3 Measurement of Existing Buildings

3.1 Preliminaries

This chapter describes the procedures for undertaking a measured or dimensional survey of existing properties. It is an exercise that sometimes forms part of an investigation of a building, particularly prior to its adaptation or conservation. Moreover, if plans of the existing building are inaccurate or unavailable a dimensional survey will usually be necessary (Swallow *et al.*, 2004).

The basic principle of measuring existing buildings is easy to learn, but accuracy is essential. A small error in the measurement of an existing building can cause a great deal of trouble when setting out, so care is necessary in taking and checking dimensions in order to give reliable results. For instance, in domestic work the client's proposals may require alterations to kitchens and bathrooms. If this is the case a very accurate survey will be necessary in the areas in which baths or kitchen fittings might be fitted. Even a small error could mean considerable expense if a standard fitting had to be changed or altered.

With practice the art of sketching can easily be acquired. Tracing paper pads are available for survey work. The object of using tracing paper is that once the ground floor plan has been sketched it is easier to sketch the upper floors by sketching over the top of the ground floor plan. Dimensions can also be checked against the upper floor dimensions. A sheet of graph paper placed under the first tracing paper sheet will make it easier to keep the plan rectangular, and easier for the surveyor to maintain a constant scale. The graph paper squares should be to a scale of approximately 1:100 or 1:50 depending on the size and complexity of the building being measured. These approximate scales will allow space for all the small dimensions to be written in legibly. It is important not to allow the survey notes to get too cramped or complicated. If parts of a room contain complicated fittings, then record this on a separate sheet. It cannot be assumed that all rooms are rectangular especially in old buildings. If rooms are irregular in plan they are measured by taking diagonals across the room as shown in Figure 3.1. It may appear that one diagonal is all that is necessary, but in practice it is wiser to take several as a check.

The majority of measured surveys, especially of large buildings, will be undertaken by two people, but there are occasions where the work must be done single

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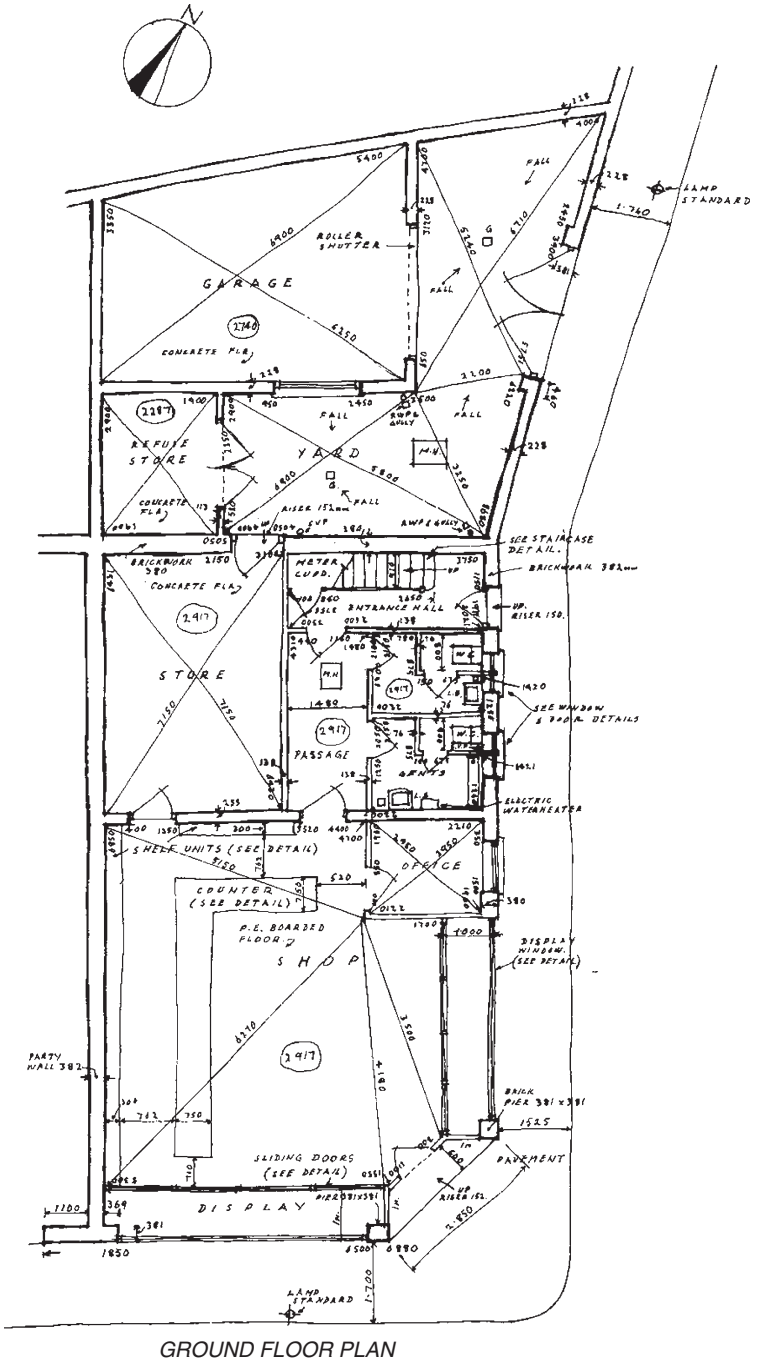


