Reading Materials for IC Training Modules

Construction Drawing Practices

IC PROFESSIONAL TRAINING SERIES

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Construction Drawing Practices

Objectives:

✓ To provide the students with knowledge of principles and techniques of manual construction drawing
✓ To enable them to appreciate the use engineering drawings as a communication medium in the construction industry.

Upon completion of the subject, students will be able to:

a. Prepare basic sketches, orthographic projections and working drawings.

b. Apply drawing standards and conventions.

c. Produce a construction drawing for structural concrete to recognized construction drawing standards.

d. Produce a construction drawing for structural steel to recognized construction standards.

e. Produce simple construction CAD drawing with MicroStation.

f. Communicate using engineering drawings as media.
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1 Introduction

Construction drawing is a means of showing in a graphical form the shape, size and position of a building on a site, together with the composition of the materials used and the way the building is to be constructed or put together. The information on construction drawings has to be presented in a precise, unambiguous way so that it can be understood by anyone with a knowledge of draughtsmanship and construction.

It should be borne in mind that the contractor’s staff using the drawings on a construction site often work under difficult circumstances, and the quality and clarity of the drawings should reflect this fact.

The term ‘construction drawing’ includes not only drawings produced by architects, which generally make up the majority of the drawings for a building project, but also structural drawings which are the province of structural engineers, and building engineering services drawings which are commonly prepared by building services engineers.
2 Drawing Lines and Shapes

GETTING STARTED

At this stage you should have the following equipment to assist you.

- Sheets of A2 cartridge paper
- A2 drawing board and tee-square
- Drafting tape
- Fine-lead mechanical pencils with H and HB leads
- Two technical pens, one for drawing lines 0.3mm thick and the other for drawing lines 0.7mm thick.
- A soft eraser
- A 300 mm long scale which includes scales of 1:100, 1:200, 1:5 and 1:50.
- A 45° fixed set-square and a 30°/60° degree fixed set-square - longest side to be about 230mm.
- A plastic circle template.

FIXING THE DRAWING PAPER

Now fix a sheet of white A2 paper (Fig. 2.1)

![Fig. 2.1 Different Sizes of Drawing Papers](image-url)
**USE THE TEE-SQUARE**

You can use a tee-square to draw horizontal lines; press the stock of the tee-square against the left hand edge of the board and allow it to slide up and down until the blade is in the required position. The pencil should be held against the ruling edge of the tee-square blade (Fig. 2.2).

![Fig. 2.2 Check contact of T-square head with drawing board edge.](image)

**USING THE SET-SQUARE**

You will need to use your set-squares for drawing vertical and sloping lines. Move the straight edge/tee-square to the required position. Place the set-square on the tee-square with its base on the top edge of the blade, and the vertical edge in the required position (Fig. 2.3).

![Fig. 2.3 Use Set-squares with T-square](image)

All construction lines should be drawn first, followed by all final lines.
DRAWING THE BORDER AND TITLE PANEL

Now that the drawing paper is fixed to the board and you have some general information about drawing lines, the first operation is to draw the border and title panel.

The border should be drawn around the four edges of the paper 10mm wide. Initially just draw the construction lines for the border.

Form the title block by drawing a construction line 40mm up from the bottom border line. Add the short vertical and horizontal lines.

DRAWING RECTANGLES

Begin by drawing the construction lines for the 4 rectangles on the bottom left hand corner of the sheet. For each rectangle first draw two horizontal lines about 30mm apart and about 75mm long. Join the ends of the horizontal lines by drawing two vertical lines about 60 mm apart forming a rectangle 60x30 mm.

DRAWING CIRCLES & QUADRANTS

Draw the construction lines for the 3 circles & 3 quadrants in the top right hand corner of the drawing. First draw the horizontal and vertical axes lines for each circle. Then draw the circle. If you are using a compass to draw the circles, the compass point should be carefully placed on the precise spot where the horizontal and vertical axes cross. Then draw the circle as a curved construction line. If you are using a circle template, you will need to relate the axes marks on the template with the axes drawn on your drawing sheet.
DRAWING LINES TYPES

Lines vary in thickness and form according to their purpose and importance.

