation. Excavation of top soil is in cubic meters while filling to stated levels is in square meters, making the reconciliation of the existing available volumes with the required importation volumes slightly awkward. This problem is solved by

calculating the area of existing 150mm thick topsoil excavated over the plan area of the new banks and deducing it from the item for the area of top soiling the new sloping banks.

Cut and fill calculation

Plot the 150.00mm contour line first on the plan, since this represents the demarcation line between the excavation and filling. Intermediate points on the contour line are found by interpolating between known spot or ground levels. For example, taking the two levels in the bottom left-hand corner (SW), the difference between the two adjacent spot levels is 150.860-149.285=1.575m, and the distance of the 150.000 level point from the edge of the area is (0.7715/1.575) x 12.000= 5.450m.

The method of working adopted here is to calculate the volumes of excavation and fill in the main area (that is 72m x 36m) from calculated average depths and to follow with the volumes of the banks. The average depths of excavation and fill are most convenient found by suitably weighing the depth at each point on the grid of levels, according to the area that it affects. Depths at the extreme corners of the area are multiplied by 1. Intermediate points on the boundary are multiplied twice and all other intermediate points are multiplied by four. The sum of the weighted depths is derived by the total number of weightings (number of squares x 4) to give the average weighted depth for the whole area.

WEEK 6

6.1 TAKING OFF IN RESPECT OF EXCAVATION AND FILLING

EXCAVATION AND FILING

AVERAGE DEPTH OF EXCAVATION TO MAN AREA
(EXCLUDING BANKS)

POINT	GROUND LEVEL	DEPTH OF EXCAVATN	WEIGHTING	WEIGTHTED DEPTH OF	COMMENTS
D1	150.20	0.150	1	0.150	150mm topsoil.
D2 twice	151.010	1.010	1	1.010	(To weight this

					Twice would give excessive high excavation
C3 150mm	150.000	0.150	3	0.450	quantities,
					Topsoil; affects 3 square.)
D3	151.450	1.450	2	2.900	
C4	150.520	0.520	3	1.560	
D4	151.950	1.950	2	3.900	
B5	150.005	0.150	3	0.450	150mm topsoil.
C5	151.010	1.010	4	4.040	
D5	152.210	2.210	2	4.420	
B6	150.860	0.860	3	2.580	
C6	151.980	1.980	4	7.920	
D6	153.020	3.020	2	6.040	
A7	149.990	0.150	1	0.150	150mm topsoil
B7	151.000	1.000	2	2.000	
C7	152.270	2.270	2	4.540	
D7	153.200	3.200	1	3.200	
			36	45.310	
				1.258	

Average depth of excavation
(Including topsoil)

NOTE: The contour line is virtually coincident with the corners of Intermediate squares. The total weighting of 36 is equivalent to 9 complete squares with 4 effectives levels to each.

EXCAVATION AND FILLING (Contd)

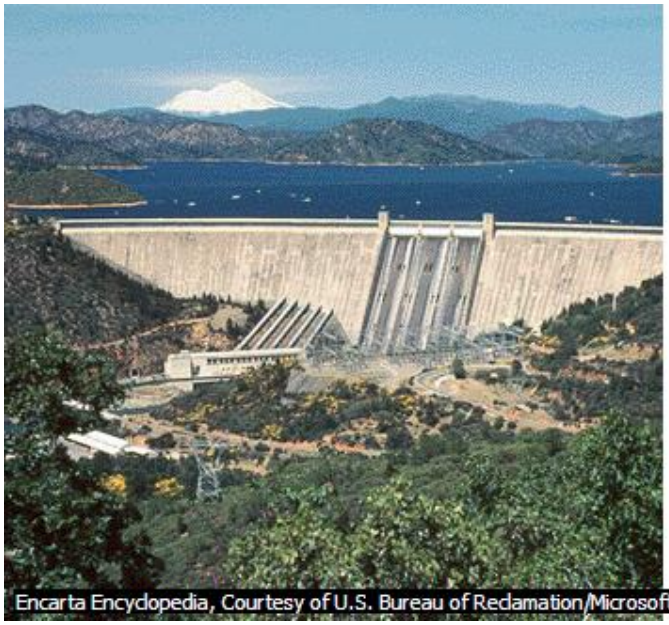
AVERAGE DEPTH FILL TO MAINS AREA
(EXCLUDING BANKS)

POINT	GROUND LEVEL	DEPTH OF FILL	WEIGHTING	WEIGTHTED DEPTH OF FILL	COMMENTS
A1	147.100	2.900	1	2.900	
B1	148.065	1.935	2	3.870	
C1	149.050	0.950	2	1.900	
D1	151.450	-	1	-	negligible quantity
A2	147.850	2.150	3	4.300	
B2	148.560	1.440	4	5.760	
C2	149.275	0.725	3	2.175	
A3	149.060	0.940	4	3.370	
C3	150.000	-	3	-	
A4	148.260	1.760	2	3.520	
B4	149.380	0.620	3	1.860	
A5	148.870	1.130	2	2.260	
B5	150.005	-	3	-	negligible quantity
A6	149.285	0.715	1	0.715	
A7	149.990	0.010	1	3.200	
			36	36.390	
		Average depth of fill		1. 011	
		Add replacement of topsoil		0.150	much more Convenient to add
		Average depth of fill		1.161	the additional

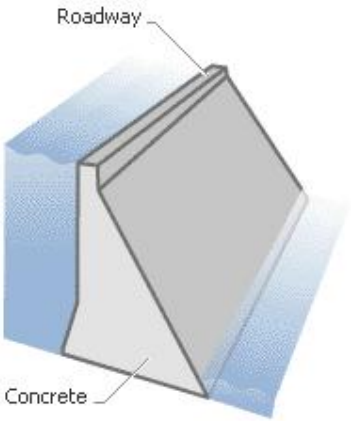
				150mm at the end rather than adding it to each individual depth.
Class E: Earthwork				
1/2	72.00		Gen. Excavan.topsoil, max. depth n.e. 0.25m E411.1 (level area	Area of dig where filling required therefore excav. complete & rule A4 does not require further description.
	36.00			
	0.15			
1/2	72.00			
	11.10			
	0.15		(west slope	
1/2	36.00			
	11.20			
	0.25		(north slope	
			Gen. Excavn. Topsoil, max. depth n. e, 025m, excvtd. Surf. U/s of topsoil. E411.2	Area of dig with further Excavation below therefore Rule A4 applies. Not all bill compilers would split these Items taking all in E411.2
1/2	72.00			
	36.00			
	0.15			
1/2	72.00			
	12.10			
	0.15		(east slope	
1/2	36.00			
	11.90			
	0.15		(south slope	
			Gen. Excavn., max. depth	

		2-5m comncg. Surf. U/s of top soil	(Rule A4) Paragraph 5.21.
		E425 &	All taken for disposal but Next item will use most of Volume for filling.
		Excavn. Ancillaries, disposal Of excavtd. mat	(Rule D4, D5) Av. Depth of Excavn. = 1.258
1/2	72.00	E532	Deduct topsoil = 0.150
	36.00		Next depth of dig = 1.108
	1.11	(level area	
1/3 2	72.00		Pyramid shape: vol. =
	10.35	(east slope	one ï third base area x altitude.
	3.20	(pyramid shape Excavn.	Base is a triangle: area = half
1/3 2	36.00		base x ht. Thus a third times
	8.90	(south slope	a half times multiplier.
	3.20	(pyramid shape excavn	
1/3	11.00		Pyramid with four ï sided base,
	10.30		with approximately a
	3.20	(corner area of slope	rectangular base