GROUND FLOOR PLAN

Figure 3.1 Survey of ground floor shop premises

Internal finishes to rooms facing rear yard

Entrance hall
Floor s.w./p.e. flooring in 152 mm widths. sound condition.
Skirting 152 × 25. s.w. painted. F.G. condition.
Walls plastered & painted. Minor cracks on outer wall. General condition F.G.
Staircase All s.w. painted with polished hardwood handrail – solid panelled balustrade painted. Stair treads & nosing slightly worn. Decorative condition fairly good.
Ceiling plastered & painted with 150-cove cornice. Minor plaster cracks around front entrance. General condition F.G.
Doors Two flush s.w. doors to passage & meter cupboard and two panelled entrance door with glazed top panel & fanlight. All doors, frames & architraves are s.w. painted in good condition.

Store
Floor Concrete screeded. F.G. condition. A few minor cracks in screed.
Skirting 100 × 25. s.w. with rounded top edge painted. Timber sound paintwork in poor condition.
Walls Plastered & painted. Plaster in F.G. condition paintwork poor.
Ceiling Plastered & painted. Plaster sound paintwork poor.
Doors Internal door s.w. flush. s.w. frame & architrave. Timber & paintwork in F.G. condition. External door s.w. two panelled & one glazed top panel. Timber & paintwork F.G. condition.

Refuse store
Floor Concrete. F.G. condition.
Walls Fair face brickwork. Pointing & brickwork in good condition.
Roof Open timber joists (no ceiling) supporting boarded and felt roof. Joists 150 × 50 treated with preservative. All in good condition.
Double doors s.w. framed doors lined with matchboarding. Evidence of movement in tenon joints & minor wet rot in bottom rails. Paintwork poor. Feet of s.w. frame shows evidence of wet rot.

Garage
Floor Concrete. No serious defects apart from oil staining.
Walls Fair face brickwork. Brickwork sound, pointing in poor condition.
Roof R.c. slab. No defects.
Roller shutter Laths & winding gear in F.G. condition. But requires overhaul.
Metal window Metalwork sound. Paintwork poor.

Figure 3.1 (cont'd)

handed. This is often the case in small occupied houses or bungalows which are often so crowded with furniture and fittings that it is not possible to use a tape. In such cases the survey must be carried out using a 2 m rod. Inevitably, there will be some loss of accuracy in this type of survey, but if the overall dimensions are added up and checked before leaving the building, the error need not be significant.

