Civil Engineering Drawings

ENCE 338

Course Topics

Chapter 1: Introduction To Civil Engineering Drawings (CED)

1.1 Overview

1.2 Review of Projections, Sections & Sketching.

1.3 Conventions and Presentation

Chapter 2: Building Drawings in general

2.1 Building Permit drawings

2.2 Architectural drawings

2.3 Structural drawings in general

2.4 Electro - Mechanical drawings

Chapter 3 : Reinforced Concrete Drawings

3.1 Basics and Concepts

3.2 Foundation details

3.3 Columns Detailing

3.4 Walls Detailing

3.5 Detailing of Flooring Systems

3.6 Detailing of Beams

3.7 Joints Details

3.8 Stairs Details

Chapter 4: Structural Steel Drawings

4.1 Introduction to Structural Steel

4.2 Typical steel buildings components

4.3 Connecting Structural Steel

4.4 Column Details

4.5 Beams & beam Connections

4.6 Trusses Details

Chapter 5: Retaining walls

Chapter 6: overview of infrastructure drawings (Lab application)

Course Objectives

- Become acquainted with the general drafting standards and practice specific for civil engineering drawing.
- Become acquainted with the major international and local civil drawing standards and practice.
- Develop ability to Read and understand multidisciplinary engineering drawings.
- Develop ability to produce civil drawings and details.
- And More …

Introduction To Civil Engineering Drawings

Chapter

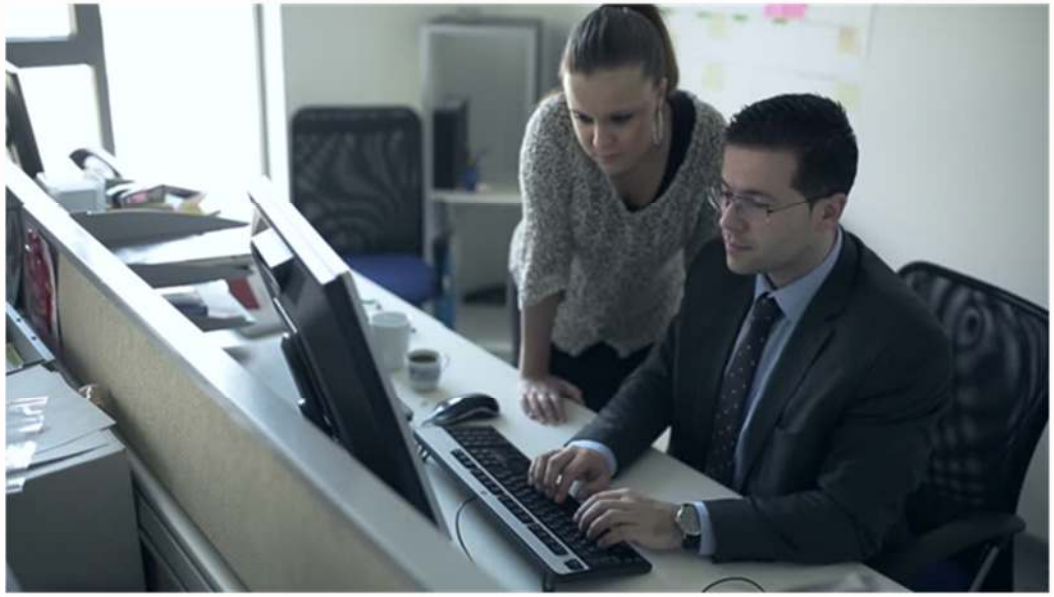
1

Civil Engineering Drawings -Overview

Section

1.1

Engineers Vs Others



Engineering Drawings Definition

- Drawing can be defined as "the process of conceiving or inventing ideas and communicating those ideas to others in a form that is understood easily." Accordingly, drawing is the language of engineers that can be used to translate ideas and concepts to reality.

- As a language, drawing have its own symbols (such as shapes, lines, …) that have specific universal meanings which identify the form, size, material and finish of the engineering work.

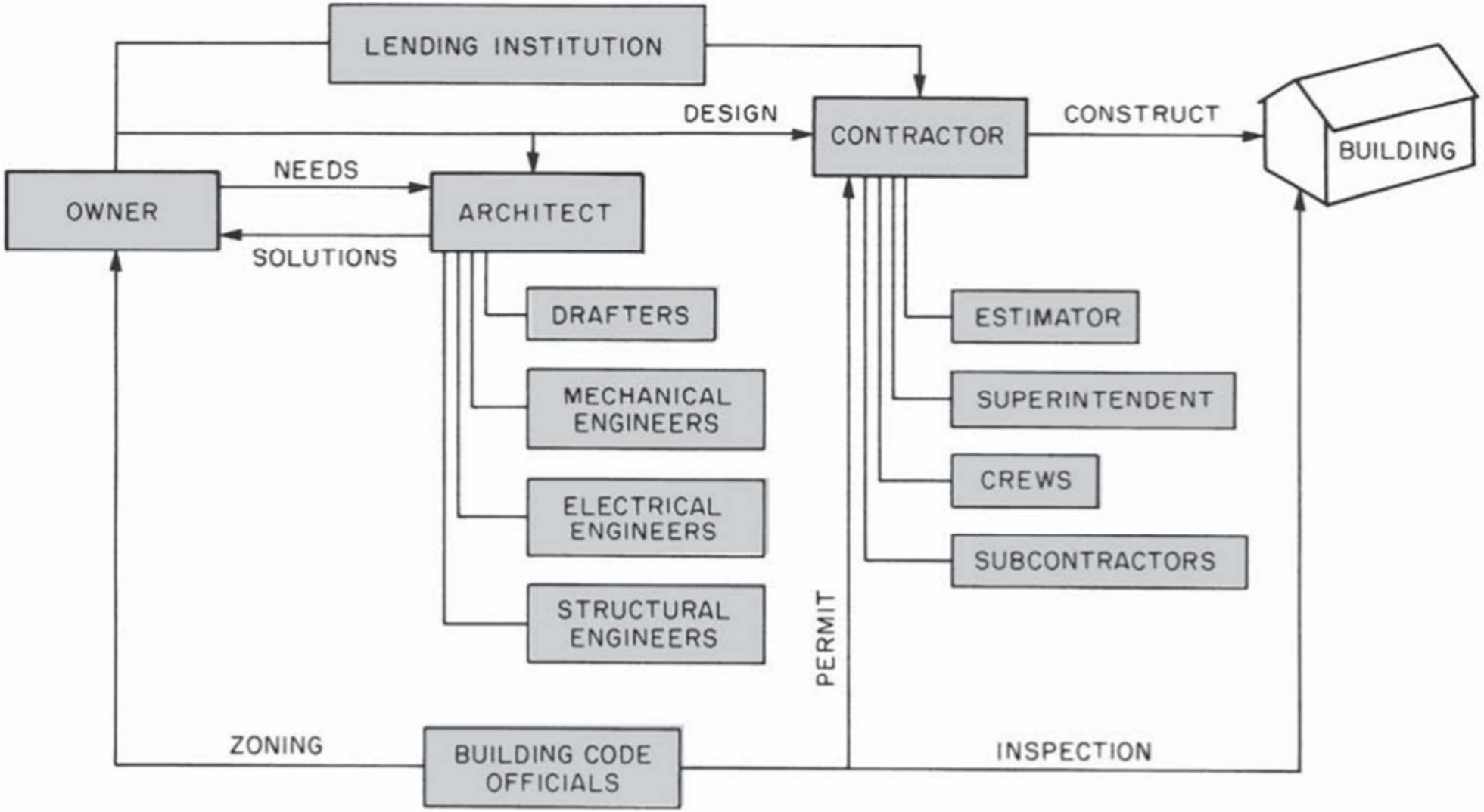
Categories of CED's

Usually civil engineers have to produce huge number of drawings for different projects. Although the same concept, these drawing differ significantly from the technical perspective.

The different categories of civil engineering drawings include:

Structural drawings	Civil Drawings	Graphics and charts of reports and presentation
• **Buildings and structures of any type using concrete, steel, wood ….**	• **Highways and transportation** • **Water and waste water** • **Site development** • **And others**	• **Organization charts** • **Cash flow** • **Schedule** • **And other quality control and project management graphics**

Who are involved in Civil Engineering drawings?



Design and construction team

Who are involved in Civil Engineering drawings?

Designer	**Draftsman**	**Project managers and technical supervisors**	**Client / client representative**	**Contractor**
Design calculation and preliminary sketches (initiate the work)	Detailing and production of construction drawings	Review of constructability, supervision and estimation (cost and time)	Legal concerns and insure the liabilities of consultant/ contractor	Implementation Quantities Contract record
Prepare		Read - understand - implement		

Role of Engineering Drawings

There are many users of a set of drawings and each may put it to more than one use. In summary civil engineering drawings forms for different people and at different times:

1. a basis for tendering or bidding
2. a contractual commitment
3. a source for the preparation of other documents
4. a statement of intent for the purpose of obtaining statutory consents
5. a source for the preparation of shop drawings
6. a shopping list for the ordering of materials
7. a construction manual
8. a model for developing the construction programme
9. a supervising document

Role of Engineering Drawings

10. a record of variations from the contract
11. a base document for measurement of the completed works and preparation of the final accounts
12. a base document for defects liability inspection
13. a record of the completed structure and a source of feedback.

Requirements & Quality of Civil Engineering Drawings

Fundamental requirements of civil engineering drawings

Civil engineering drawings are intended to give a clear picture of all things in a construction site to the user. Accordingly the information given by the drawings shall be :

1. Technically sound and represent accurate record of the designer's intentions.
2. Clearly expressed and easily understood.
3. Comprehensive and sufficiently detailed for its purpose.

Requirements & Quality of Civil Engineering Drawings

Typical drawings defects include:

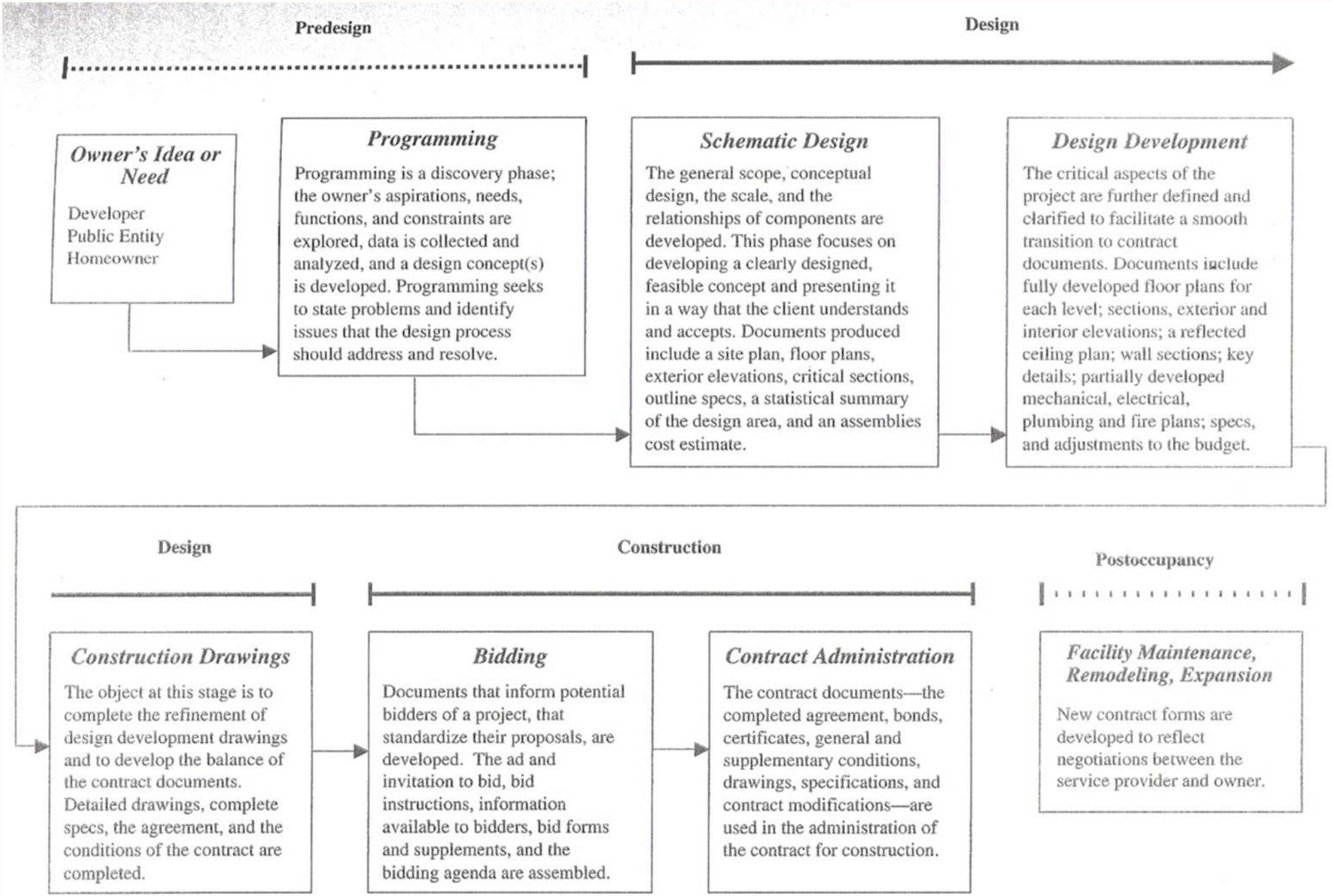
- Uncoordinated drawings: information from different sources found to be in conflict or duplicated.
- Omissions: items of information accidentally missing
- Poor presentation: the drawing or set of drawings was complete but confusing to read.

