UNIT 1 CONSTRUCTION DRAWING – PRINCIPLES AND PRACTICE

Structure

1.1 INTRODUCTION

An idea or information can be communicated by one of the following means :

(a) through text only called *text modeling*

(b) through mathematical calculations called *mathematical modeling*

(c) through figures and pictures called *graphical modeling or drawing*

(d) through various combinations of the above means.

If a building is to be constructed, detailed working drawings of the building and its components – both architectural and structural – are prepared so that it can be constructed with the help of the drawings *only*, without the presence of the architects and the structural engineers who have prepared those drawings.

These drawings are prepared according to rules and specifications laid down by International Standard Organisation (ISO) as well as by Bureau of Indian Standards (BIS) so that the same may be executed in any part of the world independent of language barriers.

Objectives

After studying this unit, you should be able to

- describe the meaning and definition of a drawing,
- classify the types of drawing,

- appreciate the requirements of drawing in civil engineering,
- discuss the drawing sheet requirements, and
- explain the principles of presentation of good drawings.

1.2 GENERAL

1.2.1 Meaning and Definition

A structure is built to meet the functional requirements of a client. Those requirements conceptualized and translated into figures and pictures by the architects are known as *Architectural Drawings.*

The civil or structural engineers design the structure for durability, safety and serviceability and prepare '*Structural Drawings'*. Both types of drawings are the prerequisite for erecting any structure.

Here the mode of communication of idea is through figures and pictures called '*Drawings*'.

This mode of communication is very simple, concise and self explanatory and this is why the proverbial statement that 'the drawing is the universal language of engineers' is very much true.

1.2.2 Types of Drawing

All objects are three dimensional. Hence, graphically they can be expressed with reference to three coordinates in space. Buildings and their components, therefore, can also be drawn with reference to these three coordinates for clear visual conception. These drawings may be of two types :

(a) Orthographic, and

(b) Pictorial

Orthographic Drawings

Orthographic drawings are two dimensional. To be more specific, the views are obtained by projecting a building or its components on different planes of three mutually perpendicular coordinate systems (Figure 1.1).

(a) Orthogonal Coordinate System (b) A Rectangular Solid Showing Six Planes

Figure 1.1

There are two universal methods of projections :

(a) First angle projection method, and

(b) Third angle projection method.

First Angle Projection Method

In this projection method (Figure 1.2), all projections are arranged with reference to front elevation of (a) as follows :

Figure 1.2 : Projections Arranged with Respect to Front Elevation (a)

The view from above, (b), is placed underneath.

The view from the left, (c), is placed on the right hand side.

The view from the right, (d), is placed on the left hand side.

The view from below, (e), is placed above.

The projected view from the rear, (f), may be placed on the left or on the right as convenient.

Third Angle Projection Method

In this projection method (Figure 1.3), with reference to front elevation (a), the other views are arranged as follows :

Figure 1.3 : Projections Arranged with Respect to Front Elevation (a)

The view from above, (b), i.e. plan is placed above.

The view from the left, (c), i.e. left side elevation is placed on the left hand side.

The view from the right, (d), i.e. right side elevation is placed on the right hand side.

The view from below, (e), i.e. bottom plan is placed below.

The view from the rear, (f), may be placed on the left or on the right side as convenient.

In building drawing, *plan* is a sectional projection viewed from above. The section is taken by a horizontal plane passing just above the window sill level so that the maximum details of components of a building may be drawn as shown in Figure 1.4(a).

Figure 14(b) shows the elevation of the building. If the views mentioned above are not sufficient to show and explain all the interior and exterior details, additional sectional elevations are drawn for the needful. These sections are marked on the plan and drawn separately on the sides as indicated by arrows (Figure 1.4(c)). Sometimes a small and complicated component may be shown on larger scale for more explicit view (Figure 1.4(d)).

Figure 1.4 : Drawing of One Room

Pictorial Drawing

Pictorial drawings are three dimensional drawings (3D). For a 3D view, the projections on three mutually perpendicular planes are drawn to help visualize the shape of an object. There are two types of pictorial view :

(a) Isometric Drawing, and

(b) Perspective Drawing.

Isometric Drawing

Isometric view (Figure 1.5) of an object may be visualized as follows :

If a *cube* (*ABCDEFGH*) (Figure 1.5(a)), of which the front elevation and bottom face plan are Figure 1.5(b) and Figure 1.5(c) respectively, is rotated in the horizontal plane by an angle 45° about its edge *HD*, and then tilted forward about point *H* such that the diagonal *HB* becomes vertical to the base, the front elevation of the cube obtained in this position is the *isometric view* of the *cube*.