Construction lines have already been mentioned. They are setting-out or guide lines, and they should be drawn as light as possible. They are generally covered over by stronger final lines.

Thick active lines are continuous, and used to indicate important parts of structures such as the outside and inside faces of walls; the faces of reinforced concrete members and ground levels.

Thin active lines are continuous, and used to show items drawn as plan views (as opposed to sectional plans) and as elevations; also to define less important items shown in section.

Hidden lines are broken lines, and can be either thick or thin depending on their important. They show work which is not visible - e.g. the position of beams on a floor plan.

Centre lines are thin chain dotted lines and are used as the name implies, to show the centre of things - e.g. the centre of a beam.

Break lines are thin continuous lines with a zig zag in them to show a break in the continuity of the line or view.

Drain and other underground pipe lines may be shown by a thick chain line or a thick continuous or broken line. In the case of underground drains, arrowheads are often added to show the direction of flow.

Dimension lines and projectors may be shown in thin lines with arrows heads.
SECTION LINES OR PLANES

A section is a view of a building or object obtained by making an imaginary cut through it. Sometimes called a section plane, it shows the position where the imaginary cut is made. The line itself is a chain dotted line, with the line terminated by arrows which point in the direction of the viewing.

THICK ACTIVE LINES
defining main outlines of structures in section

THIN ACTIVE LINES
defining outlines in plan and elevation

HIDDEN LINES-THICK OR THIN
showing work not visible or work to be removed

CENTRE LINES-THIN LINES

BREAK LINES-THIN LINES
for break in continuity

SECTION PLANES-THICK AND THIN
thick lines at ends and changes of direction only thin elsewhere

STAIRS arrow indicates direction of travel

RAMP arrow indicates direction of fall

Fig. 2.4 Line Types
3 Drawing to Scale

It is not generally feasible to draw buildings, or parts of buildings, to their actual size. Instead they are drawn in proportion to the actual measurement of the object. This proportion is known as the scale of the drawing. Common scales are 1:1, 1:5, 1:10, 1:20, 1:50, 1:100, 1:200, 1:500, 1:1000, 1:1250, 1:2500, 1:10000. If the scale is 1:5, the object is drawn a fifth of its actual size; in other words the object is five times larger than shown on the drawing. If the drawing is 1:10, the object is drawn a tenth of its actual size, and so on.

**Using a 1:50 & 1:100 Scale**

A 1:50 and 1:100 scale can be used for the floor plan of a building, both in architectural and structural layouts.

**Using a 1:200 Scale**

A 1:200 scale can be used for the floor plan of a large building, or the site plan of a small building project.
One of the most important stages in producing a construction drawing is the lettering and dimensioning of the drawing. Every drawing needs a title, and often subtitles are required. In addition in order to make the drawing easier to understand and more useful to the builder and others, descriptive notes and dimensions will generally be required. Freehand lettering is the cheapest way of annotating drawings and is generally the quickest method.

**TYPES OF LETTER & GUIDE LINES**

The two main groups of letters are ‘CAPITAL LETTERS’ and ‘lower-case letters’. The use of lower-case letters is generally restricted to notes, but capital letters can be used for both notes and titles. It is easier to produce legible capital letters than lower-case letters, it is suggested that initially you use only capital letters on your drawings. It is important that all letters be formed between guide lines. A lower and upper guide line should be drawn as lightly as possible so that you can just see them. Drawing them takes a little extra effort but is worth the trouble.

**EXAMPLE OF LETTERS AND NUMBERALS**

![Sample of Lettering](image)

Fig. 4.1 Sample of Lettering
**DIMENSIONING**

It is important that all drawings are fully dimensioned, so that the builder and others know the required size of every part of the building. It is sensible however not to duplicate dimensions, as this makes the drawing unnecessarily crowded.

Dimension lines should be unbroken lines. They can be terminated at their ends by open arrowheads, solid arrowheads, oblique strokes, dots or circles.

Thin lines called projection lines, or projectors, should extend from about 2 mm away from the part of the object being dimensioned to just beyond the dimension line termination.

If any dimension is not drawn to scale, the letters “NTS” (not to scale) should be written after the dimension.