Requirements & Quality of Civil Engineering Drawings

Causes of defects in Drawings

- Project complexity
- The design professional's project workload
- Inadequate staff
- Inadequate coordination of designer
- Severe time constraints
- Designers lack of experience (especially
- Inadequate compensation of designer
- Owner changes
- Understanding how changes affect entire project
- Poor quality control systems

Evolution of a construction contract



Levels of Civil Engineering Drawings

- Design drawings are developed during each phase of the project. In general, the level of details contained in the drawings increases as the project advances to subsequent phases.
- The following is a set of drawings at various phases:
  - Conceptual-level drawings (Schematic)
  - Preliminary-level drawings
  - Final design drawings- Construction drawings
  - As-built drawings

Conceptual-level drawings (Schematic)

- Usually developed and used at the beginning of a project to illustrate a particular concept or idea being considered.
- Typically, more than one concept or idea is being considered at this time, and sometimes these concepts lack supporting analysis or precedence, and therefore may not have sound technical bases. In fact, at this level design drawings are developed based on project requirements and constraints, engineering judgment and experience, precedence, and past projects.
- Although often considered easier to prepare than final design-level drawings, the preparation of planning-level drawing without the support of analysis and other design data requires considerable design experience and judgment on the part of the designer

Preliminary-level drawings

- The drawings at this level should be developed with sufficient details and dimensions to define all of the significant cost items associated with the selected concept. These drawings should not be used for construction, and not all the information needed for construction is necessary for preliminary-level drawings
- For many projects, construction cost estimates developed at this level are used as a basis for funding of the project, so it is important that the project cost is not underestimated.
- Usually consist of plans and a typical cross section supplemented with relevant details .
- Some engineering analysis may be required to support the design at this level.

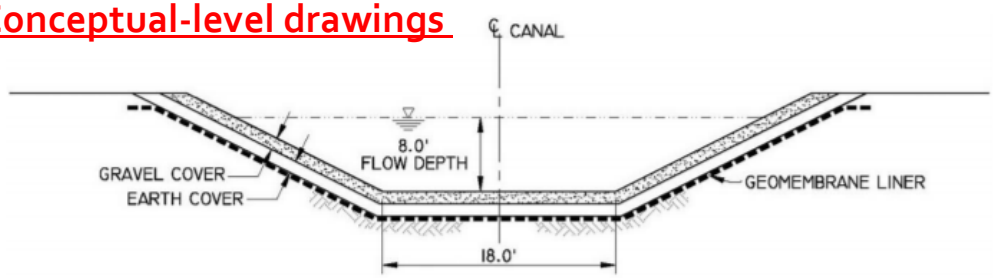
Construction drawings

- Drawings are used for construction. These drawings contain all of the information necessary for a contractor to bid and build a particular project.
- Also used to support applications for permits s from various regulatory agencies.
- Construction drawings are used in conjunction with a set of technical specifications to define completely the spatial, material, installation, and quality requirements of a project.
- Construction drawings are also used during final design to obtain an accurate estimate of quantities for a construction cost estimate and for developing the bidding schedule.
- Occasionally, bid amendments are used to change design drawings during bidding. After the contract is awarded and before construction begins, these design changes can be incorporated into the drawing set, and the revised set of drawings is referred to as *conformed drawings.*

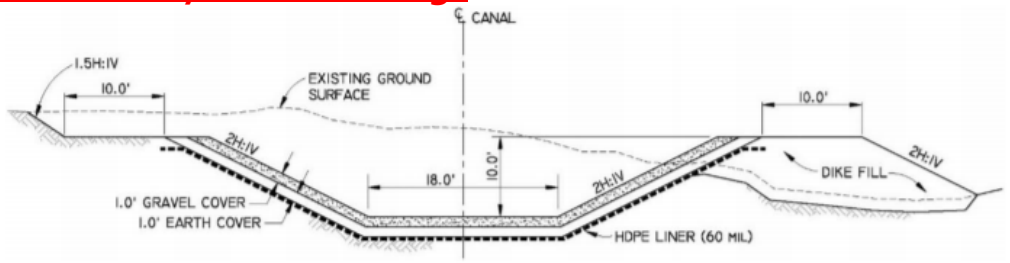
As-built drawings

When a construction project is completed, the construction drawings are updated and modified to reflect all of the changes made during construction. The resultant drawings are called record drawings. Record drawings have been commonly referred to as as-built drawings, but the current trend is to use the term record drawings.

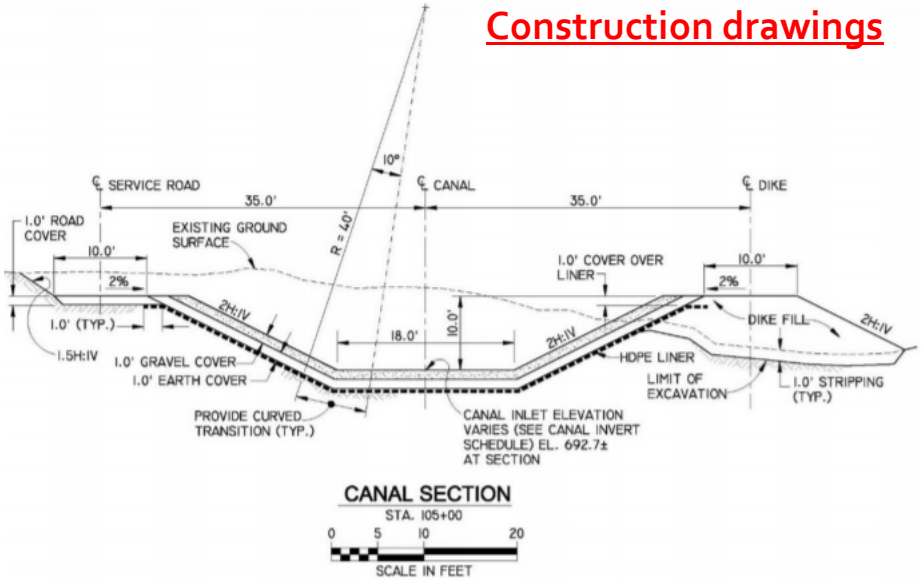
Conceptual-level drawings



Preliminary-level drawings



Construction drawings



Projections, Sections & Sketching: Review

Section

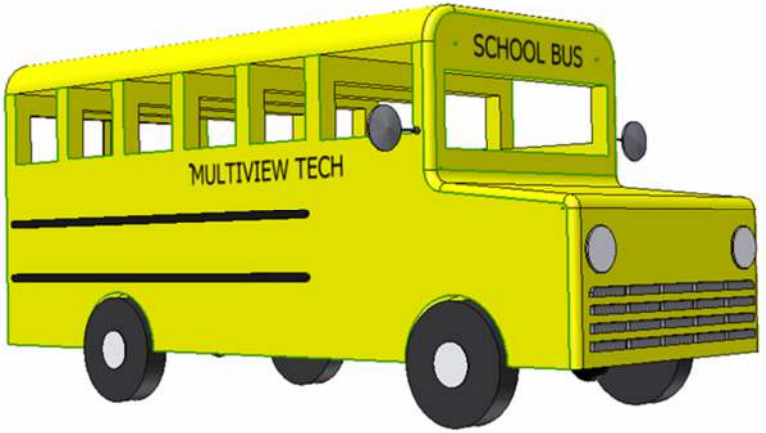
1.2

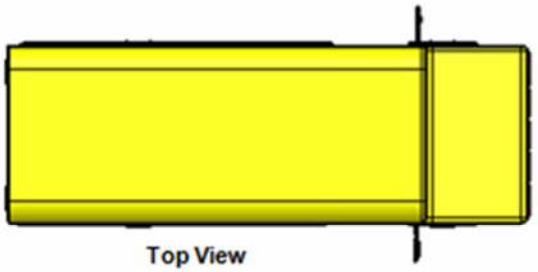
Multi-view Projections

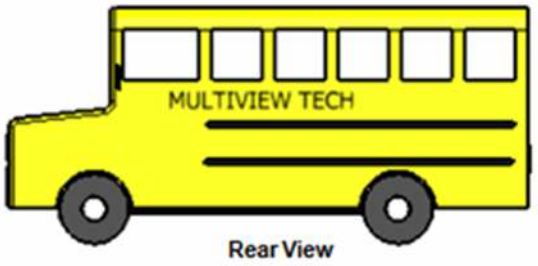
- All objects in nature including the engineering products are 3-D in shape. Three dimensional pictures (although still used for qualitive description) are inadequate for a complete definition of shape and almost useless for dimensions.
- The creation of the projection technique (***produce projected 2-D views of 3-D objects***) in the middle of the eighteenth century become the engineer's international language and led to rapid spread of technology in the nineteenth century. This is due to ease with which engineers could communicate with other engineers and with those engaged upon construction using projections drawing technique.

Multi-view Projections

Creating Six regular views of a 3-D school bus can ease understanding and accuracy of the manufacturing process.