WEEK 7: 7.0 TAKING OFF IN RESPECT OF MASS CONCRTETE RETAINING WALL



Encarta Encyclopedia, Courtesy of U.S. Bureau of Reclamation/Microsoft Corporation Illustration

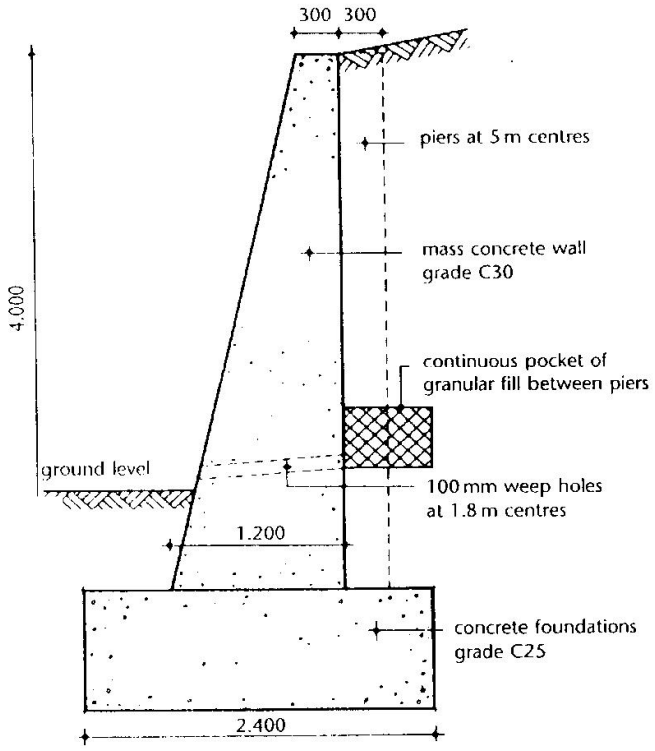


Concrete gravity dam

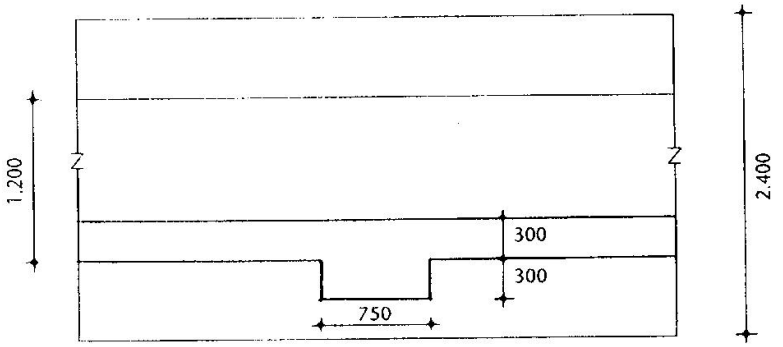
Introduction

This worked example covers the measurement of a simple mass concrete retaining wall. This example demonstrates the basic requirements of civil engineering standard method of measurement 3, classes F and G and their application in a piece of construction

MASS CONCRETE RETAINING WALL



SECTION THROUGH WALL



PLAN

SCALE 1 : 50

WEEK 8

Retaining Wall

MASS CONCRETE RETAINING WALL

For the purpose of this example a 30m length of wall has taken and the earthwork dimensions have been omitted.

Note: the principle adopted in this example would apply equally wall to the measurement of reservoirs, setting tanks bridge abutments, etc, built in concrete.

The code numbers in CESMM3 have been inserted after each item for identification purposes. They can also form the bill item references.

In situ concrete

provisn, of conc.

30.00
2. 40
0. 90

Designed mix grade C25, comment to Bs 12, 20mm agg To Bs 882, min. ct Content 120kg/m^3.

E253

The measurement of concrete is aubdivided into provision and placing

The concrete mix may be ósstandardô, ódsigneddô or óPrescribedô. The use of the grades in section 2 of Bs 5328 simplidies the spproch.

	plers	av . thickness of wall
	5130	2.200
		300
	6 + 1	2 l1.500
		750

Note the extension use of Abbreviations and the standard order of dimension i.e length

30.00
0.75

Designed mix grade C30, ct. to Bs 12, 20mm agg.

	4.00		to Bs 882, min ct. content 180kg/m^3	breadth and height. references can be made in
7/	0.75		F263	the item description to
	0.30			Sampling requirements as a specification clause .
	4.00		(piers	pier are taken from both ends of retaining wall.
			Placg. of conc.	
	30.00		mass bases. Thickness:	it is good practice to adopt
	2.40		ex. 500 mm.	The appropriate standard
	0.90		F524	terminology (F52*).

1

MASS CONCRETE RETAINING WALL(Contd.)

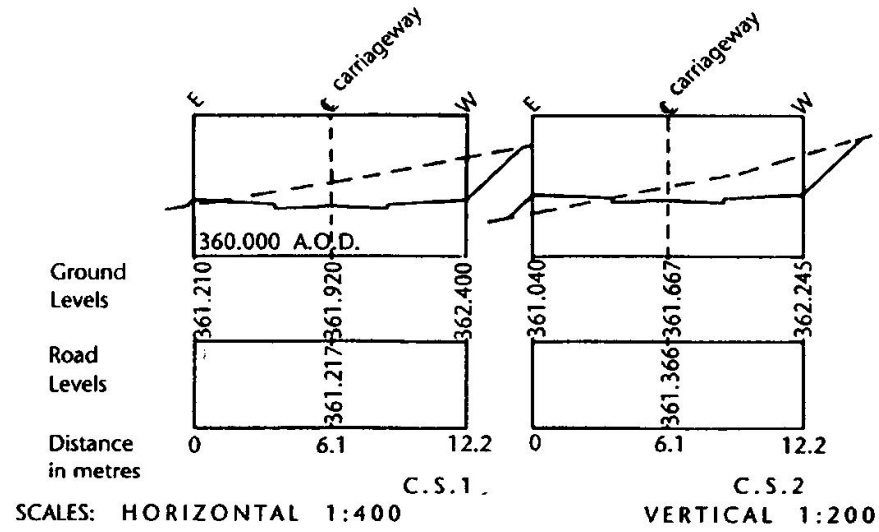
		ht. Of 300-500 th. Wall		Note build up of dimensions
			1.200	in ówasteô.
			300	the thickness of wall
			900	dertermines the amount of
		4.000x $\frac{2}{9}$ =	0.89	tamping or vibrating that has
				to be carried out for a
		given		
		av. thickness		voume of concrete - this
		500	300	affect the price and the
		1.200	500	thickness is therefore
		2l 1.700	21 800	classify in accordance with
		850`	400	the ranges in the third
		ht. of wall ex. 500th.		dvision of Class F: the wall
		4.000		has to be subdivided into the
		890		part not exceeding 500mm
		3.110		thick and that exceeding it.
	30.00	Mass wall, thickness:		Attached piers are
	0.40	300-500 mm.		included with the wall in
	0.89			acordance with rule M3 of