3.2 Internal measuring

On arrival at the premises make a careful sketch of the ground floor of the building followed by a plan of each floor including the basement (if any). When sketches of all floors have been completed the measuring can begin.

Always take dimensions in a clockwise direction and the figures on the tape will be the right way up. It is better to measure the building to a set pattern in order to avoid omitting important dimensions. Measure along walls and partitions on the plaster face including door and window openings and piers etc. 'Running' dimensions should be taken; it is far more accurate and saves time. For example, a wall of a room 5 m long containing a 1 m wide door opening in the centre would not be measured in three separate dimensions 2 m, 1 m and 2 m. By using one length of tape the dimensions are booked 2 m, 3 m and 5 m. The dimension of the door opening should be in the actual door size. When booking running dimensions each figure should be booked near the end of the length to which it refers (see Figure 3.1).

The thickness of walls and partitions should be obtained at door openings, making an allowance for any rendering or plaster. In old buildings plaster finishes are about 20 mm thick, but in modern buildings they are usually about 13 mm thick.

It sometimes happens that internal partitions cannot be measured by this method and where this is not possible, thicknesses can be obtained by measuring externally between two windows or doors and deducting from this dimension the sum of the distances from the respective window openings to each side of the internal partition or wall. This method is particularly useful when the thickness of a party wall is required as shown in Figure 3.1. Where it is difficult to obtain the thickness of a partition by either of these two methods it will have to be calculated by deducting the sum of all the internal dimensions from the overall external dimensions. The difference is the thickness of the partition required. However, if the thickness of two partitions is required, the difference will give the total thickness which will have to be divided between the two partitions. The surveyor should not assume that internal walls or partitions on the upper floors will be over those on the floors below; always check by taking measurements inside and outside the rooms.

In old buildings floor to ceiling heights are often found to vary. The heights can be booked in the centre of the room, and enclosed in a circle (see Figure 3.1). It is often difficult to take the height of a room against the wall where there is a large moulded cornice. In such cases it is easy to obtain the room height by measuring down from the ceiling to the top edge of an open door and adding this dimension to the height of the door. Industrial and warehouse buildings frequently have exposed steel roof trusses supported on stanchions. Measure from centre to centre of all stanchions and at the same time taking a note of their sizes. By using a ladder, details of the truss members and bearing connections etc. can be taken. At the same time the height from floor to the lowest horizontal truss member and the height to the apex can be obtained by using the steel tape.

The floor thickness can be measured at staircase openings or lift wells. Variations in floor thicknesses will be revealed by corresponding variations in floor to ceiling heights below. To obtain the exact size of floor joists and their condition, one or two boards should be removed. This is easily done in unoccupied property, but if the premises are occupied it will be necessary to remove some of the floor coverings. In such cases it is advisable to discuss the problem with the occupier. Usually,

an amicable arrangement can be reached and with care the coverings can be lifted up and replaced without undue damage.

Floor levels should be checked with the bricklayer's level and straight edge. All beams and direction of floor joists should be noted and plotted on the sketches. This is particularly important when new openings are to be cut in existing walls. Should the joists run towards the proposed opening, provision will have to be made for the additional load that will be carried on the lintel over the new opening.

The heights of external door and window openings are not always required, but if alterations are contemplated they are essential if sections through the building are to be drawn. The survey sketches should show the plan and elevation of the window or door; and the dimensions must clearly indicate where they are taken; edge of frame, architrave or brickwork. Figure 3.2 suggests methods of measuring window and door openings where future alterations may be necessary. The window and door details are taken from the entrance hall and ladies toilet in Figure 3.1.