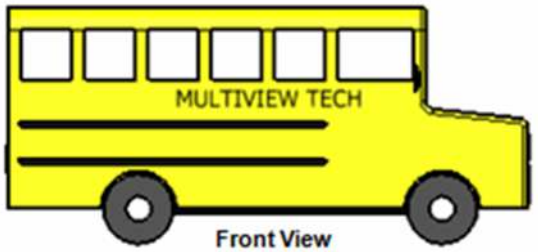



Top View



Rear View

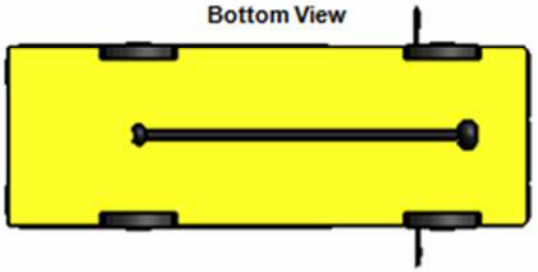
Left View



Front View

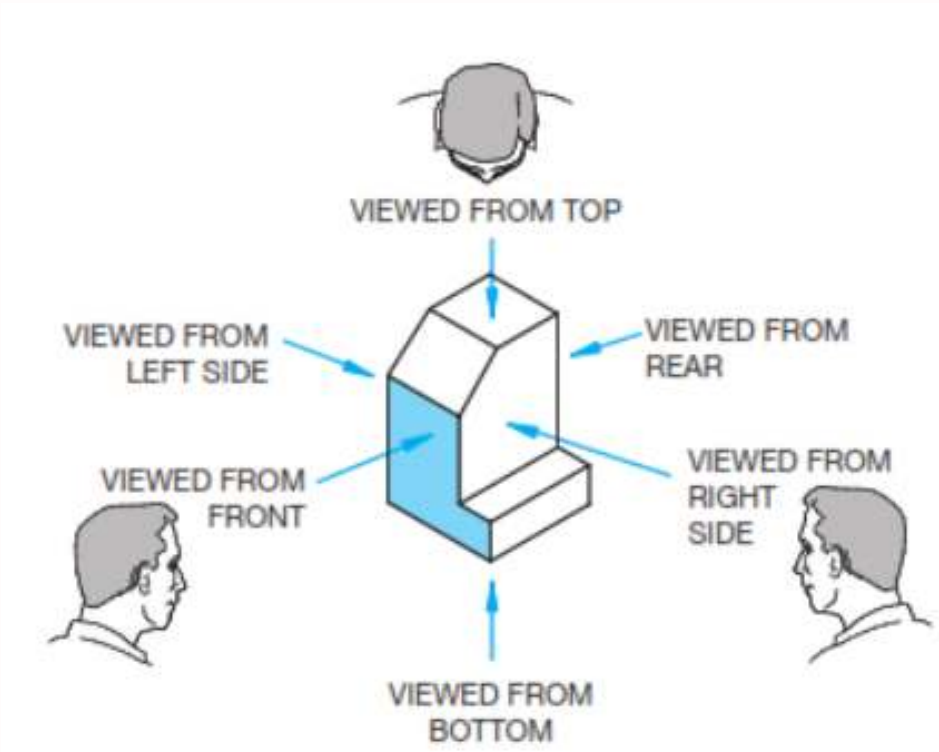
Right View

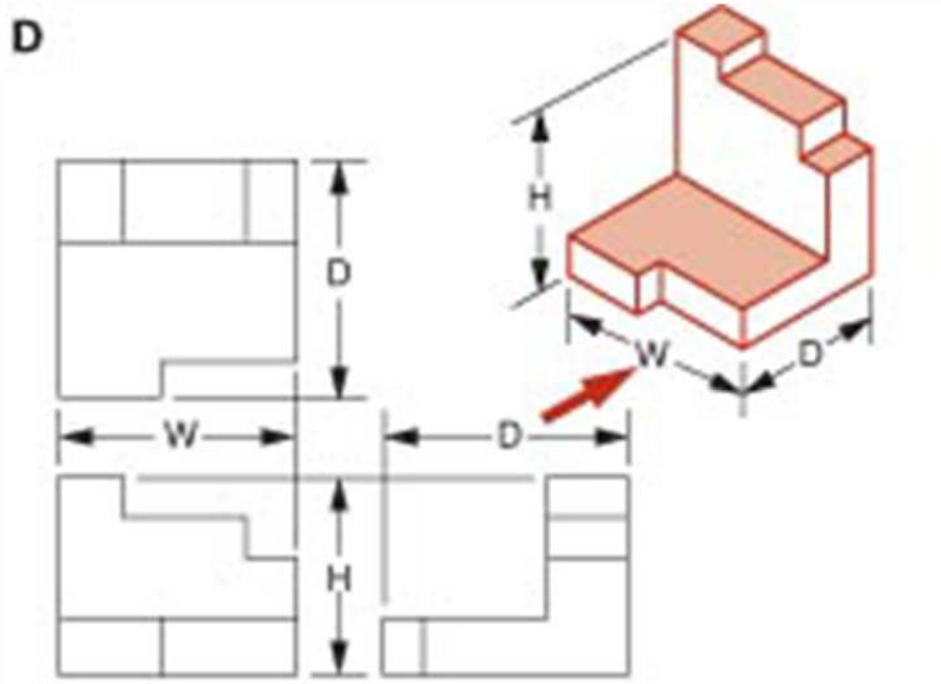
Bottom View



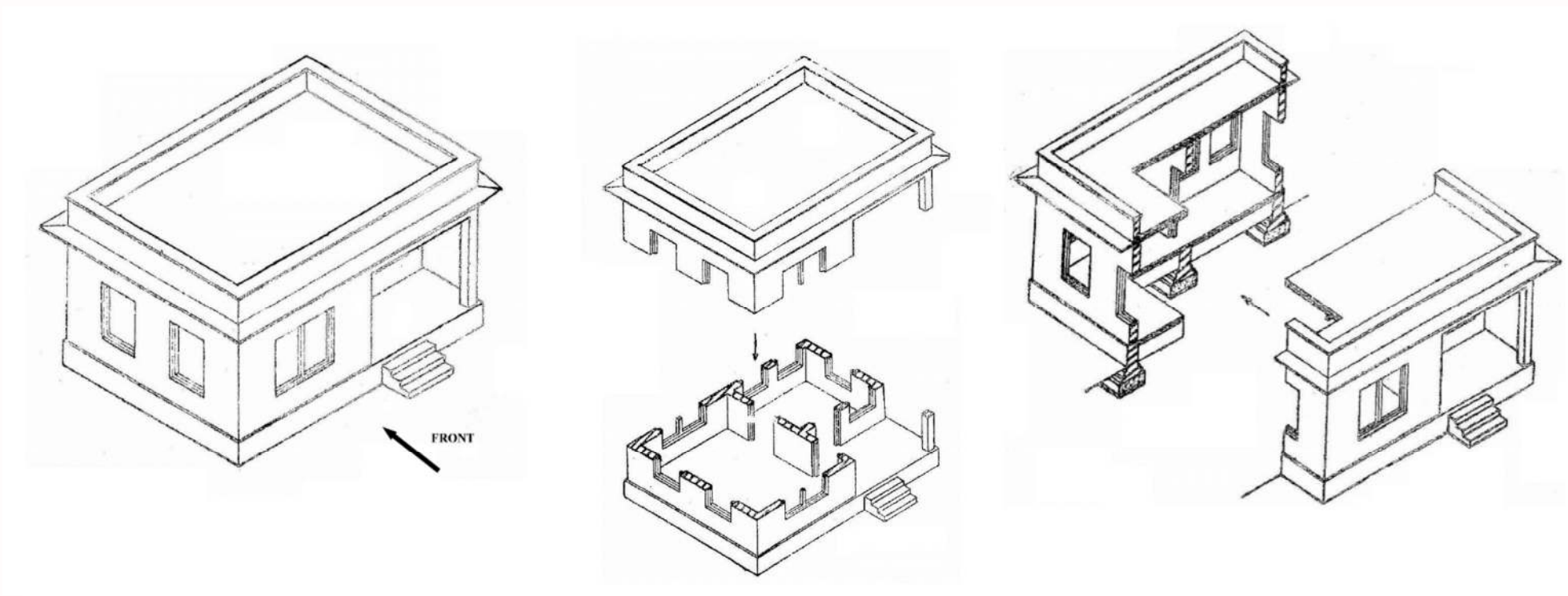
Multi-view Projections

In most of the cases Creating three regular views of a 3-D objects can be enough to construct the object.





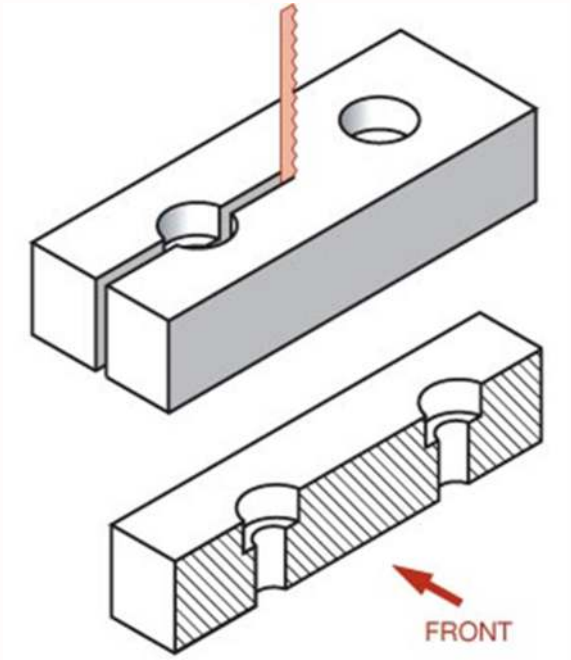
Multi-view Projections



For more complicated objects such as multi-story building, engineers need to produce more projections (at least 4 facades, several plans and sections, in addition to several details).

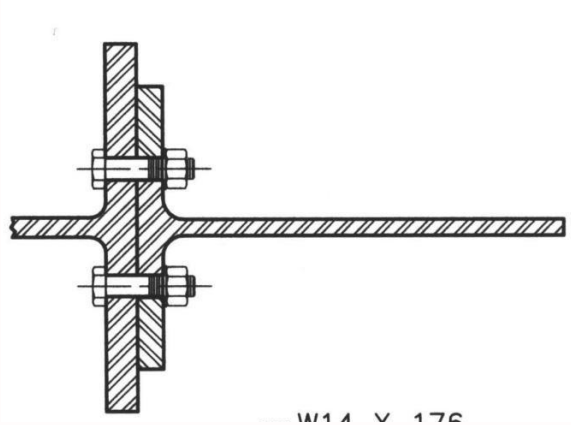
Sections

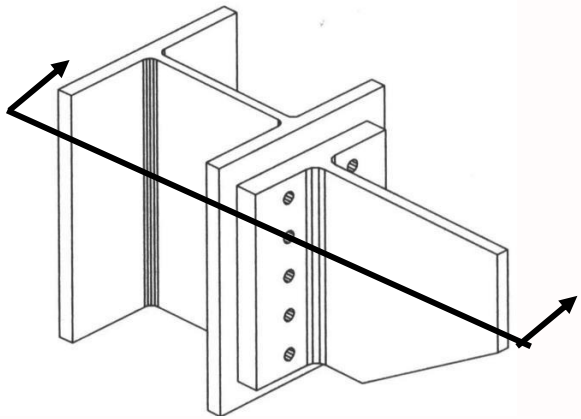
Sectional views (or just sections) are used to visualize the interior detail in the case that the interior features need to be clearly shown and dimensioned. A sectional view is obtained by creating an imaginary cutting plane.



Purposes of section views

- Clarify the views by
  - reducing or eliminating the hidden lines.
  - revealing the cross sectional's shape.
- Facilitate the dimensioning.

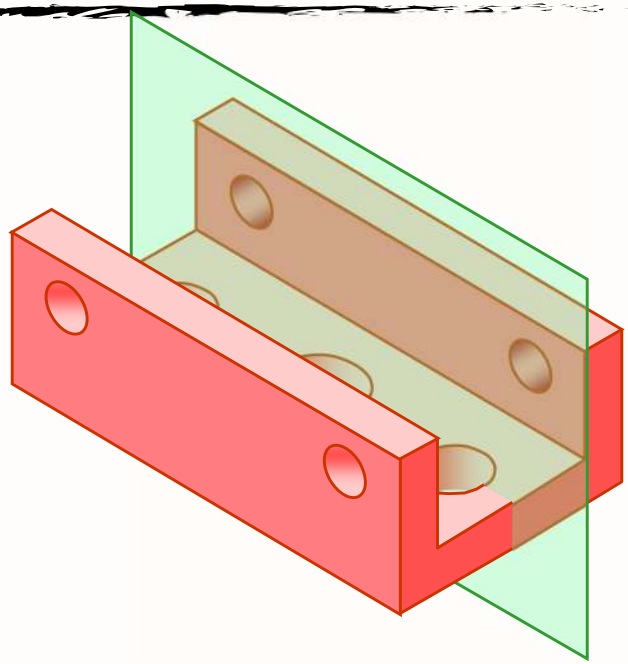


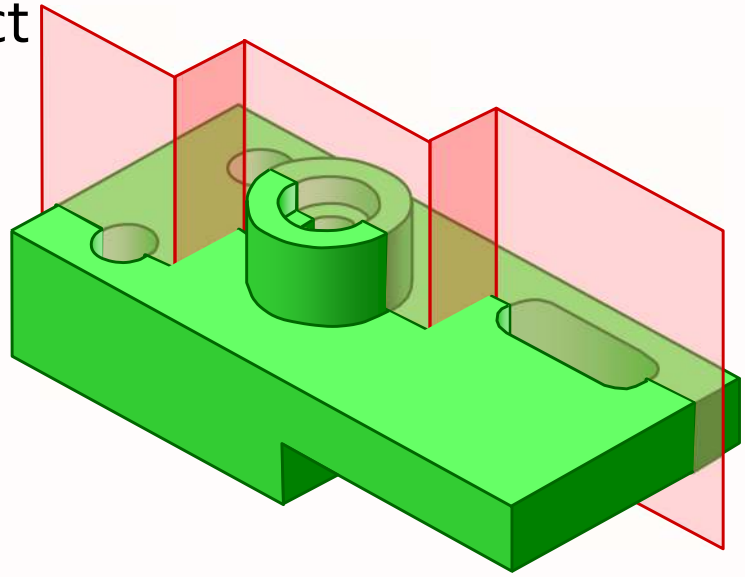


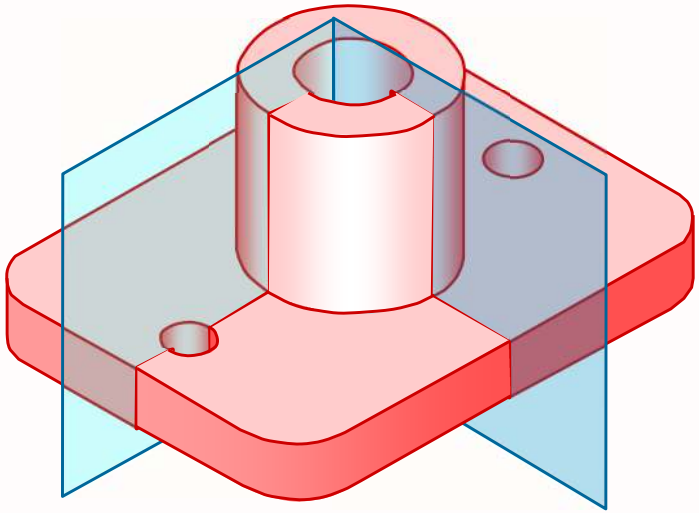
Sections

Type of sections

- **Full Sections**: the view is made by passing the straight cutting plane completely through the part.
- **Offset Sections**: the view is made by passing the bended cutting plane completely through the part.
- **Half Sections**: The view is made by passing the cutting plane halfway through an object and remove a quarter of it.
- others







Freehand Sketching

- Sketching is the simplest form of drawing. It is one of the quickest ways to express ideas. The drafter, technician, or engineer may use sketches to help simplify and explain (communicate) thoughts and concepts to other people. **Sketching, therefore, is an important and effective method of communication**.
- Sketching is also a part of drafting and design because the drafter frequently sketches ideas and designs prior to making the final drawing using computer-aided drafting (CAD). Sketching is also used by designers and engineers during the ideation and brainstorming processes.
- **Practice in sketching helps develop a good sense of proportion and accuracy of observation**. It is also effective in resolving problems in the early stages of the design process.