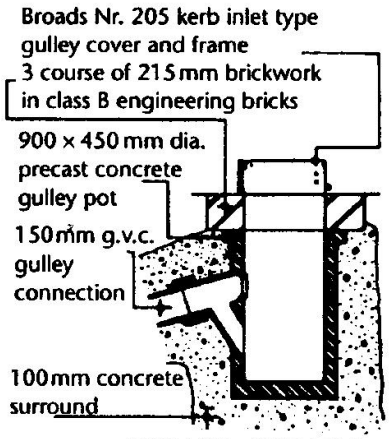
				Class F.
			F543	Assumed that concrete in
	7/	0.75		wall foundation will e cast
		0.30		against excavated surfaces.
		0.89	(piers	wrot formwork has been
				Taken for the full height of
			Mass wall thickness Ex	the wall as it will probably
		30.00	500mm	be difficult to use sawn
		0.85		formwork for the botton
		3.11	Fwk. Fair finish	section below ground
only				
				and it will avoid any
snags				
		30.00		G225 arising from variation in
the				
		0.85		finished ground level
		3.11		Formwork shall be
deemed				
		0.75		to be to plane areas and to
				exceed 1.22m wide unless
	7/	0.75		otherwise stated (rule D2
of				
		0.30		Class G).
		3.11		Note longer length of
sloping				
			Concrete Ancillaries	Face (scaled from
	drawing).			
				Described as slopping and
	not			
		50.00	Fwk fair finidh Batterind	as exceeds 10^{o}
		4.10	slopg.	from vertical.

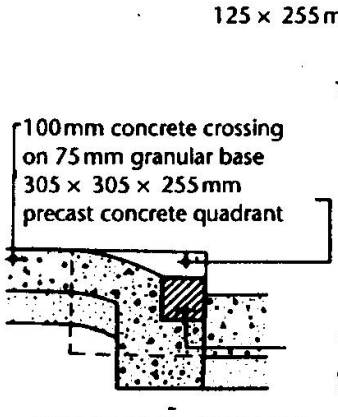
		Less piers 30.000	
		7/750 0.250	
		24.750	
		Fwk ro finish.	
	24.75	vert. G145	
	4.00		
7/	0.75	vert. width 0.4 ï 1.22m.	The formwork to the faces
	0.44	(pier faces	and returns of the piers is
		G144	kept separate from that to
			The wall face, as the narrow
7/2/	0.30	vert. width 02-0.4m	widths generate separate
bill			
	4.00	(pier retns.	items. Both are superficial
		G143	Items as they exceed 200
mm			
			wide.
		1.800 l30.000	
			Measured as inserts in
		Inserts	accordance with G832.
17/	1	100 mm clay ware land	separate items are not
		Drains, 1m lg, cast in on	required for adapting
		Rake, totally within conc.	Formwork, as the inserts are
		Vol. G832	not require to be grouted
			Into performed openings
			(rule M16 of Class G).
			Note. If expansion Jointing
			was required between the
			various sections of wall, the
			on-extruding expansion
			jinting for the full cross
			sectional are would be

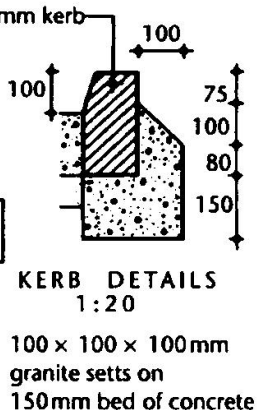
				measured in square metres with the scrip of sealing compound on the outer face of the wall taken as a linear item.
		CLASS E: Earthwork		
	24.75	granular fill in coetaneous		
	0.60	pocket behind wall.		
	0.45		E618	

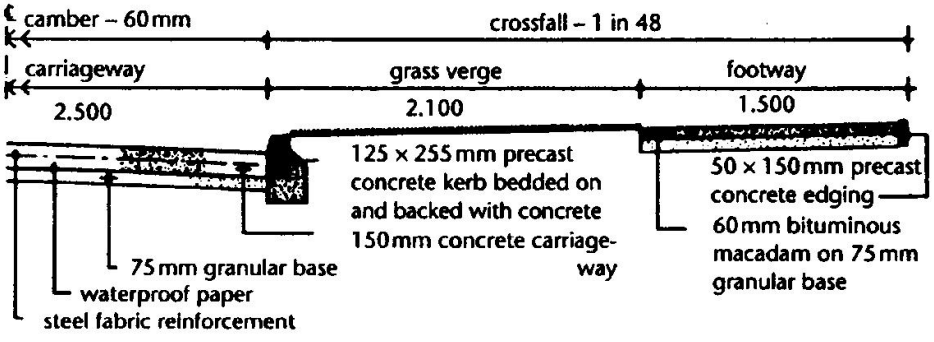
WEEK 9: STUDY DRAWINGS AND TAKE OFF BILLING OF ESTATE











TYPICAL CROSS-SECTION THROUGH ROAD
SCALE 1:50

ESTATE ROAD

Item				
			Earth carriageway av. Depth of excavation CSI CS2 361.920 361.367 361.217 361.366 add. 703 301 Road thickness 225 225 928 526 928 2 1.454 av. Depth of excavn. 727 width carriageway 5,000 add kerbs 2/225 = 450 5,450 bellmouth depths - 70 East side (fill) 350 W. side 2 280 add road 140 thickness 225 365 Excavation. For cuttings; coming. Surf. U/s of topsoil. E220 & (bell mouth) Disposal of excavated. Mat E532 41,000 less rad. Kerb 10,700 30,300 Excavation. For foundations; max. Depth: ne 0.25m; Coming. Surf. Road formation. & (kerbs E321.1 (bellmouth) Disposal of excavated. Mat. E532.	The excavation has been taken separately for carriageway, kerbs and footways, because of varying depths in each case. The measurement rules are prescribed in class E and the sequence adopted is as follows: 1.Excavation for cuttings for carriageway and disposal 2. Adjustment for kerbs 3. Excavation for cuttings for footways and disposal 4. excavation for cuttings for banks and disposal 5. Adjustment for topsoil 6. Soiling and seeding banks and verges. The additional area of one side of the bellmouth = 1 ¾ x radius2 (area of square with side equal to length of radius less area of quadrant or ¼ circle of same radius). Topsoil will be adjusted later. Alternatively, the whole area of topsoil to be stripped could be measured at the outset. With excavation for cuttings, it is not necessary to state depth ranges. Excavated materials is deemed to be other than topsoil, rock or artificial material, unless otherwise described (rule D1). Fill is a separate item. The additional excavation for kerb foundation below road formation is kept separate from excavation for cuttings as it will be a more expensive item, possibly involving hand excavation.
2/3/4	41.00 5.45 0.73			
	10.70			
2/	10.70 0.37			
	30.30			
$2/_{1/2}/22/7$	0.23 0.08			
	10.70 0.23 0.08			