Staircases are usually drawn on both floor plans, the foot being shown on the lower floor and the head on the upper. When measuring the treads and risers it should be noted that timber staircases usually have a nosing projecting beyond the face of the riser. As the total of the sums of the width of the treads will be greater than the total 'going' of the stairs, it is usual to measure the treads from the

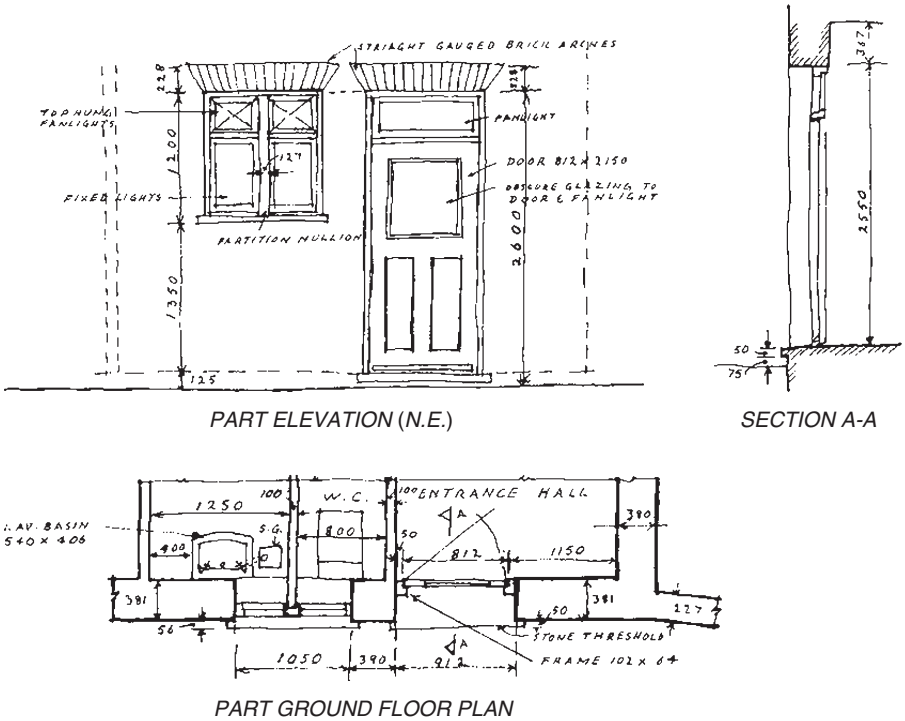
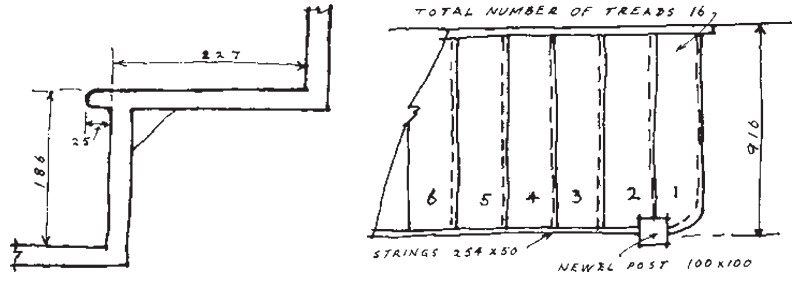


Figure 3.2 Detail of door and window openings



SECTION THRO' TREAD & RISER *PART PLAN OF STAIR*

Figure 3.3 Sketch of stair details

face of the lower riser to the face of the top riser. Enter this dimension with the number of treads on the survey sketch. The risers are similarly measured from tread to tread (see Figure 3.3). The plan and the section shown should be sufficient for a 1:50 or 1:100 scale, but details of newel posts and balustrade will probably require a larger scale.

It is often difficult to differentiate between the different forms of construction used for internal partitions. Partitions in older buildings often consist of timber studs lined with lath and plaster. This type of construction can easily be discovered by rapping sharply with the end of a measuring rod which will produce a hollow sound in parts and solid in others. Partitions in more modern buildings consist of lightweight concrete blocks, clinker, hollow clay pots or brick. Clinker or concrete blocks 51 mm to 63 mm thick often produce a slight vibration when struck with a closed fist. Thicker partitions, however, are often too solid to give an indication of their construction.