Conventions and Presentation

Section

1.3

Introduction

- Conventions are the commonly accepted methods and practices in the making of the engineering drawings including type of lines, symbols, and text style.
- Presentation is concerned with the overall appearance of the finished drawing.
- An engineer will leave something of himself in each of his drawing; his style and presentation will be different in detail from that of his colleagues.

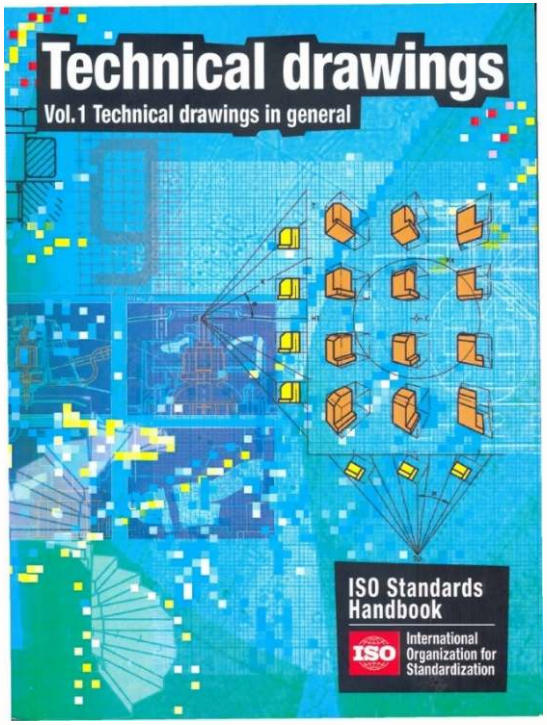
Standards for Engineering Drawings

The standard explains the way in which engineering drawings outline and present the project specifications and design works. It covers all of the symbology and information that engineers and designers need to include on their drawings whether they are produced in 2D or in 3D, created using CAD systems and 3D modelling.

Standards Committee

ISO: International Organization for Standardization

ASME: American Society of Mechanical Engineers

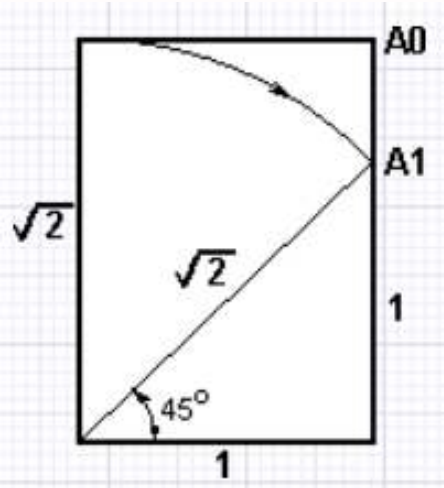


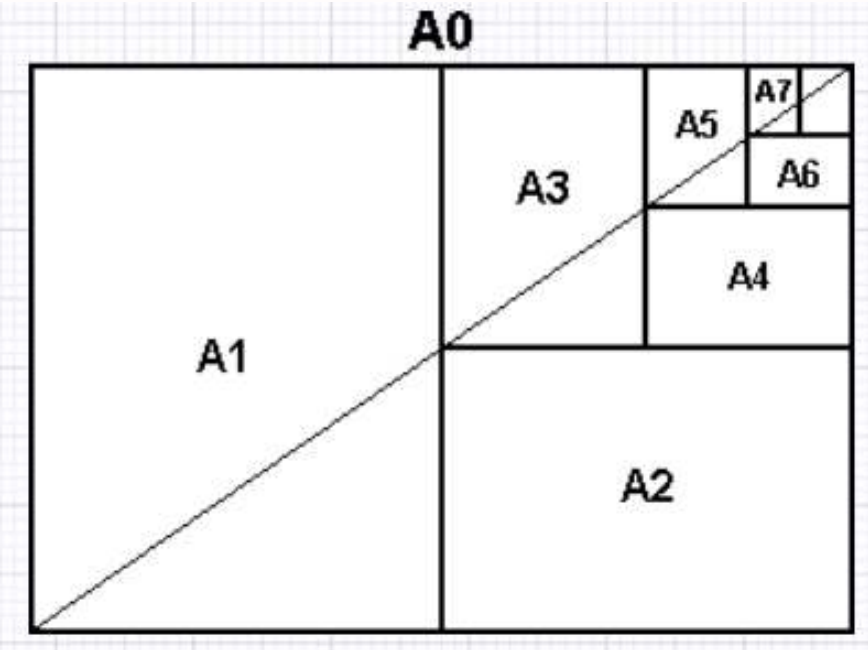
Part 3 : Construction drawings

ISO 3766:1995	Construction drawings — Simplified representation of concrete reinforcement
ISO 4066:1994	Construction drawings — Bar scheduling
ISO 4069:1977	Building and civil engineering drawings — Representation of areas on sections and views — General principles
ISO 4157-1:1998	Construction drawings — Designation systems — Part 1: Buildings and parts of buildings
ISO 4157-2:1998	Construction drawings — Designation systems — Part 2: Room names and numbers
ISO 4157-3:1998	Construction drawings — Designation systems — Part 3: Room identifiers
ISO 4172:1991	Technical drawings — Construction drawings — Drawings for the assembly of prefabricated structures
ISO 6284:1996	Construction drawings — Indication of limit deviations

Size of drawings

- The most commonly used paper sizes for engineering drawings are the international standard (ISO 216 based on the German DIN 476) which defines the "A" standard (A0, A1, …etc.) .
- The ISO 'A' series of sheet sizes is based on a constant width to length ratio of $1:\sqrt{2}$.
- The A0 size is defined as having an area of one square meter. This allows paper weights to be expressed in grams per square meter.
- Each smaller sheet size is exactly half the area of the previous size. ie. If you cut an A0 sheet in half you get two A1 sheets; If you cut an A1 sheet in half you get two A2 sheets; and so on.





Size of drawings

- Dimensions of Regular Sheets of A series are shown in the table.
- In some case Oversize Sheets are used when it is desirable to give extra protection to the drawing sheets by providing a binding or trimming margin.
- Also available in the market and frequently used with the modern printer paper Rolls of standard widths of 860 mm and 610 mm. The length of the drawing sheet can be cut as required to suit each individual drawing.

Dimensions of Regular Sheets

Designation	Dimensions
A0	841 mm x 1189 mm
A1	594 mm x 841 mm
A2	420 mm x 594 mm
A3	297 mm x 420 mm
A4	210 mm x 297 mm
A5	149 mm x 210 mm

Dimensions of Oversize Sheets

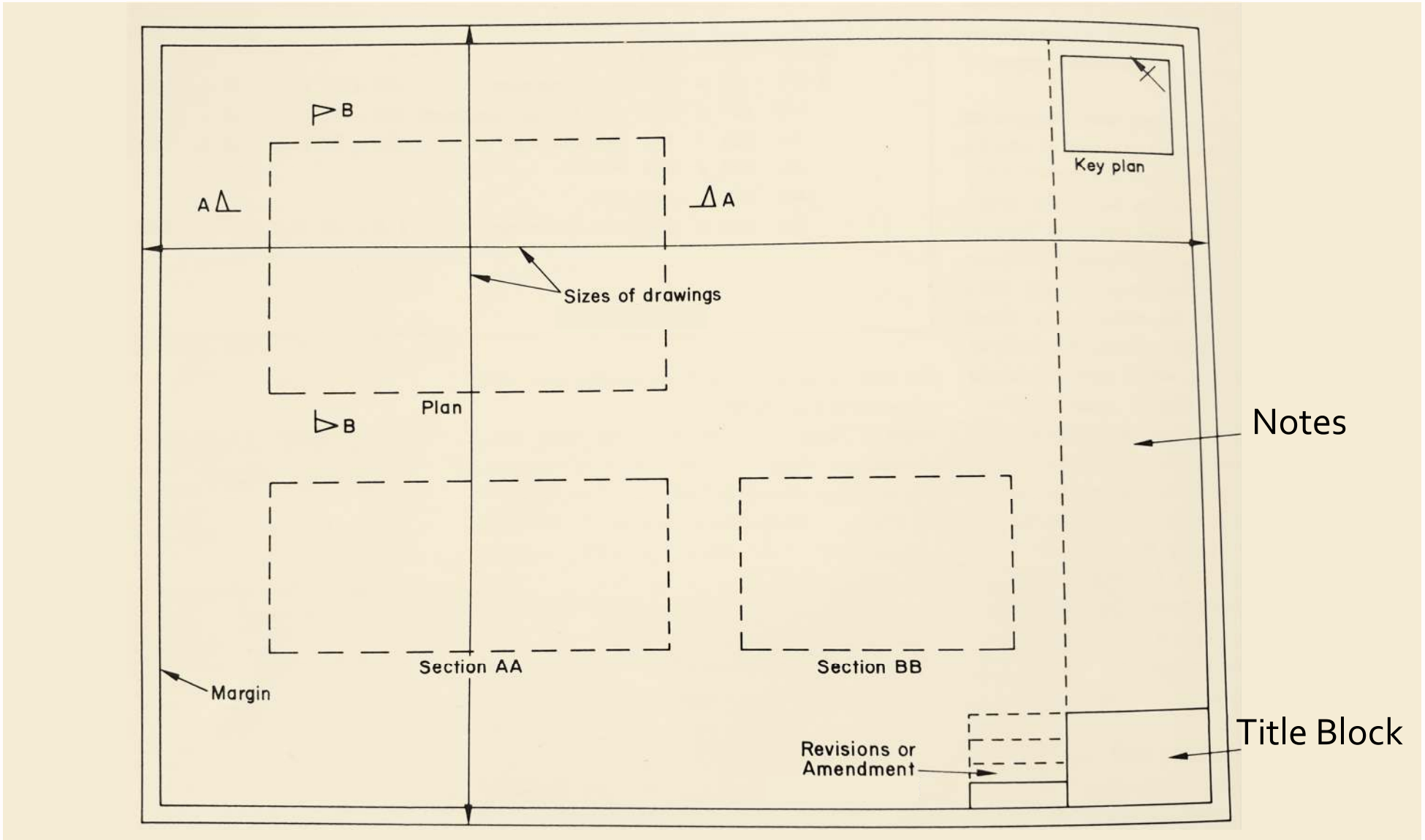
Designation	Dimensions
RA0	860 mm x 1220 mm
RA1	610 mm x 860 mm
RA2	430 mm x 610 mm
RA3	305 mm x 430 mm
RA4	215 mm x 305 mm
RA5	153 mm x 215 mm

Determination of drawings size

- In practice the paper size have to be selected passed on the size of the project and the preferable scale.
- In general and for larger projects Ao size is preferable as the larger the drawings the smaller the number of drawings required to cover the project. However smaller size drawings are more covenant to handle at site, more economical and more easier to re-produce when amendments are required.
- Currently most of roads and other liner works civil drawings are produced in A3 paper size.