Figure 1.5 : Explaining Isometric View

In this position, the projections of *HE* and *HG* make 30° to the base line, whereas projection of *HD* remains vertical. The projected lengths of the edges will be approximately 81%, (i.e. $\frac{\text{Isometric length}}{\text{Actual length}} = \frac{9}{11}$) of their respective original lengths. Hence, for an isometric drawing :

(a) The three principal axes are marked along *DA*, *DC* and *DH* each inclined to the other at 120°.

(b) The lengths of sides *parallel* to these axes (i.e. isometric lines) are $\frac{9}{11}$ times the actual length.

(c) The lines which are not parallel to the isometric lines are called *non-isometric lines*. The projected lengths of such lines depend on its orientation in the object (Figure 1.6). For example, though *AC* and *BD* are equal but their projected lengths are different as they are non-isometric lines.

Figure 1.6 : Projected Lengths of Isometric and Non-isometric Lines

Perspective Drawing

Perspective means the proper relative position of the objects as one perceives. Like photograph it gives a picture of relationships between objects in space. In Figure 1.7, though the size of each boggy is the same, successive boggy looks smaller as distance from the point of sight (in this case it is front of the engine) increases. Perspective drawing, a three-dimensional drawing, therefore, is to show how things look to a spectator. Drawing a perspective view is complicated; therefore, only one example of a small building (Figure 1.8) is given here to visualize its shape in this view.

Figure 1.7 : Perspective View

Figure 1.8 : Perspective View of a Building

SAQ 1

(a) Why an object is preferably described in graphical mode?

(b) Which types of drawings are required for construction of a structure?

(c) Write short notes on orthographic drawings.

(d) Write short notes on pictorial drawings?

1.3 DRAWING SHEET REQUIREMENTS

1.3.1 Sizes

The standard drawing sheet sizes are depicted in Table1.1.

Table 1.1 : Standard Sheet Sizes

Designation	Dimension (mm) $x \times y$
A0	841 × 1189
A1	594 × 841
A2	420 × 594
A3	297 × 420
A4	210 × 297

From analysis of the sheet sizes, as depicted in Table 1.1, it may be concluded that if the area of a standard sheet is 1 m^2 (i.e. 10^6 mm^2), then the ratio of shorter side (x) and longer side (y) will be 841 : 1189

or, $1 : \sqrt{2}$

The same conclusion may be graphically expressed as that the two series of *successive* sizes are obtained by halving along the length or doubling along the width. The areas of the two successive sizes are in the ratio of 1 : 2 (Figure 1.9).

Figure 1.9 : All Sizes of Sheet in One View

1.3.2 Layout

For a proposed drawing, a drawing sheet of appropriate size is selected so that all necessary views and sections forming complete drawing may be accommodated in the *drawing area* leaving ample space for border area, title block, schedules, north point, site plan, etc. (Figure 1.10).

Figure 1.10 : Details of Drawing Sheet

Border and Frame

A border around the sheet enclosed by the edges of the trimmed sheet and the frame is left for binding and filing. The minimum width of the border is 10 mm for A2, A3 and A4 sizes, whereas it is 20 mm for A0 and A1 sizes.

North Point

It is put at the topmost corner on the left hand side of the sheet.

Title Block

It is at the bottom most corner on the right hand side of the sheet. It is normally rectangular in shape and of size 150 mm × 100 mm for A1 and A2 sheets and 123 mm × 50 mm for A3 and A4 sheets. It contains all the references regarding the drawing such as drawing title, drawing number, scale, date of drawing, signatures of checking and vetting officers as well as of draftsman and representative of drawing agency.

Schedule

It is placed above the title block. In architectural drawing it contains details of doors, windows, ventilators, masonry mortar, plastering mortar, etc. In structural drawing schedule is named as *Notes* and it contains informations like, cover, development length, mix proportions of cement concrete, grades of steel, etc.

Site Plan

As the name indicates, it is the plan to locate the position of the site in relation to its neighbouring streets and plots. The plot number of the site as

well as those of its neighbouring plots is also mentioned. It is placed at the right topmost corner of the sheet.

Drawing Area

The drawing area contains all the necessary drawings for the execution of the construction works.

1.3.3 Folding of Prints

For easy filing, carrying them to the site etc. necessitate that they may be folded appropriately. Hence the basic principles for folding are as follows :

(a) All drawings are folded to A4 size.

(b) The full title block appears on the top for easy location of the required sheet.

(c) The bottom right corner shall be outermost visible section and shall have a width not less than 190 mm.

SAQ 2

(a) Write short notes on sizes of drawing sheets describing the principles involved in fixing these sizes.