Item				
	30.30 3.38 0.94 30.00 3.38 0.17		Footways E. side W.side Av. Depth at CS1 60 900 Add thickness of path or verg 135 195 av. Depth at CS2 ï 250 (fill 700 less thickness of path or verg 135 - 115 (fill ï 21.600 = 800 add thickness of path or verge 939 E. side CS1 195 CS2 topsoil 150 2345 172 width path 1.500 verge 2.100 3.375 excavn. For cuttings; (W.side commg. Surf. U/s of topsoil. E220 & (E.side diaposal of excvtd. Mat. E532 footways at bellmouth E.side W.side CS2 -250 700 Extremity - 407 543 2-657 2 1.243 -328 622 add thickness of path of verge 135 135 -193 (fill) 757	The fill required under footways and verge on the east side will be made up of non-selected excavated materials. The whole of the area of paths and verges is normally stripped of topsoil, so that some excavation is required even in places which will subsequently receive fill. Excavation forkerbs and backing has already been taken with the carriage way and so needs deducting from the overall width of path and verge. All excavated materials for disposal is taken as material other than topsoil, rock or other hard material in the first instance, and the necessary adjustment will be made later. The depth to surface of paving extreme ends of apths are calculated thus: E. side w. side Channel 360.770 362.170 Lev. Add depth of kerb + ½ fall 137 137 On path 360.907 362.307 Ground lev. At centre of path (interpolated) less finished 360.500 362.850 Level 360.907 362.307 Depth - 407 (fill) .543

Item				
	12.60 5.20 0.76		Excavn. For cuttgs commg. Surf. U/s of topsoil E220 paths of bellmouth Disposal of excvtd. E 532 mat. (topsoil on E. side) Width of banks (inc. 150mm additnl. Excavn. For topsoil)	The additional 40mm depth of excavation over the areas of the two crossings is not large enough to justify
	12.60 5.20 0.15		E.side W.side CSI 150 2,.650 CS2 850 2.850 21.0 25.500	separate measurement. Similarly the extra excavation for quadrants
			av. Width 500 (fill) 2.750 bellmouth 850 2.850 1.750 750 2 2.600 23.600 1.300 (fill) 1.800 height of banks E.side W.side CS1 150 1.050 CS2 450 950 2.600 22.000 300 1.000 bellmouth 450 950 1.000 750 21.450 21.700 725 850	over that required for kerbs would be largely offset by the smaller quantity of excavation required for the granite setts- a sense of proportion must be maintained . the build-up dimensions for the bank excavation is inserted in waste, to obtain the average widths and heights. The top soil component will require subsequent adjustment.
½ /	30.30 2.75 1.00		Excavn. For cuttgs; (w.side commg. Surf. U/s of topsoil E220 & (bellmouth w. side).	Disposal of excavated material is deemed to be disposal off the site unless otherwise stated in the item description (rule D4).
½ /	10.00 1.80 0.85		Disposal of excavated. Mat. E532	Slopes of 1 in 2 to banks hove been assumed. The volume of bank excavation = length x average width x average depth.

Item				
	30.30		Fillg. Embankment;	Filling to enhancements is kept separate from general fill. The description must contain the appropriate third division classification.
½	0.50		Selected excvtd. Mat. Other than topsoil or	
	0.30		(E. side rock)	
			E624 bellmouth E. side)	
½ /	10.00			
	1.30			
	0.73			
				Adjustment of topsoil excavation over area of carriageway, paths and verges. The depositing and spreading of the of the topsoil will be picked up in subsequent verge and bank slop items. The small surplus quantity of topsoil can remain on the site and make up surface irregularities.
	41.00		Ddt. Excavn. For cuttgs; Commg. Surf. u/s topsoil. (carrgway. & E220	
	5.00			
	0.15			
2 3/14/	10.70		Ddt. Disposal of excvtd. Mat. (bellmth E532 & (paths & verges)	
	10.70			
	0.15			
				The total lengths of verges are adjusted for the lengths of the crossings.
	30.30		Add excavn. For cuttings; topsoil E210	
2/	3.60		(bellmth).	
	0.15		Verges	
			30.300	The soiling of verges is kept separate from grass seeding.
	12.60		less crossings 2.500	
2/	5.20		1.500 4.000	
	0.15		26.300	
				Trimming and preparation deemed included (rule C4)
	26.30		fillg. Thickness: 150mm, excvtd. Topsoil.	
2/	1.98		& E641.1	
			landscapg., grass seedg. E830.1	

Item				
2 3/14/	27.70 2.85 10.00 1.90 27.70 0.65 10.00 1.00 41.00 5.00 10.70 10.70		Fillg. Thickness 150mm, excvtd topsoil; to surfs. Unclined at an < of 100 to 450 to the hor. E641.2 & Landscapg., grass seedg. To surfs. Inclined at ann < ex. 100 to the hor. E830.2 (E. side) (bellmth. E. side) **Roads And Pavings** Base granular mat. DTP specfd.type 1, depth: 75mm. R113 & carriageway slab of (bellmth. DTP specifd.pavg.qual. conc., depth; 150mm R414	Two items arise in connection with the banks: 1 soiling of slopes 2 grass seeding. The filling item is measured ion m2 as it is to a stated depth or thickness; stating the appropriate inclination category from rule A14. the grass seeding on banks has a separate classification that of the verges, as it falls into the inclined category under rule A18. Rule C4 states that items for landscaping shall be deemed to include fertilizing, trimming and preparation of surfaces. Thus neither trimming nor preparation is measured where grass seeding applies. However any excavation or filling which receives roads or paving requires preparation to be given as rules M11 and M23. Many details of road construction can be obtained from the department of transport specification for highway works, to which reference can be made in the item descriptions. The actual thickness of slabs and courses should be given instead of the third division depth ranges in accordance with rule A1 of class R.

Item				
	41.00		Steel fabric reinft. To BS 4483, nom. Mass 3-4 kg/m2; type A252. R443 & waterproof membrane below conc. Pavement; waterproof paper ot BS 1521 class BIF. R480 & excavn.ancillaries, prepn.of excvtd.surfaces. E522	The waterproof membrane is likely to be of waterproof paper or Impermeable plastic sheeting (250 or 500 grade). Preparation of excavated or filled surfaces to receive permant works is measured under class E (rules M11 and M23). Expansion joints are always measured but construction joints only when they are expressly required (rule M7). No formwork is measured (rule C1). The length of kerb is adjusted in ówasteô for the crossings on both sides of the road. The kerb section is identified by reference to BS 7263. kerbs laid to a radius exceeding 12m are included with those laid straight. Details of concrete beds and backings to kerbs are included in the kerb descriptions (rule C3).
2/3/14	5.00			
	10.70			
	10.70			
			joints in conc.pavements	
5/	5.00		expansion jts. (transverse depth: 150mm; as jts. Detail J, drawing (bellmouth. WE17. (do. Do. R524)	
	10.80			
	4.40			
2/	5.00		kerbs, channels & edgings less 30.200 setts 2.500 quads.2/300 3.100 27.100	
2/	27.10			
2/1/2/22/7/	10.70		precast conc. Kerb to BS 7263 pt. 12, fig. 1(do), st. or curved to rad.ex. 12m; bedded and backed w. conc. Grade C10 as detail X; Dwg We17. R611 precast conc. Kerb to BS 7263 pt. 1, fig.1(d), curved to rad.n.e. 12m; bedded & backed a.b. R612.	