Drawing Layout

- It is recommended that the standard layout for contract and working drawings should be as shown bellow



Drawing Layout - Elements of the Drawing sheet

I. A frame which prints as a clear margin all round. The edges of the printed drawing are susceptible to damage through constant handling and, if details were taken right up to the edges, they would soon become illegible. Additionally, If the drawings are to be bound, a much larger margin is required on the left hand side of the drawing. Drawing frames are standardized for each size of paper as per the following table

Paper Size	Border Width (mm)		Dimensions of Drawing Frame (mm)	
	Left & Right	Top & Bottom	Width	Height
A0	28	20	1133	801
A1	20	14	801	566
A2	14	10	566	400
A3	10	7	4003	283
A4	7	5	283	200

Drawing Layout - Elements of the Drawing sheet

II. A standard Title Block placed in the lower right-hand corner for ease of reference. The Title Block should contain the following information (see next slide):

- Name of the client
- The name of the project
- The part of the job shown in the drawing (Drawing title).
- The scales used
- The name of engineer/ consultant (may include logo)
- Drawing Number
- A unique filing identifier or a reference which identifies the drawing within the job or organization.

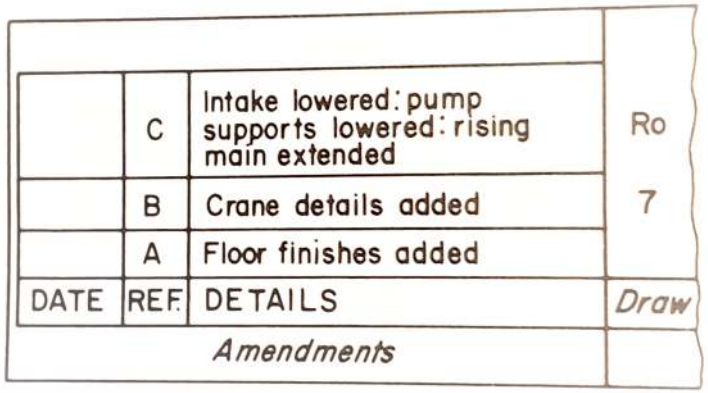
Drawing Layout - Elements of the Drawing sheet

Typical Title Block

Client	**BIRZEIT UNIVERSITY**		
Project	**Faculty of Arts**		
Drawing Title	**Ground Floor Slab**		
Consultant	**Birzeit Engineering Firm** **Architects and Engineers** **Ramallah street** **Birzeit**	*Scales*: 1:100 and 1:50 *Date*: *Dwg, No.* 674 C	
	Drawn: T.B.S.	*Checked*: S.B.	*Traced*: C.F.B.
		Approved: J. Robinson	

Drawing Layout - Elements of the Drawing sheet

III. Revision or amendments table: a table usually located above or to the left of the title block used to record any alternation of the design drawings before construction. It grow upward and include the alternation details, date and a reference number for the alternation.

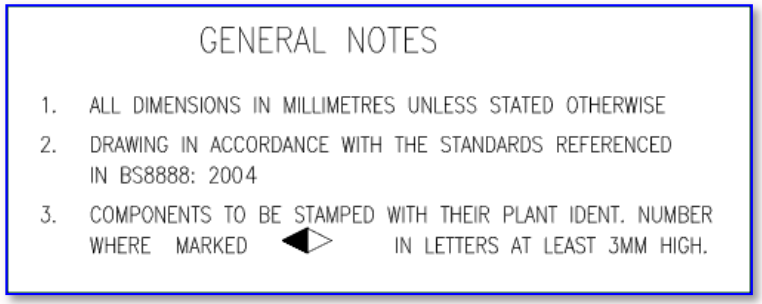


	C	Intake lowered: pump supports lowered: rising main extended	Ro
	B	Crane details added	7
	A	Floor finishes added	
DATE	REF.	DETAILS	Draw
		Amendments	

IV. Notes: A separate area, not part of the Title Block, located at the top right corner of the drawing. It Includes relevant notes, such as:

- All dimensions in mm
- All levels in meters
- Do not scale off drawing

It may also include a key to symbols used in the drawing



GENERAL NOTES

1. ALL DIMENSIONS IN MILLIMETRES UNLESS STATED OTHERWISE
2. DRAWING IN ACCORDANCE WITH THE STANDARDS REFERENCED IN BS8888: 2004
3. COMPONENTS TO BE STAMPED WITH THEIR PLANT IDENT. NUMBER WHERE MARKED ◀▷ IN LETTERS AT LEAST 3MM HIGH.

V. North Points: each drawing shall have a north points that indicates the orientation of location when needed.

Scales

- Scale is the ratio of the linear dimension of an element of an object shown in the drawing to the real linear dimension of the same element of the object. Designation of a scale consists of the word "SCALE" followed by the indication of its ratio, as follow

  SCALE 1:1 for full size

  SCALE X:1 for enlargement scales (X > 1)

  SCALE 1:X for reduction scales (X > 1)

- Dimension figures shown in the drawing are correspond to "true size" of the object and they are independent of the scale used in creating that drawing.

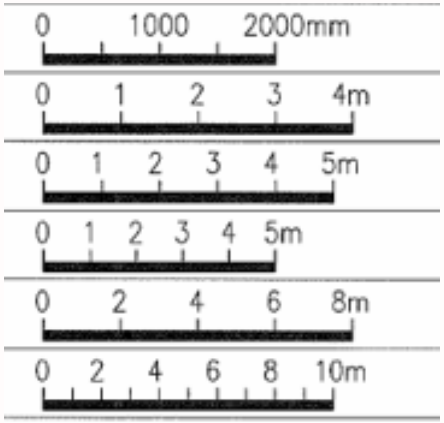
- **The correct choice of scale** is an important factor which is decided after a careful consideration of the amount and form of the information to be conveyed on the drawing. Once the content and layout of the drawing have been established, clarity then becomes the predominant factor in the choice of the scale.

Scales

- Drawings for civil engineers range from continental maps with a scale od several millions to one to full –size details or even larger. A range of suitable scales and their uses is listed in the following table.

Type of Drawing	**Recommended Scale Ratios**
Location Maps	1:50 000, 1:10 000, 1:5000
Site Plan	1:2500, 1:1250, 1:500
Road and sewage longitudinal sections	Vertical - 1:5, 1:10, 1:20, 1:50
	Horizontal – 1:1250, 1:500, 1:200, 1:100
Building plans, elevations and sections	1:100, 1:50
Details	1:25, 1:20, 1:10,1:5, 1:1

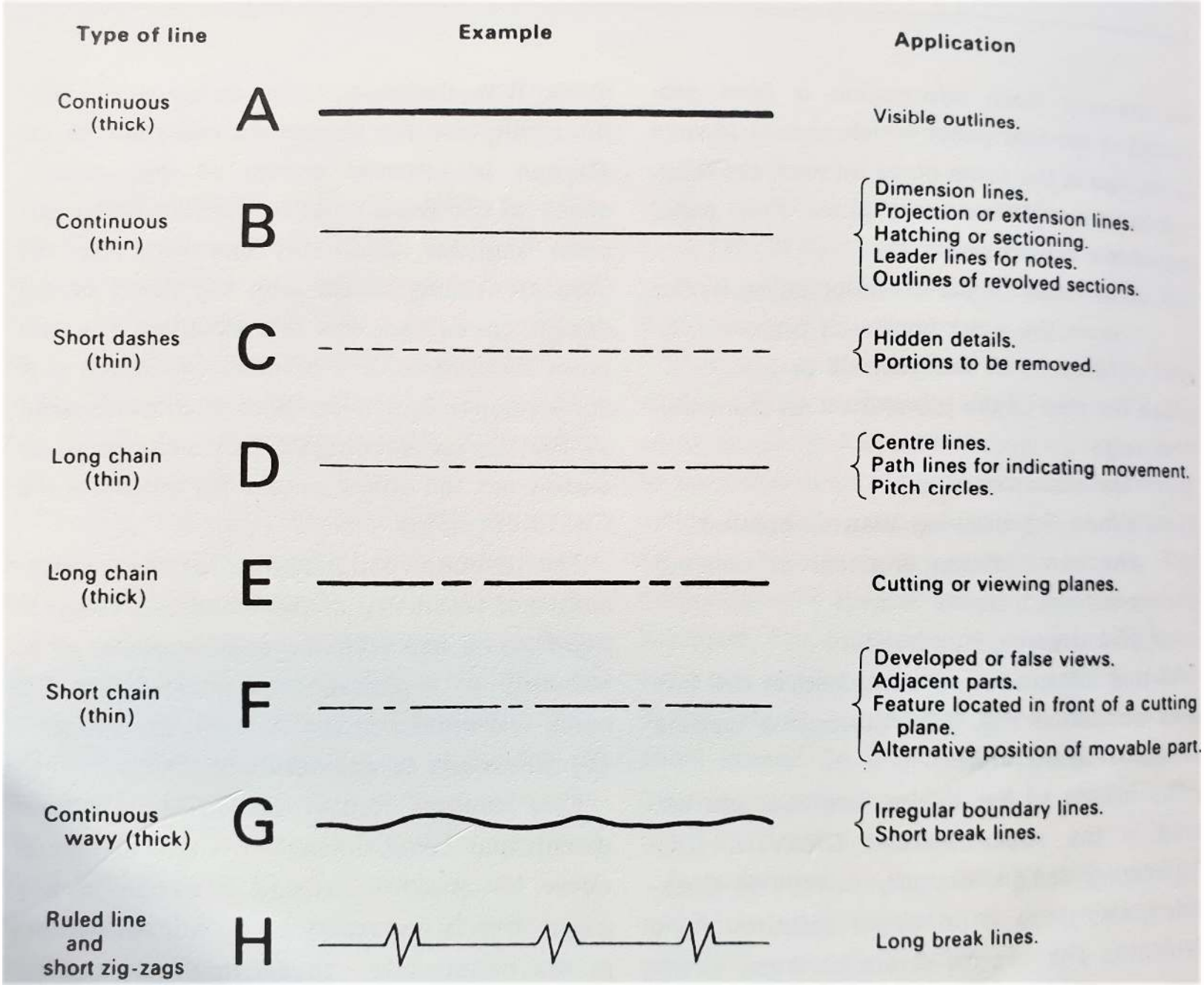
- When a drawing is to be reproduced in a reduced or enlarged form (for example, microfilming or photocopying) it may be advisable to draw a diagram scale on the original drawing or negative.



Type of Line

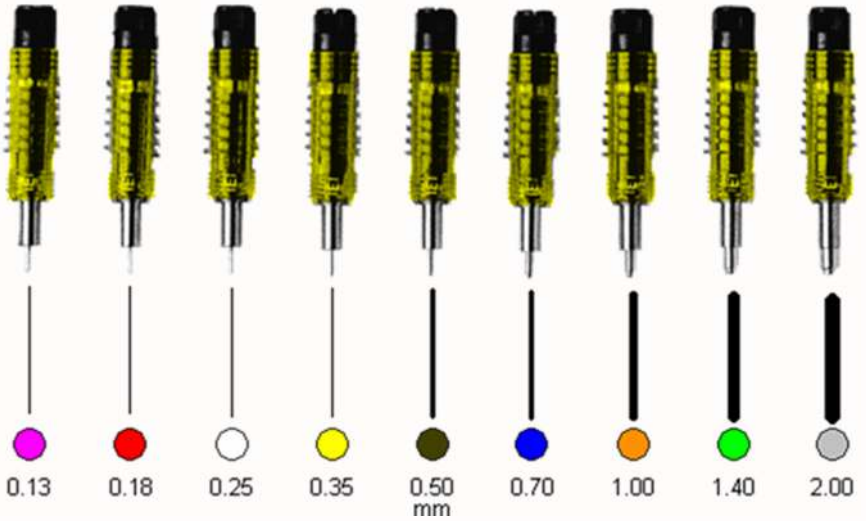
- Most engineering drawings are complicated and contain many surfaces and edges. For this reason, a line is the fundamental, and perhaps the most important, single entity on an engineering drawing. Actually, the various lines used on engineering drawings form the alphabet of the drafting language.
- Like letters of the alphabet, they are different in their appearance. Some are light, others are dark. Some are thick, others are thin. Some are solid, others are dashed in various ways.
- Figure in the next slide illustrates the basic types of lines used in engineering drawing.

Type of Line


Type of line
Example
Application
Continuous (thick)
A
Visible outlines.
Continuous (thin)
B
Dimension lines.
Projection or extension lines.
Hatching or sectioning.
Leader lines for notes.
Outlines of revolved sections.
Short dashes (thin)
C
Hidden details.
Portions to be removed.
Long chain (thin)
D
Centre lines.
Path lines for indicating movement.
Pitch circles.
Long chain (thick)
E
Cutting or viewing planes.
Short chain (thin)
F
Developed or false views.
Adjacent parts.
Feature located in front of a cutting plane.
Alternative position of movable part.
Continuous wavy (thick)
G
Irregular boundary lines.
Short break lines.
Ruled line and short zig-zags
H
Long break lines.