If alterations or additions are contemplated a careful note should be made of the type and condition of the internal and external finishings adjoining the area of the proposed alterations. It is quite extraordinary how often this type of information is wanted. These details can be booked on a separate sheet or written at the side of the sketches as shown in Figure 3.1 which describes the internal finishes to the rear rooms of the ground floor plan.

Old wall and ceiling plaster is often suspect and should be carefully examined; this particularly applies to lath and plaster ceilings which have lost their 'key'. When plaster repairs are put in hand it usually involves far more 'cutting away' than was originally anticipated. In such cases it is often found more economical to replaster a complete ceiling or partition. Signs of any defects in timber floors and roofs should also be noted at this stage if they are likely to interfere with the additions or alterations.

It may also be necessary to take measured sketches of cornices, skirtings, window sills and joinery etc. if the proposed work is to match what already exists. Full size sections of mouldings are taken with the lead strip described under 'Equipment' in Chapter 2. After carefully pressing the strip round the mould-

ing, it is placed on a sheet of tracing paper and drawn by running round the inside of the lead pattern with a grade B pencil. All details should be lettered and this letter noted on the sketch plan of the floor concerned, and in the exact position where the detail was taken. Take note of the main service entry positions, meters, stop valves, heaters, boilers, radiators, lighting points and socket outlets etc. and plot these on the floor plan sketches. This sort of information is useful if alterations or extensions are proposed and service mains or meters have to be repositioned or renewed (Douglas, 2006). In fact, the more information you can collect during this type of survey, the easier will be the subsequent work on the drawing board.

3.3 Roof space

The survey of a pitched roof can be divided into two parts, the interior and the exterior. When measurements have been completed on the top floor it is logical to continue into the roof space by way of the trap door, not forgetting to mark the position of the trap door on the top floor plan. Measurements should be taken from ceiling joists to ridge together with sizes, position and direction of all the structural timbers. A detail of the wall plate and joists at the foot of the rafters can also be taken, but the difficulty here is the confined space in the lower portion of the roof especially in low pitched roofs.

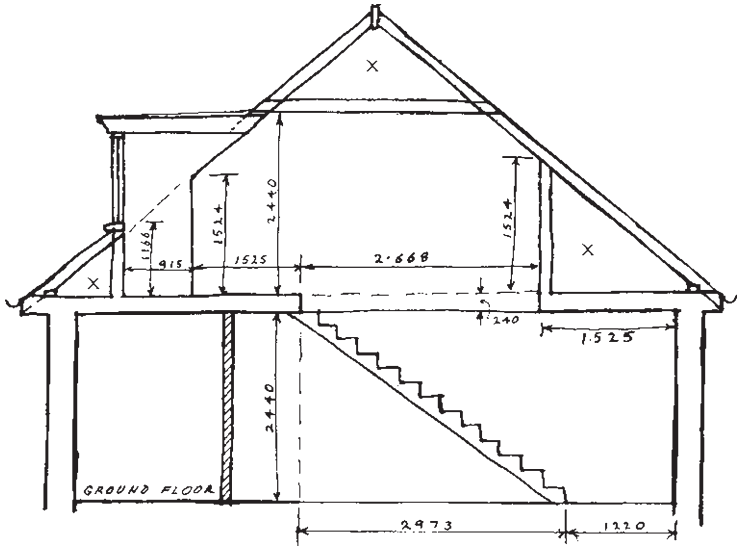
Whilst in the roof space ascertain the position and size of any water storage tanks or feed tanks etc. including a description of the cover and any insulation provided. A note of the size and direction of pipe runs and overflows should also be plotted on the sketch.

Care should be exercised when measuring rooms in roof spaces lit by dormer windows. The partitions do not always coincide with the partitions on the floor below and are usually of timber construction. If such is the case, the only point that can be fixed in relation to the floor below is the top of the staircase, and all dimensions should be tied back to this point as shown in the section through a roof space and ground floor plan in Figure 3.4. Basements also do not always extend over the full area of the ground floor. They are similarly measured back to the staircase serving the ground floor.