Item				
	2.50		**Granite setts**	This item is not listed in class R and hence the figure 9 is used in the second division to represents a non-standard item.
2/	10.70		Granite sett edging (2 crossings.) 100 x 100mm,st. or curved to rad.junctn. w ex12m; bedded(xtg.road on conc. grade (do C10 as detail Y, R691 Dwg.We17.	
2/	5.00			
	10.70		Take up and remove xtg. Precast conc.kerbs. R900.	Kerbs at junction of new and existing roads; another non-standard item.
2/	5.00			
2/	2		Precast conc.quadrant, 305 x 305 x 255mm type QHB ot BS 7263,fig.1(q)bedded & backed w.conc. grade C10 as detail Q, Dwg.WE17. R693.	To crossing (one each side at junction of kerbs and setts). Enumerated item but following the same approach as for kerbs. Excavation was dealt with previously.
			Light duty pavements crossings	Vehicular crossing traversing paths and verges.
	3.600		less setts. 100	
			3.500	Similar base to that for carriageway.
			gran. Base DTP specfd. Type 1, depth: 75mm.	
2/	3.50		&	
	2.50		insitu conc. To BS 5328 mix grade C25 depth: 100mm: w. tamped non-skid fin. R773	The description of the concrete slab follows the approach prescribed for light duty pavements, but subsisting the grade of concrete in accordance with BS 5328.
			&	
			waterproof membrane below conc.pavment; w.p. paper to BS 1521 class BIF R480	

Item				
	3.50		**Excavn.ancillaries, prepn. Of excvtd.surfs.** E522	
2/	2.50		**Footways**	
			30.200	Each course constitutes a separate item and the particulars are obtained from the department of transport specification of highways works, with the thickness given in each case. Locational notes are given in waste for identification purposes. All preliminary calculations are also inserted to prevent errors and provide the facility for checking.
			less crossings. 2.500	
			27.700	
			verges crossgs.	
			Verg 2.100	
			Less kerb 125	
			1.975	
			gran.base,DTP specfd.type 1., depth: 75mm. R713	
2/	27.70		&	
	1.50		Dense bit.macadam base course DTP	
2/	1.98		specfd. clause 906,depth: (bellmouth	
	1.50		50mm. R752	
2/	12.60		&	
	5.20		dense bit.macadam basecourse DTP	
			specfd. clause 912,depth: (bellmouth	
			10mm. R751	Precast concrete falg description include the types f slab in BS 7263 and the thickness. Precast concrete edging is measured and described in a similar manner to precast concrete kerbs. Figure 1 (m) of BS 7263 shows three sets of dimensions for the round top variety and so dimensions have to be included in the description. First calculate the average depth of the surface water gully connections.
			&	
			excavn. ancillaries, prepn. Of excvtd.surfs. E522	
			edgings	
			precast conc.edging to BS 7263 PT.1,fig.1 (m) 50 x 150mm; st. or curved to rad.ex.12m, bedded & backed w.conc.grade C10 as detail E.Dwg. WE17. R651.	
2/	27.70			
2/	10.00			

Item				
			Surface water drainage depths (inc.150mm conc. Bed) gully 900 MH 1.287 22.187 av.depth 1.094	
	3.00 6.50		Clay pipes of SW qual.to BS 65 w.s & s flex.jts., nom.bore: 150mm in trs., depth: ne 1.5m., in rd. gully connections. 1112 &	The description of pipes include materials, joint types and nominal bores with references to British standard where appropriate (rule A2 of class 1).
2/	1		currround, mass conc.grade C10,pipe nom. Bore: 150mm: thicnkness: 150mm L541 clay pipes fittgs. SW qual to BS 65w.s & s flex. Jts., bends, nom.bore: 150mm J111	Materials and thickness of beds, haunches and surrounds are stated initem descriptions (rule A3 of class L). Pipes fittings a re enumerated giving similar particulars as for pipes (rule A1 of class J).
2/	1		Gullaries,precast conc. Trapped; to BS 5911, fig 2 (a) as detail 2Dwg. We17, w. broads Nr. 205 kerb inlet gully cover K360	Gullairies are enumerated with adequate references for detailed particulars and stating the tye of cover (rule A1 and A2 of class K).

WEEK 10: TAKING OFF BILLING OF ESTAE ROAD CONTINUED

Item				
	30.30			Filling to enhancements is kept separate from general fill. The description must contain the appropriate third division classification.
½	0.50		Fillg. Embankment;	
	0.30		Selected excvtd. Mat. Other than topsoil or	
			(E. side rock)	
½ /	10.00		E624 bellmouth E. side)	
	1.30			
	0.73			
				Adjustment of topsoil excavation over area of carriageway, paths and verges. The depositing and spreading of the of the topsoil will be picked up in subsequent verge and bank slop items. The small surplus quantity of topsoil can remain on the site and make up surface irregularities.
	41.00		Ddt. Excavn. For cuttgs; Commg. Surf. u/s topsoil. (carrgway. & E220	
	5.00			
	0.15			
2 3/14/	10.70		Ddt. Disposal of excvtd. Mat. (bellmth E532 & (paths & verges)	
	10.70			
	0.15			
				The total lengths of verges are adjusted for the lengths of the crossings.
	30.30		Add excavn. For cuttings; topsoil E210	
2/	3.60		(bellmth).	
	0.15		Verges	
			30.300	The soiling of verges is kept separate from grass seeding.
	12.60		less crossings 2.500	
2/	5.20		2.500 4.000	
	0.15		26.300	
				Trimming and preparation deemed included (rule C4)
	26.30		fillg. Thickness: 150mm, excvtd. Topsoil.	
			& E641.1	
2/	1.98		landscapg., grass seedg. E830.1	

Item				
2 3/14/	27.70 2.85 10.00 1.90 27.70 0.65 10.00 1.00 41.00 5.00 10.70 10.70		Fillg. Thickness 150mm, excvtd topsoil; to surfs. Unclined at an < of 100 to 450 to the hor. E641.2 & Landscapg., grass seedg. To surfs. Inclined at ann < ex. 100 to the hor. E830.2 (E. side) (bellmth. E. side) **Roads And Pavings** Base granular mat. DTP specfd.type 1, depth: 75mm. R113 & carriageway slab of (bellmth. DTP specifd.pavg.qual. conc., depth; 150mm R414	Two items arise in connection with the banks: 1 soiling of slopes 3 grass seeding. The filling item is measured ion m2 as it is to a stated depth or thickness; stating the appropriate inclination category from rule A14. the grass seeding on banks has a separate classification that of the verges, as it falls into the inclined category under rule A18. Rule C4 states that items for landscaping shall be deemed to include fertilizing, trimming and preparation of surfaces. Thus neither trimming nor preparation is measured where grass seeding applies. However any excavation or filling which receives roads or paving requires preparation to be given as rules M11 and M23. Many details of road construction can be obtained from the department of transport specification for highway works, to which reference can be made in the item descriptions. The actual thickness of slabs and courses should be given instead of the third division depth ranges in accordance with rule A1 of class R.