**HORIZONTAL DIMENSIONS**

Horizontal dimensions should, where possible, be indicated on plans rather than on elevations. Where feasible dimension lines should be located outside the building or object rather than inside it.

![Image of Dimensioning Methods]

Fig. 4.2 Dimensioning methods
VERTICAL DIMENSIONS

Vertical dimensions should, where possible, be indicated on sections rather than on elevations. All vertical dimensions of a building should relate to a site datum. The site datum is a fixed vertical level on the site, and for convenience is often set at the ground floor level of the building under construction.

DIMENSIONING BY LEVELS

Different members of the building team tend to follow different practices regarding the measuring points for vertical dimensions. The client is concerned with clear storey heights i.e. the dimension between the finished floor level and the finished ceiling levels. Architects will invariably give the finished floor level (FFL) on their drawings. Site staff work initially to the structural floor level (SFL). Structural engineers need to know the structural floor level (SFL), and their vertical dimensions will generally be measured from SFL to SFL.

ORIENTATION OF PLANS

North points are generally shown on key plans, site plans, block plans and sometimes floor plans, to indicate the position of north relative to the site or building. The point of the arrow should be drawn to face north.

DATUM, LEVEL SYMBOLS

North point

SSL FFL
Level on plans
Level on plans

123
Ceiling height on plans
Level on sections and elevations

Fig. 4.3 North Points and Level Marks
5  Graphic Conventions

Construction drawings are a means of communication between the various members of the building team, and it is important that they employ a common graphical language. It helps to achieve this if agreed standards are followed in respect of lines, hatching and symbols, etc.

**REPRESENTATION OF MATERIALS**

In sectional views of a building, the parts of the structure which are cut by section plane may be hatched to indicate the nature of the materials used.

Common examples of hatching for construction materials.

**MATERIAL SYMBOLS IN SECTION**

- **Brickwork**
- **Blockwork**
- **Concrete**
- **Plaster/Render**
- **Timber-planed**
- **Subsoil**
- **Topsoil**
- **Granular fill**
- **Damp-Proof Membrane**
- **Metal**

Fig. 5.1 Graphical Symbols of Building Materials
DOORS

There are standard ways of indicating on plans the opening methods for doors—i.e. whether they are swing doors or sliding doors—and the direction in which they open.

Fig. 5.2 Door Symbols

WINDOWS

The opening methods for windows are generally indicated on the elevations.

Fig. 5.3 Window Symbols
SYMBOLS

There are wide range of standard graphic symbols available to indicate the position of various components, and related information. Some common examples are given below, but reference needs to be made to BS 1192 for full details of the recommendations for symbols and other graphic conventions.

Fig. 5.4 Architectural and Building Services Symbols

References:
BS 1192 Part 1 and 3: 1987
6 Orthographic Projection

Buildings, and the materials and components of which buildings are constructed, are three dimensional. That is to say they have length, width and height. It is possible to draw a picture of a building or object to show these three dimensions. Generally however in construction drawing the method used to describe buildings or objects pictorially is called orthographic projection. This method uses views termed plans, elevations and sections, which have only two dimensions.

**FIRST AND THIRD ANGLE PROJECTION**

Since there are two systems of orthographic projection, it is necessary to give them names for identification. They are commonly known as first angle projection and third angle projection.

To explain why they are so called, you may place the two boxes together as shown. It can be seen that one system falls neatly in the first quadrant and the other in the third quadrant (Fig. 6.1).

Orthogonal projection of an object

Fig.6.1 1st and 3rd angle Projection
**PROJECTION SYMBOLS**

In order to indicate the angle of projection to be used, the symbols has to be printed on the drawing (Fig.6.2). Examples of Orthographic Projection are shown in Fig 6.3.