Type of Line

- The thickness of the lines differ based on the size of the drawing (i.e thicker lines are usually used on larger drawings). As a role of thump, Lines specified as thick should be from two to three times the thickness of lines specified as thin. For example in Ao sheets the thick lines are usually 0.7 mm while the thin lines are 0.25 – 0.35 mm.
- To facilitate the selection of line thickness in deferent sheets size, ISO defines a set of standard metric line widths for drafting. Like the ISO A and B series sheet sizes, the pen sizes increase by a factor of √2. This allows additions and corrections to be made on the enlargements or reductions of drawings.



Following ISO recommendation thick line in A1 will be 0.5 mm, while thin line will be 0.18 -0.25

Type of Line

Visible Lines

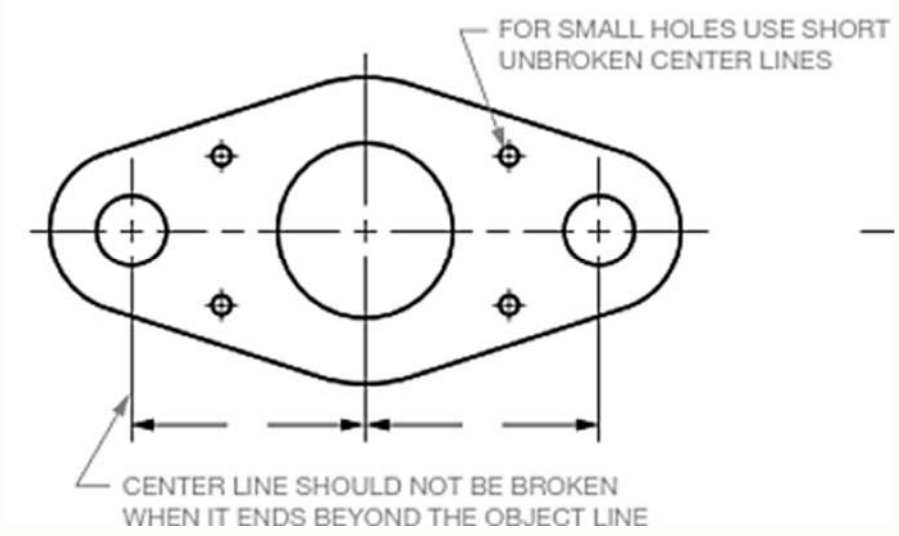
Visible lines are thick, continuous, bold lines used to indicate all visible edges of an object. They should stand out clearly in contrast to other lines, so that the shape of an object is quickly apparent to the eye.

Hidden Lines

Hidden lines are used to describe features that cannot be seen. These lines consist of short, evenly spaced thin dashes and spaces. The dashes are three to four times as long as the spaces.

Center Lines

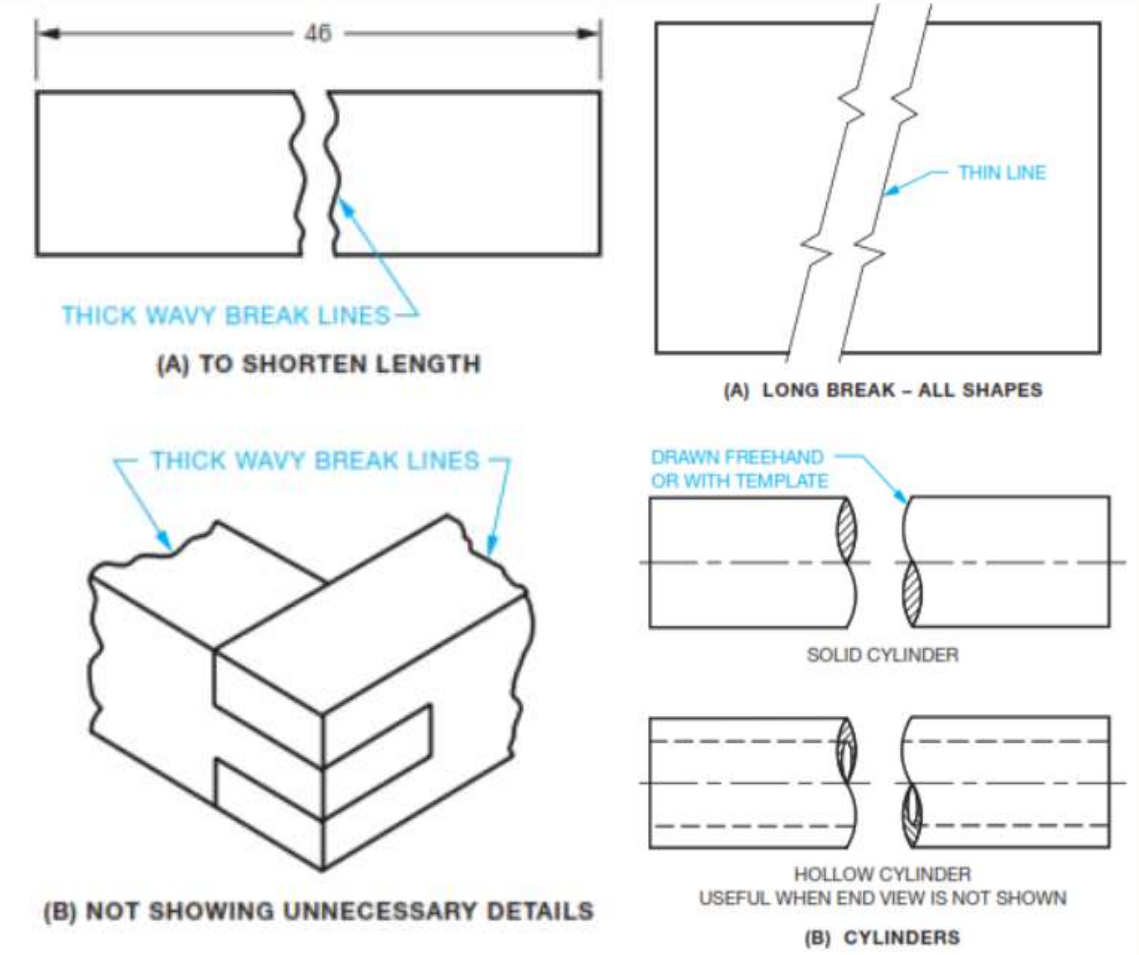
Circular and symmetrical parts, including holes, columns ..etc. must have their centers located. Center line is used to locate these features. A center line is drawn as a thin, broken line of long and short dashes, spaced alternately, as shown in Figure. The long and short dashes may vary in length, depending on the size of the drawing.



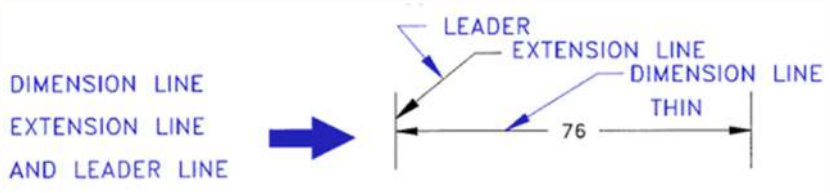
Type of Line

Break Lines

Break lines serve many purposes. For example, they are used to shorten the view of long uniform sections, which saves valuable drawing space.