Item				
	41.00		Steel fabric reinft. To BS 4483, nom. Mass 3-4 kg/m2; type A252. R443 & waterproof membrane below conc. Pavement; waterproof paper ot BS 1521 class BIF. R480 & excavn.ancillaries, prepn.of excvtd.surfaces. E522	The waterproof membrane is likely to be of waterproof paper or Impermeable plastic sheeting (250 or 500 grade). Preparation of excavated or filled surfaces to receive permant works is measured under class E (rules M11 and M23). Expansion joints are always measured but construction joints only when they are expressly required (rule M7). No formwork is measured (rule C1). The length of kerb is adjusted in ówasteô for the crossings on both sides of the road. The kerb section is identified by reference to BS 7263. kerbs laid to a radius exceeding 12m are included with those laid straight. Details of concrete beds and backings to kerbs are included in the kerb descriptions (rule C3).
2/3/14	5.00			
	10.70			
	10.70			
			joints in conc.pavements	
5/	5.00		expansion jts. (transverse depth: 150mm; as jts. Detail J, drawing (bellmouth. WE17. (do. Do. R524)	
	10.80			
	4.40			
2/	5.00		kerbs, channels & edgings less 30.200	
			setts 2.500	
2/	27.10		quads.2/300 3.100 27.100	
2/1/2/22/7/	10.70		precast conc. Kerb to BS 7263 pt. 12, fig. 1(do), st. or curved to rad.ex. 12m; bedded and backed w. conc. Grade C10 as detail X; Dwg We17. R611	
			precast conc. Kerb to BS 7263 pt. 1, fig.1(d), curved to rad.n.e. 12m; bedded & backed a.b. R612.	

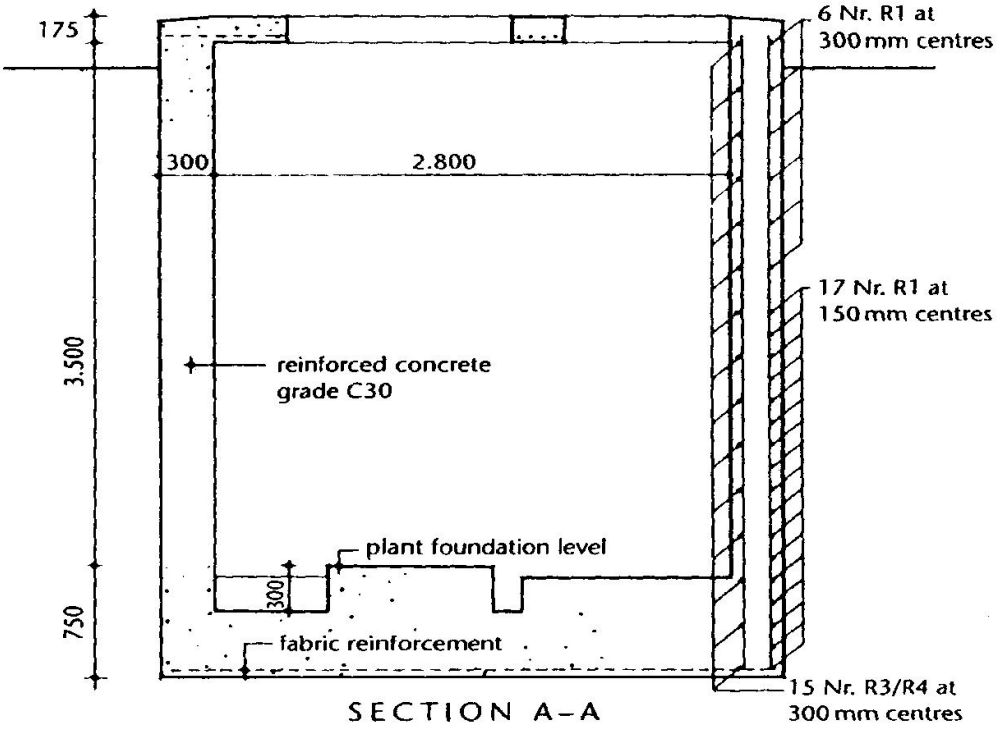
WEEK 11: TAKING OFF FOR ESTATE ROAD (CONTINUED)

Item				
	2.50		**Granite setts**	This item is not listed in class R and hence the figure 9 is used in the second division to represents a non-standard item.
2/	10.70		Granite sett edging (2 crossings.) 100 x 100mm,st. or curved to rad.junctn. w ex12m; bedded(xtg.road on conc. grade (do C10 as detail Y, R691 Dwg.We17.	
2/	5.00			
	10.70		Take up and remove xtg. Precast conc.kerbs. R900.	Kerbs at junction of new and existing roads; another non-standard item.
2/	5.00			
2/	2		Precast conc.quadrant, 305 x 305 x 255mm type QHB ot BS 7263,fig.1(q)bedded & backed w.conc. grade C10 as detail Q, Dwg.WE17. R693.	To crossing (one each side at junction of kerbs and setts). Enumerated item but following the same approach as for kerbs. Excavation was dealt with previously.
			Light duty pavements crossings	Vehicular crossing traversing paths and verges.
	3.600			
			less setts. 100	
	3.500			
			gran. Base DTP specfd. Type 1, depth: 75mm.	Similar base to that for carriageway.
2/	3.50		&	
	2.50		insitu conc. To BS 5328 mix grade C25 depth: 100mm: w. tamped non-skid fin. R773	The description of the concrete slab follows the approach prescribed for light duty pavements, but subsisting the grade of concrete in accordance with BS 5328.
			&	
			waterproof membrane below conc.pavment; w.p. paper to BS 1521 class BIF R480	