<table>
<thead>
<tr>
<th>Projection</th>
<th>Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>First angle</td>
<td><img src="image" alt="Symbol" /></td>
</tr>
<tr>
<td>Third angle</td>
<td><img src="image" alt="Symbol" /></td>
</tr>
</tbody>
</table>

![Projection symbol proportions](image)

**Fig. 6.2 Projection Symbols**

![Plan](image)

![Side elevation](image) ![Front elevation](image)

**Fig. 6.3 Example of 3rd Angle Projection**
SECTIONAL VIEWS

Objects with little interior detail can be represented satisfactorily in orthographic projection by exterior views, the interior construction being shown by hidden detail lines: When the interior detail is more complicated, then the hidden detail lines may be confusing and difficult to interpret correctly. In such cases the draughtsman imagines the object to be cut by a plane, and assumes the part of the object between his eye and the plane to be removed. This exposes the interior detail which can then be shown by full lines instead of hidden detail lines. The position of the cutting plane is selected by the draughtsman to show the interior of the object to the best advantage. For an object which has internal details that are not on one line, a staggered section may be appropriate. When a revolved section of an object is required, it may be drawn directly on the part under consideration.

![Fig. 6.4 Sectional Elevation and Plan](image-url)
The example below shows the offset cutting plane of the staircase, this practice should be continued to the top landing; each step should be drawn but once. The top landing will look much as it would with a normal cutting plane. The view down the stairwell would show the down flight as it would normally appear in the stairwell. The limit line shows where the stairs break between floor plans in the same location on the plans of each floor. Double limit lines are used to separate the up half from the down half where they meet in plan.

Fig. 6.5  Section of Staircase
7 Pictorial Views (3D)

7.1 Isometric Projection

Isometric projection is a method of showing three faces of an object on one drawing (Fig. 7.1). The word isometric means ‘equal measure’ and the basis of isometric projection is that three lines defining the three faces or planes produce three equal angles of 120 degrees and the sides are shortened to 82% of their true length (Fig. 7.2). which shows, in isometric view, a solid concrete building block and a hollow concrete building block. Isometric projection is achieved in practice by drawing all vertical lines as vertical, and all horizontal lines at 30 degrees to the horizontal, sloping either to the right or left.

Fig. 7.1 Examples of Isometric Projection
It is normal practice to make the measurements on isometric drawings to the same scale as used for plans, elevations and sections. This is not mathematically correct however, and slightly distorts the appearance of the plan view. It is possible to produce an accurate isometric drawing by using a special scale, but consideration of this aspect is inappropriate to an introductory book on construction drawing.

An isometric projection is found by constructing a view that shows the diagonal of a cube as a point. An isometric drawing is not a true projection since the dimensions are drawn true size rather than reduced in size as in projection. By using the isometric drawing instead of the isometric projection, pictorials can be measured using standard scales, the only difference being the 18% increase in size (Fig. 7.2).

The four-center ellipse method can be used to construct an approximate ellipse in isometric by using four arcs that are drawn with a compass. The four-centre ellipse is drawn by blocking in the orthographic view of the circle with a square that is tangent to the circle at four points. This square is drawn in isometric as a rhombus. The four centres are found by constructing perpendiculars to the sides of the rhombus at the midpoints of the sides (step 1 to 3).
7.2 Perspective Projection

A perspective is a view that is normally seen by the eye or camera, and is the most realistic form of pictorial. All parallel lines converge at infinite vanishing points as they receded from the observer. There are three basis types of perspectives are: one-point, two-point, three-point, depending on the number of vanishing points used in their construction (see Fig. 7.3).

One-point perspective: The one-point perspective has one surface of the object that is parallel to the picture plane: therefore it is true shape. The other sides vanish to a single point on the horizon called a vanishing point.

Two-point perspective: A two-point perspective is a pictorial that is positioned with two sides at an angle to the picture plane; this requires two vanishing points. All horizontal lines converge at the vanishing points, but vertical lines remain vertical and have no vanishing point.

Three-point perspective: The three-point perspective utilizes three vanishing points since the object is positioned so that all sides of it are at an angle with the picture plane. The three-point perspective is used in drawing larger objects such as buildings.

Fig. 7.3 Aerial Views and Vanishing Points

Abbreviation:

PP = Picture Plane is the plane on which the perspective is projected. It appears as an edge in the top view.
SP= Station Point is the location of the observer’s eye in the plan view. The front view of the station point will always lie on the horizon.

CV= Center of Vision is a point that lies on the picture plane in the top view and on the horizon in the front view. In both cases, it is on the line from the station point that is perpendicular to the picture plane.