3.4 External measuring

When all the internal measuring is completed, the external measurements can be taken. The horizontal dimensions can be booked on the floor plans. Carefully sketch all elevations and measure the widths and heights of all openings; note the position of rainwater and soil pipes, and their size and material (Swallow *et al.*, 2004).

If difficulties are encountered when measuring external heights, this can be overcome in brick faced buildings by counting the brick courses. To convert



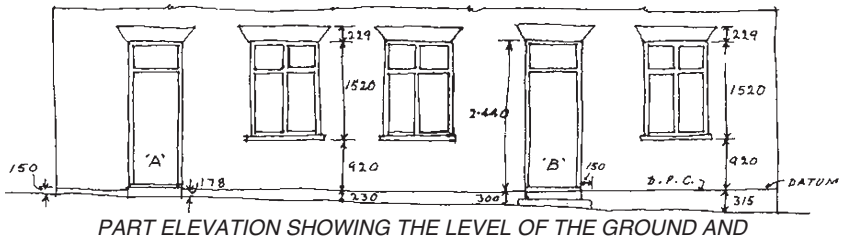
SECTION THRO' ROOF SPACE & GROUND FLOOR.
(X = VOID SPACES, WHICH SHOULD BE VENTILATED).

Figure 3.4 Section through roof space and ground floor

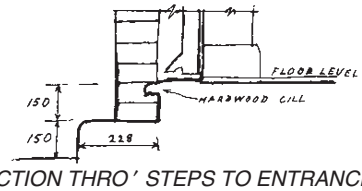
these to metric dimensions, four courses should be measured centre to centre of mortar joints in several different parts of the building, and the average rise used as a denominator. This method is particularly useful in obtaining the height of chimney stacks, although binoculars are sometimes necessary when counting the brick courses on a high building. Alternatively, if the building is rendered, the height of the windows, and the heights between the heads of windows and the sills of the windows above can be measured from inside the room through an open window using a 2 m rod. If no levelling has been done along the face of each external wall, the ground line of each elevation should be taken from a constant datum, such as a damp course line or top of a plinth. Measurements can then be taken from this line down to the ground level at appropriate points along each elevation (see Figure 3.5). Heights of window sills and heads can also be related to this line. This information can then be checked against the internal heights.

Elevations with complicated projections such as cornices and pediments etc. should be measured with the aid of a plumb line, the plumb being secured at the foot and offsets taken from the line. The heights from which these offsets are taken must also be measured. This method of measuring is particularly important when walls are out of plumb or bulging.

As previously mentioned in Chapter 2 'Procedure and Equipment' photographs are a great help when surveying a building with complicated elevation details or with extensive defects. The photographs can be enlarged and form valuable



PART ELEVATION SHOWING THE LEVEL OF THE GROUND AND SILL HEIGHTS E^{TC}, TAKEN FROM THE D P C DATUM.



SECTION THRO' STEPS TO ENTRANCE 'B'

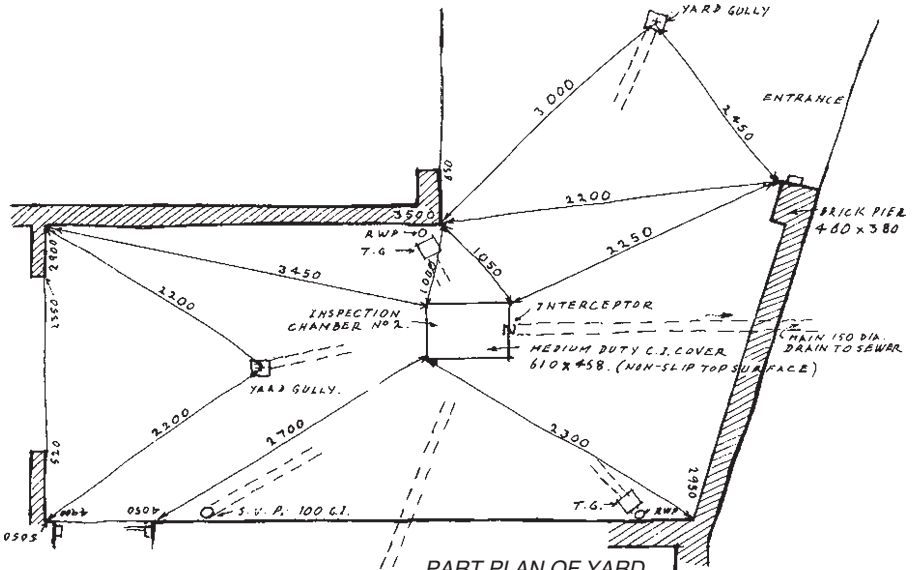
Figure 3.5 Part elevation showing the level of the ground and sill heights etc. taken from the damp-proof course datum