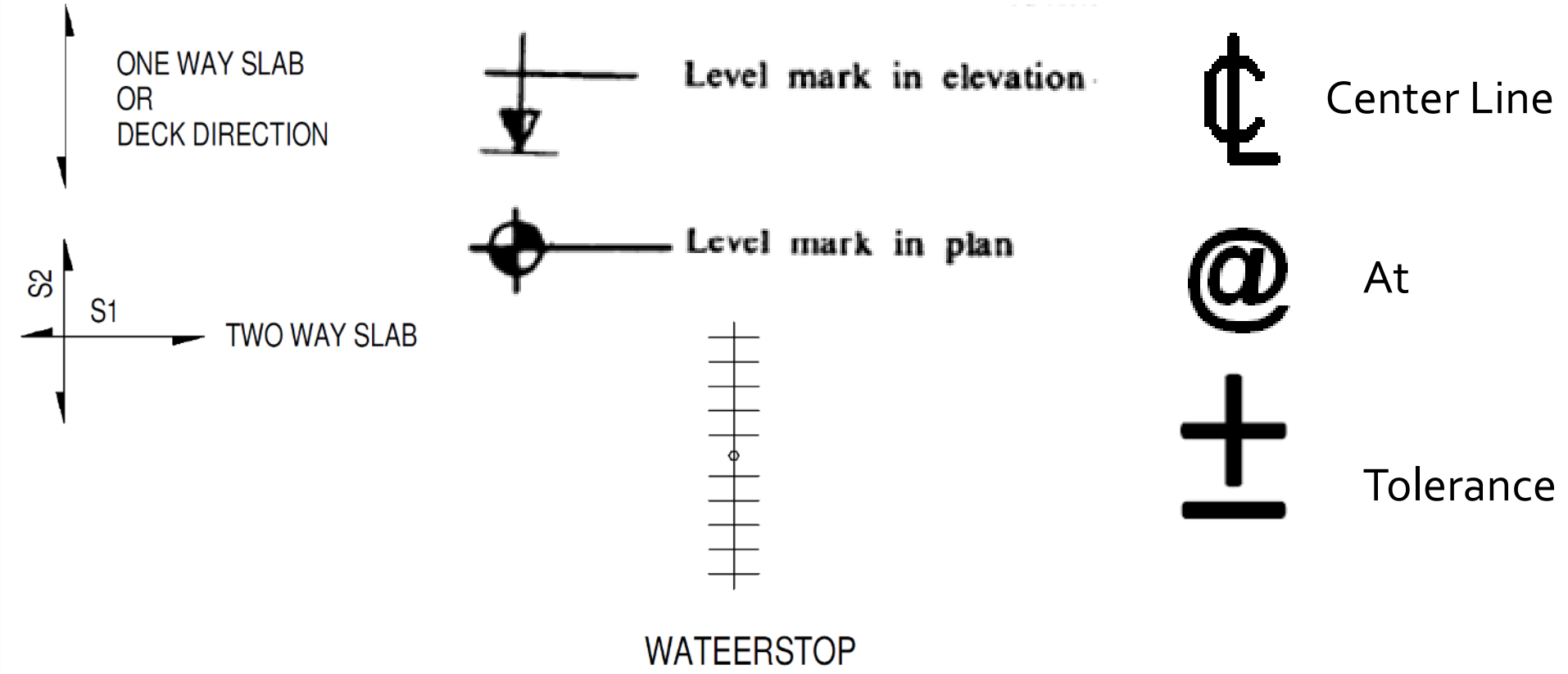
Dimension Lines



Symbols and Abbreviations

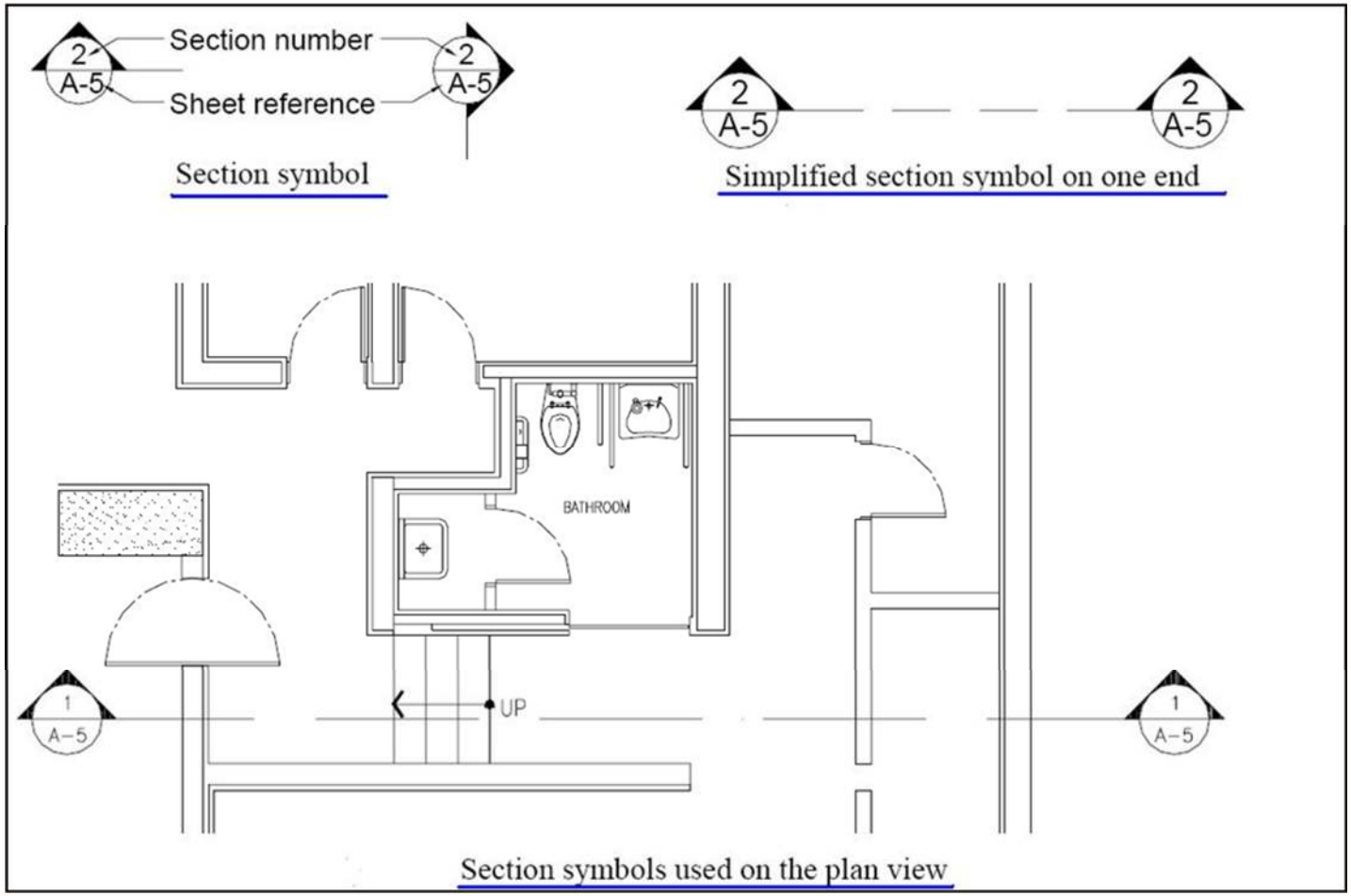
Symbols and abbreviations are extensively used on engineering drawings. They reduce drawing time and save valuable drawing space. The symbols are truly a universal language, as their meanings are understood in all countries.

Commonly used symbols

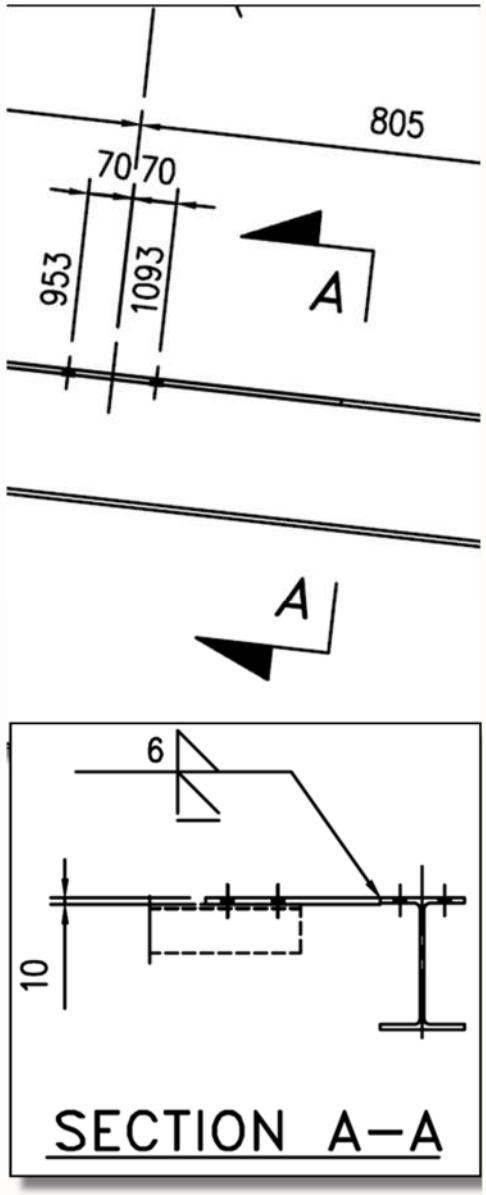


Symbols and Abbreviations

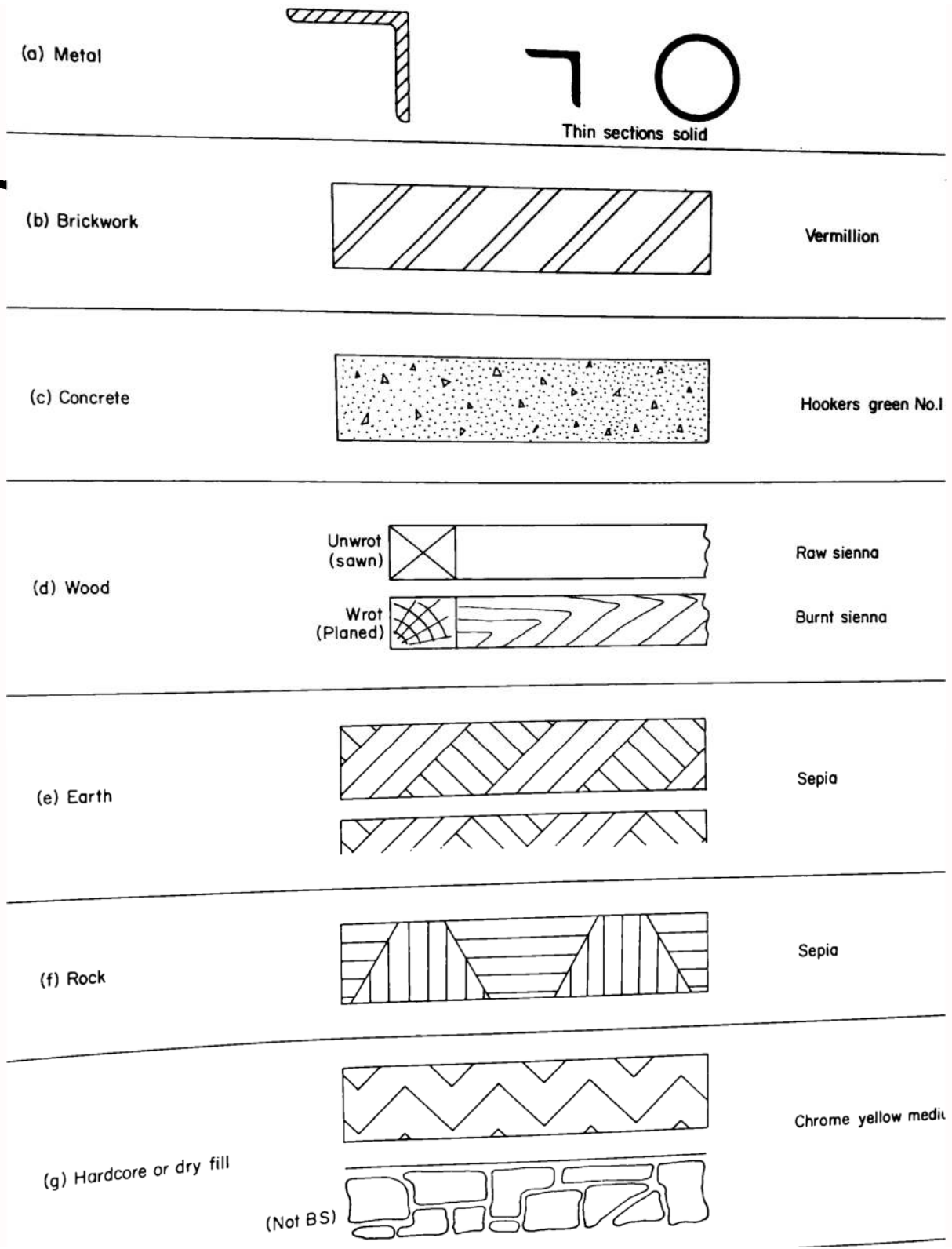
commonly used and understood symbols



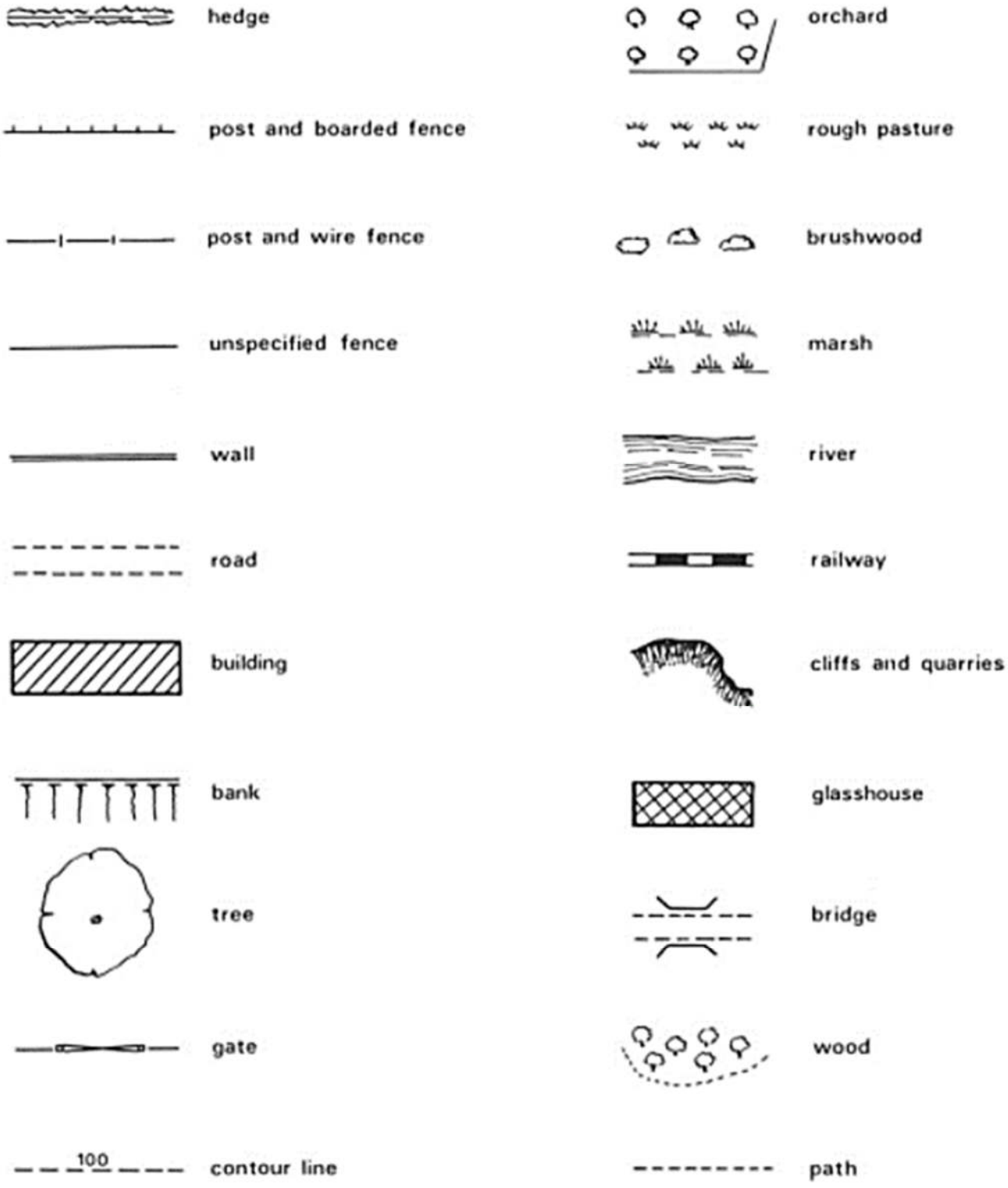
Section Symbols
(on same sheet)



Commonly used material symbols/ keys



Commonly used Symbols on land surveying plans



Abbreviations

General

- Abbreviations of whole words are in lower case, for example min (minimum), reqd (required), …
- Abbreviations are the same in the singular and plural.
- Abbreviations for multiple words are in upper case, for example CJ (construction joint),
- There is no need for full stop in any abbreviation
- Abbreviations fall into 3 categories:
  - Metric Abbreviations
  - Accepted Abbreviations
  - When Space is Limited