VP= Vanishing Point is all vanish line (VL) Converge at infinite vanishing points as they recede from the observer.

Hor.= Horizon or Eye level is a horizontal line in the front view that represents an infinite horizontal, such as the surface of the ocean.

GL= Ground Level is an infinite horizontal line in the front view that passes through the base of the object being drawn.

Different views can be obtained by changing the relationship between the horizontal and the ground line (Fig. 7.4). An aerial view will be obtained when the horizon is placed above the object in the front view. When the ground line and the horizon coincide in the front view, a ground-level view will be obtained. This would give the view that would be seen if your eye was looking from the ground. A general view is one where the horizon is placed above the ground line and through the object, usually at a height equal to the height of a person.

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Fig. 7.4 Ground Level View and General View
7.3 Oblique Projection

Oblique pictorials are three-dimensional pictorials made on a plane of paper by projecting from the object with parallel projectors that are oblique to the picture plane. There are three basis types of oblique drawings are used that are based on these principles: The three types are: (1) cavalier, (2) cabinet, (3) general (Fig. 7.5). In each case, the angle of the receding axis can be at any angle between 0° and 90°. Measurements along the receding axes of the cavalier oblique are true length (full scale). The cabinet oblique has measurements along the receding axes reduced to half length. The general oblique has measurements along the receding axes reduced to between half and full length. An oblique should be drawn by constructing a box using the overall dimensions of height, width, and depth with light construction lines.

Fig. 7.5 Oblique Projection
8 Construction Drawings

8.1 Site Plans

A site plan is a location drawing, and like most plans is a view looking downwards. It supplies a bird’s eye view of the shape, size and layout of the entire site.

The purpose of a site plan is to

- provide a general picture of the site, including its shape and extent;
- locate the buildings and other elements of the project - e.g. roads, garden walls and landscaping - both horizontally and vertically;
- indicate the levels and surface features of the finished site;
- sometimes provide information on external services, especially underground drainage.

GRIDS

The use of grids to which sizes and locations of building components may be related, is helpful in preparation of all types of drawings and particularly so when modular coordination is applied to design and construction. Grid rotations should be used as appropriate for each form of grid. Most common grid rotation is using letters to define the lines on axis and numerals to define the lines on the other axis.

8.2 Floor Plans

Floor plans are generally the most useful, and the most used of the location drawings. They are really sectional plans because they show the view obtained by cutting horizontally through a building at some point above the floor level. It is assumed that you move away the top part of the building and look down at the plan of the remaining bottom part. This plan view will not only illustrate the arrangement of the rooms and spaces and their shapes, but will also show the thickness of all the external and internal walls.

The level at which you cut horizontally through a building is commonly assumed to be 1 metre above the floor level. This has the advantage of passing through most of the windows and doors, which means that dimensions giving the positions of all openings can be given. An example of a floor plan is shown on Fig. 8.1.
The purpose of a location floor plan is to:

- indicate the shape and the layout of the building;
- provide the setting out dimensions for the building;
- locate spaces such as rooms, and parts such as doors;
- provide references stating where more detailed information can be found.

**WALLS AND PARTITIONS**

- Thick lines should be used to define the inside and outside faces of external walls, and both faces of the internal partitions.

- Where cavity walls form part of the construction the cavity may be indicated by thin lines, but it is suggested you omit this detail on the 1:50 floor plan.

- Hatching is often used, particularly on larger scale plans. Where floor plans show existing walls, they are often filled in solid.
**WINDOWS**

- Windows will be positioned laterally on the floor plans. Their positions within the wall thickness will be shown on the assembly drawings if these are provided. However, where the scale of the floor plan is 1:50 or larger, it is sensible to locate the windows in approximately their correct positions relative to the wall faces.

- It is usual practice to number each window - W1, W2, W3 etc.

**DOORS**

- Doors should also be numbered - D1, D2, D3 etc.

- At each door position it should be made clear which way the door is hung.

**OTHER ITEMS**

- Sanitary fittings, cupboards and other fittings should be shown in outline on floor plans. It is important however not to repeat information which is given on other drawing, such as assembly and component drawings. If too much information is provided, the drawing will become confusing and difficult to read.