records of the structure in its existing condition. They are also of value when preparing the specification.

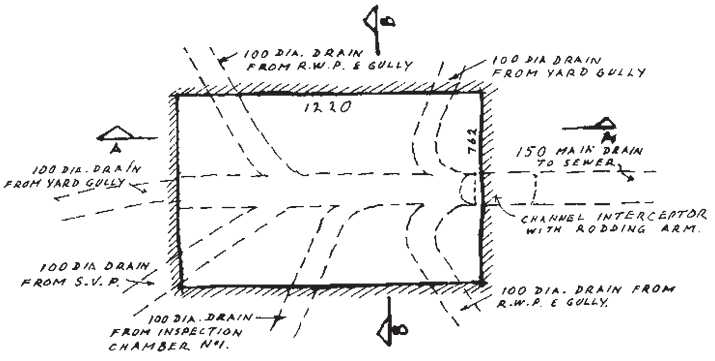
If alterations or additions are proposed which involve alterations to the drainage system, it will be necessary to plot the positions, sizes and depths of inspection chambers, gullies and drain runs together with the positions of rainwater and waste pipes. The term 'inspection chamber' on all drainage systems is now in general use and is the term used in the Building Regulations.

Inspection chamber positions can be established by taking measurements to suitable points on the external or boundary walls of the building. Figure 3.6 shows an enlarged survey sketch of the drainage system taken from the yard survey in Figure 3.1. The inspection chamber cover should be removed and the internal measurements of the chamber taken, together with the depth from cover to invert and the position and size of all pipe runs. Do not assume that the inspection chamber is the same size as the cover, as large inspection chambers are often corbelled over at the top and fitted with a small cover as shown in Figure 3.6. Trace all the drain branches by flushing WCs and running taps in basins and sinks so that every run is accounted for and at the same time note the condition of the installation.

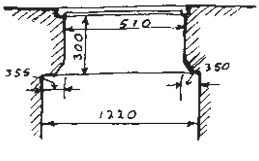
At this stage, care should be taken not to overcrowd the sketch sheets. It is often wise to plot the drainage details on a separate sheet thus avoiding confusion when the survey reaches the plotting stage. This is why the drainage system has been omitted in the yard of Figure 3.1. Large irregular areas are often found around the boundaries of a site as shown in the yard of Figure 3.1. These are measured by taking diagonals as explained earlier in this chapter.



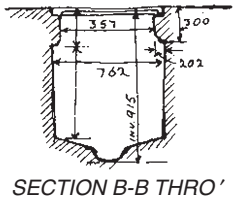
PART PLAN OF YARD.
DIMENSIONS ARE IN METRES