(b) Describe the standard layout of a drawing sheet for complete visualization of the drawing.

(c) How the print of a drawing sheet is folded for easy handling?

1.4 REQUIREMENTS OF DRAWINGS

1.4.1 Lines

All drawings are made of lines. These lines may be of different types, thicknesses and colours representing different applications and features.

Line Types and their Applications

Different types of lines, having different applications and features, have been described in Table 1.2*.

* SP 46 – 1988 : Engineering Drawing Practice for Schools and Colleges.

Line Thicknesses

Line thickness varies in the range of 0.18 mm and 2 mm with grading of lines in $\sqrt{2}$ increments. To be more specific, the lines may be of the following thicknesses : 0.18, 0.25, 0.35, 0.5, 0.7, 1.0, 1.4 and 2 mm. In a particular drawing, only two thicknesses of line may be used. The ratio of thick to thin lines shall not be less than 2.

Table 1.2 : Lines and Their Applications

Lines	Description	General Applications
A	Continuous Thick	A1 Visible outlines A2 Visible edges
B	Continuous thick (straight or curved)	B1 Imaginary lines of intersection B2 Dimension lines B3 Projection lines B4 Leader lines B5 Hatching B6 Outlines of revolved sections in place B7 Short centre lines
C	Continuous thin freehand	C1 Limits of partial or interrupted views and sections, if the limit is not a chain
D 	Continuous thin (straight) with zigzags	D1 Thin line (interrupted view)
E	Dashed thick	E1 Hidden outlines E2 Hidden edges
F	Dashed thin	F1 Hidden outlines F2 Hidden edges
G	Chain thin	G1 Centre lines G2 Lines of symmetry G3 Trajectories
H 	Chain thin, thick at ends and changes of direction	H1 Cutting planes
J	Chain thick	J1 Indication of lines or surfaces to which a special requirement applies
K	Chain thin double-dashed	K1 Outlines of adjacent parts K2 Alternative and extreme positions of movable parts K3 Centroid lines K4 Initial outlines prior to forming K5 Parts suited in front of the cutting Plane

Line Spacing

Spacing between any two parallel lines shall be neither less than twice the thickness of the two adjacent lines nor less than 0.7 mm.

Different types of lines and their applications have been shown in Figures 1.11 to 1.13.

Figure 1.11 : Different Type of Lines

Figure 1.12 : Part Located in Front of a Cutting Plane

Figure 1.13 : Interrupted View

1.4.2 Lettering

The Code (SP 46–1988) recommends two standard ratios $\left(\frac{1}{14} \text{ and } \frac{1}{10}\right)$ for $\frac{\text{Thickness of line } (d)}{\text{Lettering height } (h)}$. These ratios are the most economical as they result in a minimum *number of line thickness* shown in Tables 1.3 and 1.4. For example, if the height of letter (h) = 5 mm, then thickness of lines $d = \frac{h}{14} = 0.35$ mm which is the standard thickness of line (Section 1.4.1).

The other standard dimensions such as height of lower case letters spacing between characters, minimum spacing of base lines and minimum spacing between words taking height as base dimension are given in Tables 1.3 and 1.4 and illustrated through Figure 1.14.

Table 1.3 : Lettering for $\frac{d}{h} = \frac{1}{14}$

Characteristic	Ratio	Dimensions (mm)						
Lettering height h	(14/14) h	2.5	3.5	5	7	10	14	20
Height of capitals								
Height of Lower-case letters c (without stem or tail)	(10/14) h	–	2.5	3.5	5	`7	10	14
Spacing between characters a	(2/14) h	0.35	0.5	0.7	1	1.4	2	2.8
Min. spacing of base lines b	(20/14) h	3.5	5	7	10	14	20	28
Min. spacing between words e	(6/14) h	1.05	1.5	2.1	3	4.2	6	8.4
Thickness of lines d	(1/14) h	0.18	0.25	0.35	0.5	0.7	1	1.4

Table 1.4 : Lettering for $\frac{d}{h} = \frac{1}{10}$

Characteristic	Ratio	Dimensions (mm)						
Lettering height h	(10/10) h	2.5	3.5	5	7	10	14	20
Height of capitals								
Height of Lower-case letters c (without stem or tail)	(7/10) h	-	2.5	3.5	5	7	10	14
Spacing between characters a	(2/10) h	0.5	0.7	1	1.4	2	2.8	4
Min. spacing of base lines b	(14/10) h	3.5	5	7	10	14	20	28
Min. spacing between words e	(6/10) h	1.5	2.1	3	4.2	6	8.4	12
Thickness of lines d	(1/10) h	0.25	0.35	0.5	0.7	1	1.4	2

Figure 1.14 : Dimensions of Lettering

The above recommendations are both for vertical as well as inclined lettering. The inclination of lettering is taken as 15° to the right. The specimen of vertical

as well as inclined lettering for both standard ratios of $\frac{d}{h}\left(\frac{1}{14} \text{ and } \frac{1}{10}\right)$ have been illustrated through Figures 1.15 and 1.16.