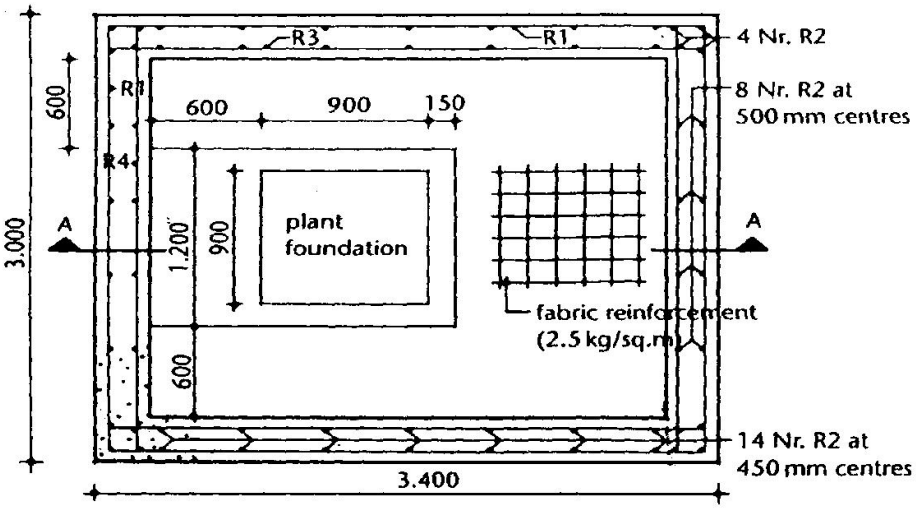
Item				
	3.50		**Excavn.ancillaries, prepn. Of excvtd.surfs.** E522	
2/	2.50		**Footways**	
			30.200	Each course constitutes a separate item and the particulars are obtained from the department of transport specification of highways works, with the thickness given in each case. Locational notes are given in waste for identification purposes. All preliminary calculations are also inserted to prevent errors and provide the facility for checking.
			less crossings. 2.500	
			27.700	
			verges crossgs.	
			Verg 2.100	
			Less kerb 125	
			1.975	
			gran.base,DTP specfd.type 1., depth: 75mm. R713	
2/	27.70		&	
	1.50		Dense bit.macadam base course DTP	
2/	1.98		specfd. clause 906,depth: (bellmouth	
	1.50		50mm. R752	
2/	12.60		&	
	5.20		dense bit.macadam basecourse DTP	
			specfd. clause 912,depth: (bellmouth	
			10mm. R751	Precast concrete falg description include the types f slab in BS 7263 and the thickness. Precast concrete edging is measured and described in a similar manner to precast concrete kerbs. Figure 1 (m) of BS 7263 shows three sets of dimensions for the round top variety and so dimensions have to be included in the description. First calculate the average depth of the surface water gully connections.
			&	
			excavn. ancillaries, prepn. Of excvtd.surfs. E522	
			edgings	
			precast conc.edging to BS 7263 PT.1,fig.1 (m) 50 x 150mm; st. or curved to rad.ex.12m, bedded & backed w.conc.grade C10 as detail E.Dwg. WE17. R651.	
2/	27.70			
2/	10.00			

Item				
			Surface water drainage depths (inc.150mm conc. Bed) gully 900 MH 1.287 22.187 av.depth 1.094	
	3.00 6.50		Clay pipes of SW qual.to BS 65 w.s & s flex.jts., nom.bore: 150mm in trs., depth: ne 1.5m., in rd. gully connections. 1112 &	The description of pipes include materials, joint types and nominal bores with references to British standard where appropriate (rule A2 of class 1).
2/	1		currround, mass conc.grade C10,pipe nom. Bore: 150mm: thicnkness: 150mm L541 clay pipes fittgs. SW qual to BS 65w.s & s flex. Jts., bends, nom.bore: 150mm J111	Materials and thickness of beds, haunches and surrounds are stated initem descriptions (rule A3 of class L). Pipes fittings a re enumerated giving similar particulars as for pipes (rule A1 of class J).
2/	1		Gullaries,precast conc. Trapped; to BS 5911, fig 2 (a) as detail 2Dwg. We17, w. broads Nr. 205 kerb inlet gully cover K360	Gullairies are enumerated with adequate references for detailed particulars and stating the tye of cover (rule A1 and A2 of class K).

PUMPING CHAMBER



SECTION A–A



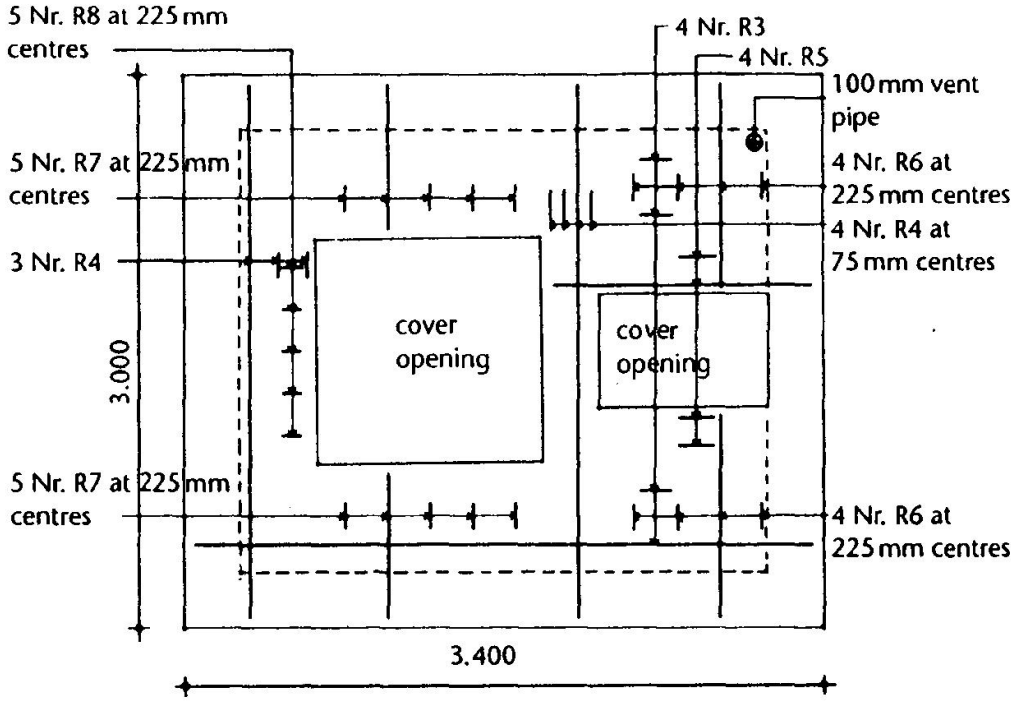
FLOOR PLAN

SCALE 1: 50

BAR SCHEDULE

Note: All bars are 12 mm diameter

BAR REFERENCE	SHAPE OF BAR	LENGTH	TOTAL NUMBER
R1	L SHAPED 1.650 / 1.800	3.450	92
R2	STRAIGHT (in two lengths)	2.500	120
R3	STRAIGHT	3.300	34
R4	STRAIGHT	2.900	37
R5	STRAIGHT	1.400	4
R6	STRAIGHT	1.100	8
R7	STRAIGHT	800	10
R8	STRAIGHT	600	5



ROOF PLAN SCALE 1:50

WEEK 13: TAKE OFF FOR PUMPING CHAMBER

		Total depth	Excavation for pits and
		175	similar structures is
measured			
		3.500	as total depth, but taken in
		750	the stages listed in the Third
		4.425	Division of class E.
		Less ht. above grd. 350	it is not considered
necessary			
		4.075	to separate the topsoil for
		Earth works.	Subsequent reuse, because
of			
	30.40	Gen. excatn. Max, depth:	the small quantity involved.
	3.00	2-5m.	
	4.08	E425	Separate items are not
			Required for upholding
sides			
			Of excavation or additional
		Excavn. Ancillaries	excavation to provide
			Working space (rule CI of
	3.40	prepn. Of excvtd. Surfs.	Class E), but disposal of
	3.00	E522	excavated material requires
			measuring.
			Note: Preparation of
			Vertical surfaces not
			Given as formwork is
	3.40	Diposal of excvtd. Mat.	Measured, see rule
	3.00	E532	M11 in class E.
	4.08		
		In situ concret	The provisiob and placing of
			Concrete are measured
		Provsn. Of conc. Designed	separately as prescribed in
		Mix grade C30, ct, to BS 12,	class E it seens logical to
		20mm agg. To BS 882, min.	take all cubic provision
items			
	2.80	Ct. content 240kg/m.	first folloed by the placing
	2.40	F223	items in their various
	0.68	area depth	categories. Alternatively the
		Less 3.400 3.000 750	activities could be taken
		2/300 600 600 less 75	simutaneously with each st
		2.800 2.400 675	
		Base len.	Duplication.
		600	
		900	
		150	
		1.650	
	1.65	Ddt. Ditto	
	1.20	(area ard.	
	0.23	plant fdn.	