PLAN OF INSPECTION CHAMBER



SECTION A-A THRO' INSPECTION CHAMBER



SECTION B-B THRO' INSPECTION CHAMBER

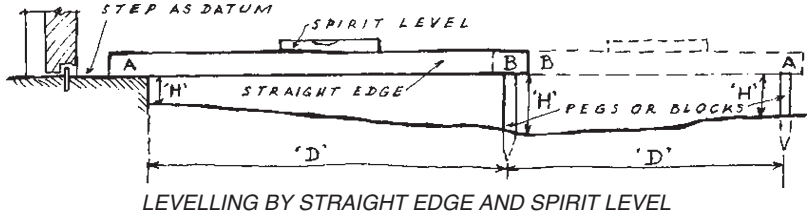
Figure 3.6 Drainage details

3.5 Levelling

There are several accepted text books on land surveying which deal fully with the theory and practical side of levelling (e.g. Clancy, 1991; Irvine, 1995). Here we shall deal briefly with the subject only as far as existing buildings and their surroundings are concerned. If extensive alterations or extensions are visualised, it is essential to obtain some information concerning the surface slope of the ground around the building and its relation to the ground floor level of the building. It is desirable to make use of ordnance survey maps, which are very accurate and can be used as a check to show whether your angles are correct. If there is no ordnance survey bench mark near the site, then some suitable fixed point will have to be selected as a temporary bench mark, such as a door step or inspection chamber cover. This point should be carefully noted on the survey plan so that it can be easily located at a later date.

Having set up the level the first reading is taken with the staff on the bench mark followed with further levels on predetermined positions such as steps, plinths, string courses, openings etc., on the various elevations which are likely to interfere with the proposed extension. The level of the existing floors must also be ascertained as well as that of the adjoining ground. Provided there are no obstructions, it is advisable to use the same setting up of the level for all readings. In properties of the type shown in Figure 3.1 it is possible that this can be easily accomplished. Much depends on the type of instrument being used, and the eyesight and experience of the surveyor.

When booking the levels be sure to finish on the point from which you started and reduce the levels while you are on site so that any error found can then be checked and adjusted. For small extensions or alteration jobs it has often been found that only three or four approximate levels are necessary. The levels required are usually between the existing ground floor and the external paving and can be taken from an entrance using the step as a datum. In such cases, the simplest method of levelling is to use a straight edge cut from a board approximately 150 mm × 25 mm × 3 m long. The board is used in conjunction with a spirit level as shown in Figure 3.7 using a series of pegs or small blocks of timber on a flat base board. The spirit level should be checked for accuracy by reversing it on the straight edge. The bubble should come to rest in the same position. When levelling, the board and level should be reversed at each move



LEVELLING BY STRAIGHT EDGE AND SPIRIT LEVEL

Figure 3.7 Levelling by straight edge and spirit level

as indicated by the letters 'A' and 'B' at each end of the board. By reversing the board and level any error will be minimised. The distance between the pegs or block and their height can then be measured, as indicated by the letters 'D' and 'H' on the sketch.

3.6 Plotting the survey

Plotting the survey is usually done to the scale of 1:100 or 1:50. If the building has a complicated plan and requires extensive alterations it is better to use the larger scale.

The ground floor plan is drawn first, the dimensions to be plotted being the overall dimensions of the width and length of the building. Then, commencing at one end of the building, set out the walls to each room so as to build up the 'skeleton' of the building. No details of door and window openings, staircase etc. should be drawn in until the partitions and walls have been set out within the overall dimensions.

When this first stage has been completed and checked the details can be filled in. The remaining parts of the plan such as outbuildings, pavings, drainage and soil and rainwater pipes can then be plotted. The upper floors can then be set out in a similar manner together with sections and elevations. It is often difficult to draw a complete section showing structural details. However, if sufficient information has been gathered, an outline section showing the thickness of walls, floors, sizes of roof timbers and beams etc., should be drawn and described.

No doubt the surveyor will set up sections through those parts where structural alterations are proposed, particular attention being paid to floor-to-floor heights and where changes in levels occur. There are several methods of finishing a survey drawing. Existing walls and partitions can be hatched as shown in Figure 3.1 or filled in in black ink. Alternatively, they can be left in outline and the prints tinted grey or black. Hatching or colouring of plans and sections will tend to make the construction stand out and so simplify the reading of the plans.