Figure 1.15 : Lettering of Ratio $\frac{d}{h} = \frac{1}{14}$

Figure 1.16 : Lettering of Ratio $\frac{d}{h} = \frac{1}{10}$

Additional conventions followed in lettering are as follows :

(a) The letters are designated by their heights, and

(b) The lettering should be done on the drawing in such a manner that it may be read when the drawing is viewed from the bottom edge. The lettering may also done perpendicular to direction mentioned above such that it may be read from right side of the orientation of drawing. All the above recommendations and conventions have been illustrated through Figure 1.17.

Figure 1.17 : Plan of One Room with Lettering and Dimension

1.4.3 Scales

Definition and Designation

Scale is the ratio to which the original object is drawn on drawing sheet. This ratio may be of the following three categories :

Full Size – Designated as scale 1 : 1

Enlargement scale – Designated as scale X : 1 (where $X > 1$)

Reduction scale – Designated as scale 1 : X (where $X > 1$)

Recommended categories of scale for drawing are shown in Table 1.5.

Table 1.5 : Recommended Categories of Scales

Category	Recommended Scale		
Full size			1 : 1
Enlargement	50 : 1	20 : 1	10 : 1
Scale	5 : 1	2 : 1	
Reduction	1 : 2	1 : 5	1 : 10
Scale	1 : 20	1 : 50	1 : 100
	1 : 200	1 : 500	1 : 1000
	1 : 2000	1 : 5000	1 : 10000

The scale should be so chosen that the structures and their components may be shown and dimensioned with clarity.

Sometimes, small and complex components of structures are drawn on larger scale addionally for clarity (Figure 1.4(d)).

1.4.4 Dimensioning

Dimensioning lines (straight or curved), angles, arcs, chords, radii, diameters, levels, etc. is an art of putting its measurement in numerical value of appropriate unit in graphical format (Figure 1.4).

The graphical formatting is to put numerical value above or in the mid-break of the dimension line. If unit of measurement is the same for almost all measurements, then instead of putting unit after each numerical value it is put as *Note* at the bottom of the drawing sheet. The dimension line is put between *projection lines* and marked by *arrows, oblique, stroke*, small bulleting, etc. (Figure 1.17). Sometimes angular and radial dimensions are indicated as ϕ 25°, R50, respectively.

If the dimension lines are inclined their numerical values may be written as indicated in Figure 1.18.

A few additional specific rules for dimensioning are as follows :

(a) A few *symbols*, which precede the numerical values, are used for easy identification of object and to improve drawing interpretation as in Figures 1.18(e) and (f).

Figure 1.18 : (a) Values on Oblique Dimension Lines; (b) Angular Dimension Values; (c) Alternative Way for Showing Angular Dimension Values; (d) Alternative Way for Showing Angular Dimension Values; (e) Circular Foundation and Circular Column; and (f) U/R Pile

These symbols are depicted in Table 1.6.

Table 1.6 : Symbols for Dimensioning

Item	Symbols	Application
Diameter	ϕ	ϕ 35
Radius	R	R 90
Square	□	□ 40
Spherical Diameter	Sϕ	Sϕ 100

Spherical Radius	SR	SR 50

(b) *Levels* on site layout and on different components of a building are shown respectively in Figures 1.19 and 1.20.

Figure 1.19 : Level on Site Layout

Figure 1.20 : Levels of Different Components of a Building

(c) The dimensioning of cords, arcs and angles may be done as shown in Figure 1.21.

Figure 1.21 : Dimensioning of Chords, Arcs and Angles

SAQ 3

(a) Describe different types of lines with their applications and also line thickness and spacing in drawings.

(b) Describe the principle behind selecting $\frac{d}{h}$ ratios as $\frac{1}{14}$ and $\frac{1}{10}$.

(c) Write short notes on lettering in drawings.

(d) Define scale. Write short notes on standard categories of scales.

(e) Show the different formats of dimensioning on a drawing.