**ROOM NAMES AND NOTES**

- A name should be given to each room or space. On large projects room numbers will also be provided.

- Notes should be kept to a minimum and duplication of information provided on other drawings should be avoided.

- The most important thing is that the lettering should be easy to read.
8.3 Sections

A section is a view of a building or object obtained by making an imaginary cut through it. The term section is mainly used where the cut is made in a vertical direction, and this is so in the case of location sections.

A vertical section through a building will show details of the construction of the foundations, walls, floors, roof and other parts. The number of sections required of a building will depend on its size and complexity. Generally there will be at least two sections - one of these will be a cross section, across the width of the building. The other will be a longitudinal section, along the length of the building. Sections are intended to help the builder construct the building, so the exact position of the section should be chosen to show as much construction as possible.

The purpose of a location section is to (a) give a vertical view of the building; and (b) provide overall vertical dimensions and levels.

Walls and Partitions

- Thick lines should be used to define the inside and outside faces of external walls, and both faces of the internal partitions.

- Where cavity walls form part of the construction the cavity is often indicated by thin lines.

- Hatching is often used, particularly on the larger scale sections.
OTHER STRUCTURAL ELEMENTS

- Thick lines should be used to define both faces of concrete floor and roof slabs.

- Thick lines should also be used to define the faces of other structural elements, such as foundations and beams, when these are viewed in section.

Fig. 8.2 Section A-A of House in Fig. 8.1
### 8.4 Elevations

An elevation is a view you get if you look in a horizontal direction at the vertical side, or face, of a building or object. When drawing an elevation you need to take the horizontal dimensions from the plans and the vertical dimensions from the sections. An example of a elevation is shown in Fig. 8.3.

The purpose of a location elevation is to (a) show the external faces of the building; and (b) locate the door and window openings and other features of the building.

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**Fig. 8.3 Elevation of House in Fig. 8.1**
8.5 Assembly Drawings

Assembly drawings provide precise, detailed information as to the construction of buildings, including matters such as the fixing of materials, components and elements. The usually consist of sectional plans and vertical sections, but it will be appropriate on occasions to use other methods, including isometric projection and elevations.

On some smaller projects it may not be necessary to produce assembly drawings, as the assembly information can be given on the location drawings, particularly when they are drawn to a scale of 1:50.

The purpose of an assembly drawing is to:

- show the construction of individual elements of structure such as foundations, walls, floors and roofs
- show the arrangement where two elements meet each other - e.g. the junction between a wall and a roof, and between a column and a wall
- provide a reference as to where more detailed information about a particular part of the construction is provided.

**EXAMPLES OF ASSEMBLY DRAWINGS**

Assembly drawings provide information to contractors which enable them to construct buildings on site. They include the assembly of both structural and non-structural elements, components and materials. An example is given below.

![Roofing Detail](image)

**Fig. 8.4 Details at Roof Edge**
8.6 Component Drawings

A component drawing provides detailed information about the nature and manufacture of a specific item incorporated in a building. This is in contrast to an assembly drawing which shows several parts, or a location drawing which provides general information. Components include things such as skirting and lintels, as well as larger items manufactured off-site, such as windows and kitchen cupboards.

The purpose of a component drawing is to (a) show the nature, shape, assembly method and further details of components, required by the manufacturer and others; and (b) provide additional information which cannot be conveniently given on location or assembly drawings.

Fig. 8.5 Component Drawings of Wooden Doors
8.7 Structure Engineering Drawing

Structural engineering drawings help those, whose job it is to fabricate, erect, supervise and integrate the structural engineering work. The different needs and priorities of these people influence the method of providing, the information, which will sometimes vary from architectural drawing techniques previously discussed. Some of the implications are mentioned below.

**TYPES OF STRUCTURAL ENGINEERING WORK**

Structural engineers and structural engineering technicians produce drawings for a wide range of structural methods, including structural steelworks, reinforced concrete using in situ, precast and prestressed concrete, structural brickwork and blockwork, and structural timber work.

**STRUCTURAL DETAILING**

The process of preparing working drawings for structural engineering work is generally referred to as structural detailing. The general principle followed is to break down the total structure into individual elements such as columns, beams, floor slabs etc., and then to detail each element in turn.