		Provsn. Of conc. A.b. F223	
0.90		Add ditto. (plant fdn.	Note method of building up
0.90		ht.	the girth of the chamber
0.30		3.500	wall, measured on its centre
		750	line, by taking the internal
		4.250	perimeter and adding the
11.60		len.	Thickness of the wall for each
0.30		2.800	corner.
4.25		(walls 2.400	
		2/	
		5.200	
		10.400	the order of measurement
3.40		add corners 4/300 1.200	follows a logical sequence ï
3.00		11.600	the order of construction on
0.18		(cover slab	the site ï base, walls and
1.20		Ddt. dtto.	
1.20			Deduction of concrete is
0.18			made for the opening as
			They exceed the area of ódarge
0.90			Voidsô as defined in rule D3
0.60			of class G.
0.18		(cover opgs.	
		Placg. Of conc.	
		Reinforced	
2.80		Bases and ground slabs,	Bases are measures in cubic
2.40		thickness: ex. 500mm.	metres, distinguishing
0.68			
		F624	between different classes of
			Concrete (mass, reinforced
			and prestressed) and
1.65		Ddt. Ditto (area and	separating into the thickness
1.20		- plant fdn.	Ranges listed in the third
0.23			Division.
			It is deemed describe to
0.90		small plant base,	keep the concrete in the
0.90		thicknesses: 150 -300mm.	plant base separate from the
0.30		F622	remainder because of its small volume.
11.60		walls, thickness:	The walls are 300mm thick
0.30		150-30mm.	and so fall within the
4.25		F642	thickness range of 150- 300mm.
30.40		Susp. Slab thickness:	All suspended slabs are
3.00		150-300mm.	Measured in cubic metres.
0.18		F632	

WEEK 14:

			PUMPING CHAMBER (CONTD)		
			Placg. Of conc. Reinforced		
		1.20	Ddt. Ditto.		F632 same deductions for
		1.20			opening as before, as does
		0.18		(cover	not fall within the
inclusion					
				Opgs.	Provisions in rule MI of
class					
		0.9			E.
		0.60			
		0.18			Formwork providing
rough					
			Conc. Ancillaries		and fair finishes must be
			FWK. Fair fin: 2/1.650 3.300		distinguishes and the
plane					
				1.200	classified in accordance
with					
				4.500	the second division of
class					
		4.50	vert. width:		G (horizontal, sloping,
		0.23	0.2-0.4m.	(Sump	battered, vertical and
(curved)					
					Widths not exceeding
	4/	0.90		(plant fdn.	200mm are measured as
		0.30		G243	linear items and greater
					Widths in square metres.
			Conc. Accessories		
		2.80	Finishg. Of top surfs. Steel		To obtain smooth finish
to					
		2.40	trowel. G812		concrete base.
		4.50	Finishing. Of formed surfs.,		To vertical surfaces to
sump					
		0.23	steel trowel. G823		and plant base.
		3.60			
		0.30			
			Conc. Ancillaries		Note build up of external
			KWK. Ro. Fin		girth of pumping station.

			11.600	Alternatively, the external
		Add 4/300	1.200	dimensions of the chamber
			12.800	could be taken: 3.400
		Less pt.	4.250	3.000
		Above G.I	225	2/6.400
			4.025	12.800
	12.80	vertical	(ext. face	
	4.03		of walls	Unnecessary to state width
			G145	as it exceeds 1.22m (rule D2
				of class G).

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PUMPING CHAMBER (CONTD)

	Fwk. Fair fin.		Taking smooth face of
12.80	vertical width (ext. face		concrete to 75mm below
0.23	0.2-0.4m.	of walls	ground level to allow for any
		G243	irregularities in the finished
		3.500	ground surface. The
		75	formwork to the edges of the
		3.575	cover slab are taken later.
		11.600	
	Less corners	1.200	
		10.400	
10.40	vertical	(int. face	wrought formwork to
3.58		of walls	internal faces of walls.
		G245	
	Conc. Accessories		
11.60	finishg. Of top slopg. Surfs,		sloping top surfaces to edges
0.30	steel trowel		of cover slab. CESMM3 (Class
		G812	G) does not require the
			Inclusion of the word
	Conc. Ancillaries		sloping but additional
	FWK. Fair fin.		Information may be given in
			Accordance with 5.13 where advisable.
2.80	Horizontal	G215	Formwork to underside of
2.40			cover slab.

	1.20		Ddt ditto.	Formwork to underside of
	1.20		G215	openings deducted as they
	0.90		(cover	exceed the large void areas
	0.60		opgs.	Prescribed in rule D3 of class G.
			1.200 900	
			1.200 600	
			2/ 2.400 2/ 1.500	
			4.800 3.000	
	4.80		Vert. widths: (sides of	Linear items of formwork as
			0.1-0.2m, opgs.	Not exceeding 200mm wide.
	3.00		G242	
				The cover slab would be
	12.80		Ditto. (Edges of	constructed later than the
			Cover slab	walls, after the plant has
			G242	been installed ï hence the
				Need for a separate 150mm
				Strip of formwork to the edge of the
cover slab.				

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WEEK 15

Worked Examples

PUMPING CHAMBER (CONTD)

		Conc. Accessories. Inserts	
	1	100mm dia. C.i pipe proj. From one surf. G832	Items for inserts shall be Deemed to include their supply unless otherwise Stated (rule C7 of Class G).
		Conc. Ancillaries Reinforcement	
		3.400 3.000 Less 2/40 80 80	40mm cover has been allowed to the fabric reinforcement to all edges in
		3.320 2..920	base slab.
	3.32 2.92	High yield steel fabric to BS 4483, nominal mass 2-3KG/m2, ref. A142. G562	Laps are not measured (rule M9 of class G). Item descriptions for high yield steel fabric to BS 4483 Shall state the appropriate Reference (rule A9 of class G)
		M.S. bars to BS 4449 R3 R4	
		34 37 Less bars in 4 7 Cover slab 30 30	
92/	3.45	Diam. 12mm (R1	Check the bar bending Schedule against the
120/	2.50	(R2	Drawings before extracting The quantities from it. If no
30/	3.30	(R3	schedule is supplied. It will Usually be necessary to Prepare one .
30/	2..90	G514 (R4)	40mm cover is provided to The reinforcement unless

					(walls	otherwise specified and the normal allowance for hooked
	4/	3.30	Diam.	12mm	(R3	Ends is an addition of 12 times the diameter of the bar
	7/	2.90			(R4	For each hooked end. The total length of bar will be Weighted up and billed in
	4/	1.40			(R5	tonnes. Separate items are Not required for supporting
	8/	1.10				Reinforcement (rule CI of class G)
	10	0.80				Bars exceeding 12m in Length are given
					(R7	separately in stages of 3m (rule A7 of
	5/	0.60			(R8	clad G).
					G514 (Cover slab	
5						

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