1.5 SYMBOLS AND ABBREVIATIONS

1.5.1 Symbols

Symbols are used to indicate the materials of construction of different components of a building. The symbols are sometimes coloured to show the materials in more natural form (Tables 1.7 to 1.11)

Table 1.7 : Symbols for Doors and Windows

Table 1.8 : Symbols for Materials in Section

Table 1.9 : Conventional Breaks

Table 1.10 : Symbols for Electrical Installations

Table 1.11 : Symbols for Sanitary Installation

1.5.2 Abbreviations

Standard *Abbreviations* are used in drawing to save space and time. These are written in capital letters unless mentioned otherwise. Commonly used abbreviations are given in Table 1.12.

Table 1.12 : Standard Abbreviations

Term	Abbreviation	Term	Abbreviation
Approved	APPD	Ground level	G.L.
Approximate	APPROX	Horizontal	HORZ
Auxiliary	AUX	Indian Standard	IS
Centers	CRS	Internal	INT
Centre line	CL	Left hand side	LHS
Centre of gravity	CG	Maximum	max.
Centre-to-centre	C/C	Minimum	min.
Checked	CHKD	Miscellaneous	MISC
Coursed rubble	C.R.	Millimeter	mm
Continued	CONTD	Nominal	NOM
Constant	CONST	North	N
Cylinder/cylindrical	CYL	Number	NO.
Cement concrete	C.C.	Opposite	OPP
Cement mortar	C.M.	Quantity	QTY
Cement pointing	C.P.	Reference	REF
Cast iron	C.I.	Required	REQD
Centimeter	cm	Right hand side	RHS
Cubic meter	cu.m	Sheet	SH
Country cut teak wood	C.C.T.W	South	S
Centimeter	cm	Square meter	Sq.m
Cubic meter	Cu.m	Screw/Screwed	SCR
Centre to centre	C/C	Serial number	Sl.No.
Diameter (in a note)	DIA	Specification	SPEC
Dimension	DIM	Standard	STD
Drawing	DRG	Symmetrical (in a note)	SYM
Door	D.	Sketch	SK
East	E	Thick	THK
etcetera	etc.	Typical	TYP
External	EXT	West	W
Figure	FIG.	With respect to (in a note)	WRT

Foundation.	Fdn.	Window	W.
Flooring	Fl.	Weight	W
Galvanised corrugated iron.	G.C.I.	Wrought	W.I.

1.6 PRINCIPLES OF PRESENTATION OF GOOD DRAWINGS

The layout rules must be observed strictly for uniformity in presentation. The drawing shall preferably be drawn in First Angle Presentation Method. The number of drawings may be limited to the minimum, but covering all details to facilitate easy execution.

Dimensioning shall not be repetitive. All elements shown in plan shall be first dimensioned and then only those dimensions of elements which have not been put in previously dimensioned views shall be done.

The size of digits, alphabets, the arrow size, etc. must be proportionate to the drawing. Ample space shall be provided between views for clarity and to avoid crowding.

SAQ 4

(a) Show symbols of Electric and Sanitary Installations in tabular form.

(b) Write short notes on abbreviations illustrating at least ten abbreviations.

(c) Describe as to how a good drawing can be prepared.

1.7 SUMMARY

Drawing is the language of engineers. Through a drawing, true form of an object can be visualized more distinctly than through any other form of expression.

Two types of drawings – (a) Orthographic drawings, i.e. plan, elevations and sections, and (b) pictorial drawings, i.e. isometric and perspective views – are prevalent for construction drawings.

These drawings are made on drawing sheets of standard sizes known as A0, A1, A2, A3 and A4 sizes.

Sometimes these sizes are lengthened and widened in the multiples of lengths or widths of respective sizes as required for appropriate layout.

The positions and sizes for drawings (drawing area), references, schedule, north point, site plan, etc. (title block on a sheet) have been standardised so that they may be placed proportionately and located quickly.

The types, thickness and colours of lines have been codified for easy and clear understanding of the drawings.

Similarly, lettering, scales, dimensioning, symbols, abbreviations, etc. have also been standardised for universal uniformity of presentation and quick visualisation.

Following all the above specifications of drawing and detailing and also by maintaining appropriate spacing between the drawings as well as drawing and other detailing a good presentation of drawing can be made.

1.8 ANSWERS TO SAQs

SAQ 1

(a) Refer Section 1.1.

(b) Refer Section 1.2.1.

SAQ 2

(a) Refer Section 1.3.1.

(b) Refer Section 1.3.2.

(c) Refer Section 1.3.3.

SAQ 3

(a) Refer Section 1.4.1.

(b) Refer Section 1.4.2.

(c) Refer Section 1.4.3.

(d) Refer Section 1.4.4.

SAQ 4

(a) Refer Section 1.5.1.

(b) Refer Section 1.5.2.

(c) Refer Section 1.6.