**STRUCTURAL STEELWORKS**

The three main groups of drawings for illustrating steelwork structures are general arrangement drawings, fixing details, and details of individual members.

General arrangement drawings include steel framing plans, elevations and sections. Fig. 8.6 is an example of a steelworks floor framing plan. Steel framing plans indicate the positions and sizes of beams at a specific floor or roof level, together with the positions and sizes of columns. Elevations and sections will show columns and beams as well as additional members such as wind bracing.

**MARK REFERENCES FOR BEAMS AND COLUMNS**

It is necessary to identify each steel member by a distinctive mark reference whenever it appears on a drawing. The same mark must also be painted on the actual member before it leaves the workshop for dispatch to the site.

A common system is to mark the horizontal grid lines on the steel framing plans with numbers-1, 2, 3 etc. -and the vertical grid lines with letters- A, B, C etc.
This system enables each member to be identified. Columns are given a mark related to the grid intersections on the plans. Thus the top left hand column is given the mark of A1 because it is located where grid lines A and 1 intersect. The marks for the beams are a combination of the floor reference and the grid line letter and number. For example in Fig. 8.6 the horizontal beam in the top left hand corner is marked as C-1A. The letter C indicates it is a second floor beam; the figure 1 denotes that the beam is located at grid line 1; and the letter A denotes that it begins at grid line A.

Fig. 8.6 General Layout of Structural Steel Framed Building

Notes: All columns are 254x254x73kg UC
FIXING DETAILS

Fixing details provide information on the fixing of members to each other, or to different parts of the structure. Examples are the fixing of a column to a foundation, a connection between a beam and a column, the connection of one beam to another beam, and the splicing of similar members to each other. Fig. 8.7 is an example of a fixing detail showing the connection between a steel column and a concrete base.

![Fig. 8.7 Details of Steel Column and Holding Down Bolts](image)

The various steel members -universal beams, universal columns, rolled joists, rolled channels, tees and angles- are fixed together by welding or bolting, either in the workshop (shop connections) or on the construction site (site connections). Fig. 8.8 is an example of details of connections.

![Fig. 8.8 Connection Details of Steel Members](image)
**REINFORCED CONCRETE STRUCTURES**

The two main groups of drawings for illustrating reinforced concrete structures are general arrangement drawings, reinforcement drawings. General arrangement drawings are floor plans, roof plans, sections and elevations, drawn to a small scale and providing an overall view of the work. They supply the setting out dimensions, the positions and sometimes the sizes of all the members. Fig. 8.9 is an example of a small plan of a typical floor showing slab thickness and reinforcement, beam serial numbers and sizes. A reference grid is provided similar to that previously described for a structural steel building. Reinforcement drawings of structural elements are drawn to a larger scale and give detailed information about the reinforcement (Fig. 8.10). There is no excuse for ambiguity, and it is essential that all drawings are easy to read, and cannot be misunderstood.

![Fig 8.9 R.C. Details of Floor Slab](image-url)
REINFORCEMENT IDENTIFICATION

Standard abbreviations are used to provide information about the reinforcement.

- **R**-mild steel round bars
- **T**-high tensile bars
- **T1/B1**-reinforcement near the top and bottom face of the concrete respectively.

Each reinforcing bar on a drawing is given a notation consisting of standard abbreviations, dimensions in mm and mark numbers. This information is provided in the following sequence: number, type, size, mark, centres and location.

The meaning of the notations given to the reinforcement (Fig. 8.9 and Fig. 8.10).

- **21T10-10-200T1**, this means that there are 21 bars, which are of high tensile steel, with a diameter of 10 mm, and an bar mark of 10. The bars are spaced 200 mm apart and placed near the top face of the concrete.
- **Links 18T10-9-200**, this means that there are 18 stirrups, which are high yield bars, of diameter 10 mm and bar marked as 9.
8.8 Service Drawings

**TYPES OF BUILDING SERVICE WORK**

Building services are generally assumed to include hot and cold water supplies, above and below ground drainage, including sanitary appliances, refuse disposal, heating, ventilation, air conditioning, electrical installations including lighting, telecommunications, gas installations, fire protection, mechanical conveyors and security systems. Drawings are required for all of these services.

In this introduction to construction drawing a few simple examples are given of below ground drainage, water supplies and electrical installations for domestic buildings.

**MAIN GROUPS OF DRAWINGS**

The three main groups of drawings for illustrating services work are general layouts locating the arrangement of pipes, cables and ducts; details of plant areas; and details of specific items. In addition there are schedules for items such as manholes, radiators, valves etc., but these are beyond the scope of this reading material.

**USE OF GRIDS**

In projects where a structural grid is used, the services elements should be related to this grid. In other cases the plant and equipment will be shown on services drawings in relation to a modular grid.

**IDENTIFICATION OF SERVICE COMPONENTS AND EQUIPMENT**

Services drawings provide information about a wide variety of different components and equipment. In order to identify individual items, it is usual to give them a reference number on drawings such as services layout drawings and location plans. An example is that a radiator might be given a reference of R305, which would mean it was a radiator, on the third floor, and was the fifth consecutive radiator on that floor.
**GENERAL LAYOUTS**

Copy negatives (transparent copies) of the architect's 1:100 location drawings are often used by the building services engineers and technicians to show the general layout of the pipe work, ductwork, trunking, cables etc. It is advisable to obtain these copy negatives from the architect at an early stage before too much detail is added. However, where this procedure is adopted, it is important that later revisions to the architect's drawings are taken into account on the copy negative. A simple example of a general layout is shown on Fig. 8.11 which is a wiring layout for lighting in a bungalow.

**PLANT AREA DRAWINGS**

Areas where the services equipment is concentrated are normally drawn to a larger scale, such as 1: 50 and 1: 20. Plans of these plant areas are the commonest form of plant area drawings, but elevations and sections are often required. Typical areas to be covered are boiler rooms, air handling plant rooms and electrical substations.

**DETAILS OF SPECIFIC SERVICES ITEMS**

As the scales of general layouts and plant room area drawings are comparatively small, additional detailed information on individual items is also required. This additional information is given on details of specific services items.

![Building Services Drawing - Electrical Wiring Layout](image-url)
8.9  Freehand Drawings

Freehand or sketch drawings are used for a variety of purposes. They may record or explain the appearance and construction of an existing building, or sketch in outline a designer’s ideas for a proposed structure. Often freehand drawings will be used as preliminary constructional details, or to clarify on-site details which have not been made clear by the production drawings issued to the contractor. Freehand drawings may also be used as presentation drawings. This type will need to be of a high standard and will often incorporate advanced drawing techniques, including perspective drawing, shadow projection and rendering.

DRAWING TECHNIQUES

In order to produce satisfactory freehand sketches of existing structures the draughtsperson will need to gain experience in the art of observation-sometimes referred to as training the eye. They will also need to acquire the ability to draw straight and curved lines of an even quality. Thirdly they will need to gain the ability to draw in proportion.

PRODUCTION INFORMATION SKETCH DRAWINGS

Sometimes architects and other design team members will need to produce immediate information. The information must be precise and accurate, but can conveniently be provided in the form of freehand sketch drawings.

Some general advice on the matter of freehand sketches is given below.

1. Draw everything first as light construction lines, and only firm in the lines when you are satisfied that everything is drawn accurately and in proportion.

2. Where feasible, divide what you are drawing into a number of simple geometrical shapes.

3. If what you are drawing is symmetrical, draw in the axes.

4. Draw in the main geometrical shapes first. Then add the detail.

5. Draw horizontal lines from left to right, unless you are left handed, in which case you will probably find it easier to draw them from right to left. If the line to be drawn is a long one, you can draw it as a continuous line made up of a series of shorter lines about 50 mm long.

6. Draw vertical lines from top to bottom.
7. Ensure that lines which are at right angles to each other are drawn as exact right angles.

8. In the case of circles first draw the axes, and mark the points on the axes where the circle is meant to cross.

Fig. 8.12 Freehand Sketch of a Site Plan
References:

1. B.S. 1192 : Part 1,2,3,4,5 Construction Drawing Practice
2. Construction Unit (1998), Computer-Aided Design using MicroStation 95, Industrial Centre, The Hong Kong Polytechnic University