Abbreviations

Accepted Abbreviation

Term	Abbreviation	Symbol
Above Floor Level	AFL	
Above Finished Level	AFL	
Above Ground Level	AGL	
As Built	AB	
Bottom	BOT	
Building	BLDG	
Both Ways	BW	
Control Joint or Construction Joint	C.J.	
Centres	CRS	
Clearance	CLR	
Cross Centers	C/C	
Centre line	CL	
Diameter..in a note	DIA	
Diameter..preceding a dimension		ϕ
Dimension	DIM	

Matric Abbreviation

UNIT	SYMBOL
Degree (Celsius)	°C
Kilogram	kg
Kilometre	km
Kilopascal	kPa
Kilonewton	kN
Megapascal	MPa
Metre	m
Millimetre	mm
Pascal	Pa
Radian	Rad
Tonne	t

Lettering

- lettering should be clear, simple and legible. Care should be taken with the size, shaping and spacing of individual letters, and the arrangement of notes on the drawing.
- The size of lettering must be considered in relation to its purpose on the drawing. The next table shows suggested minimum character heights.
- All lettering on the drawings set should be done by a similar method, style and font. Simple open fonts, without serifs are preferable

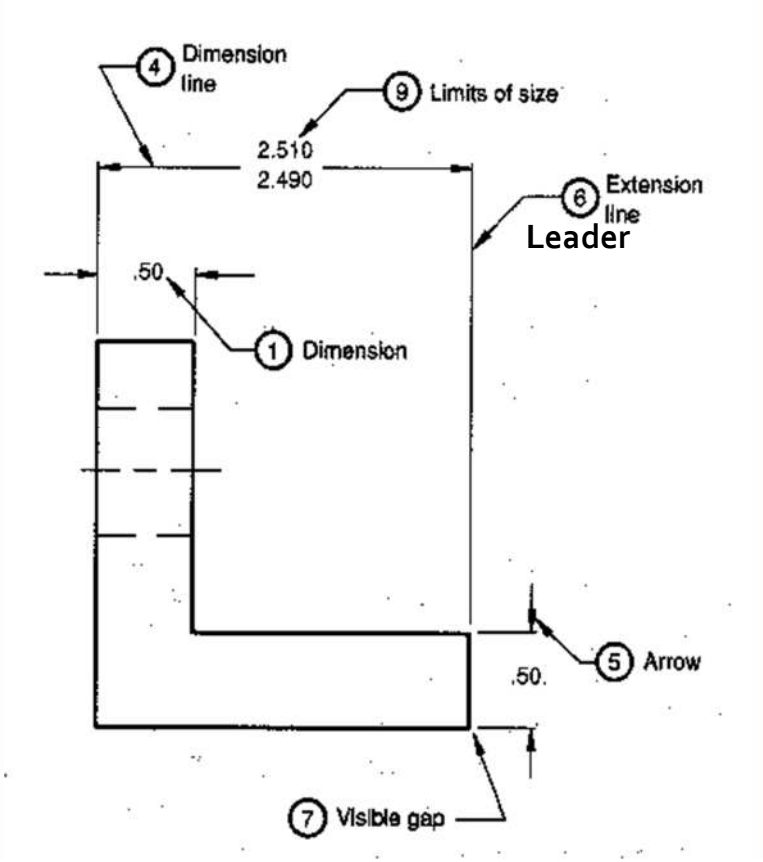
Character heights (BS 308)

Application	Drawing Sheet Size	Minimum Character Height (mm)
Drawing numbers, etc.	A0, A1, A2 and A3	7
	A4	5
Dimensions and notes	A0	3.5
	A1, A2, A3 and A4	2.5

Dimensioning

- **Dimensioning** is fundamental communication process that aims to specify part' s information by using of figures, symbols and notes. Dimensioning adds information that specifies
  - Geometrical characteristics of the object (column size and shape)
  - Location of features (e.g. steel bars in a column section)
  - Characteristics of features (e.g. number and diameter of the bars)

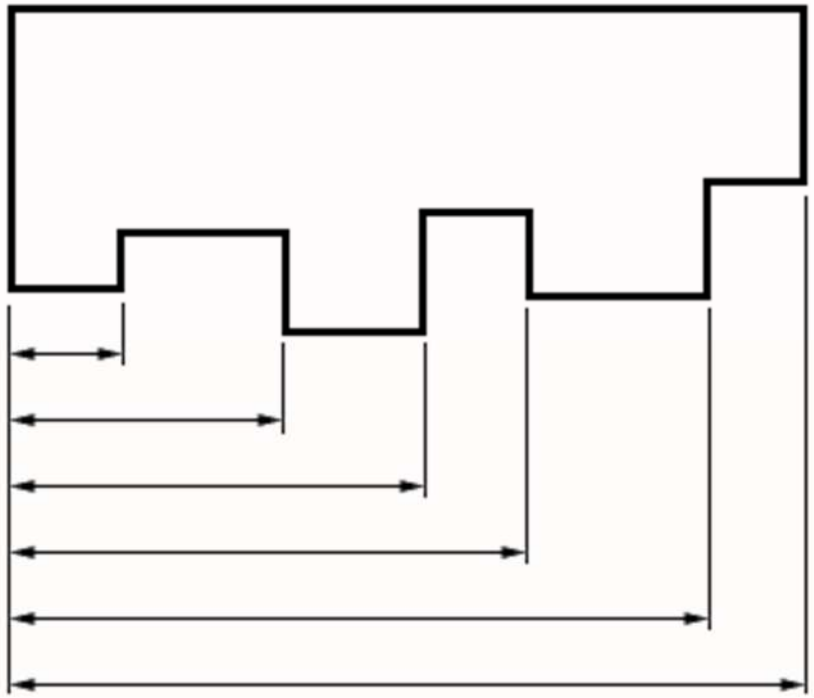
- **Elements of dimensions**: dimensions are indicated by extension lines, dimension lines, leaders, arrowheads as well as figures, notes, and symbols.
- **Note that** : The lines used in dimensioning are thin in contrast to the visible lines of the object.



Dimensioning Type

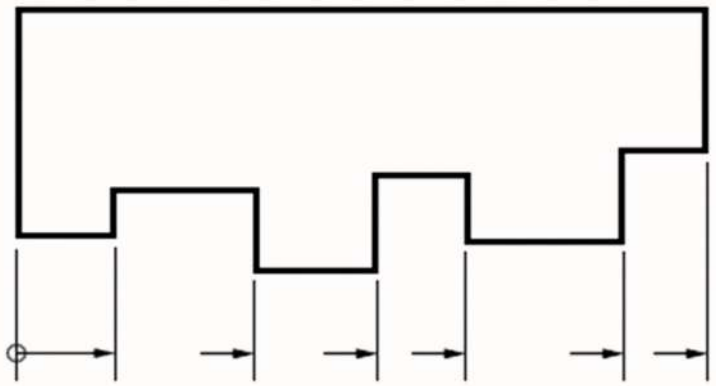
- **Parallel dimensioning**

Parallel dimensioning consists of several dimensions originating from one common edge (datum) as shown in the upper figure.



- **Superimposed Running Dimensions**

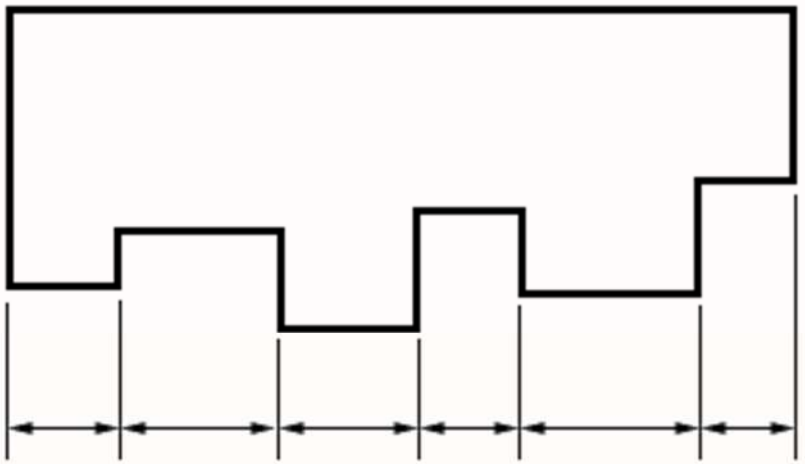
simplifies parallel dimensions in order to reduce the space used on a drawing (see lower figure). The common origin for the dimension lines is indicated by a small circle at the intersection of the first dimension and the projection line. In general all other dimension lines are broken. Note that figures on running dimension lines are shown next to the arrowhead.



Dimensioning Type

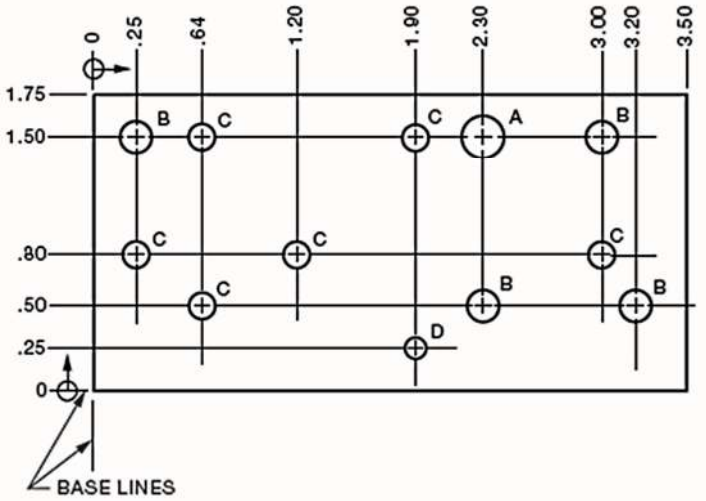
- **Chain Dimensioning**

As shown in the figure (upper). Only used if the function of the object won't be affected by the accumulation of the tolerances.



- **Dimensioning by Coordinates**

Two sets of superimposed running dimensions running at right angles can be used with any features which need their center points defined, such as holes.



HOLE SYMBOL	HOLE Ø
A	.250
B	.188
C	.156
D	.125

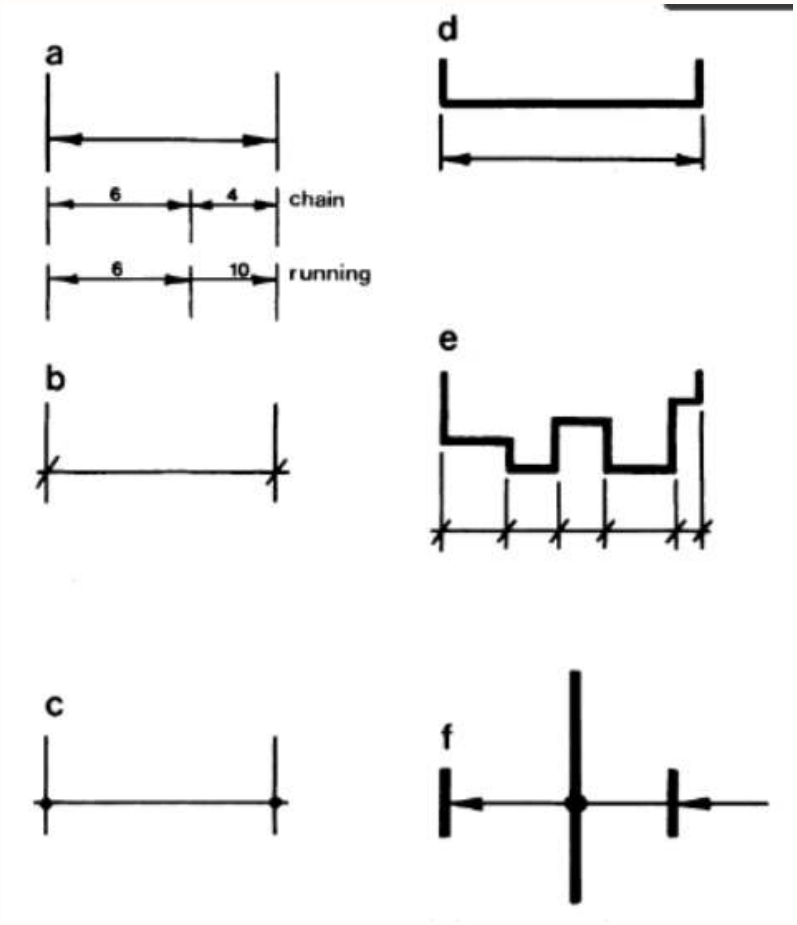
Note that it is also possible to simplify co-ordinate dimensions by using a table to identify features and positions

Recommended conventions & techniques

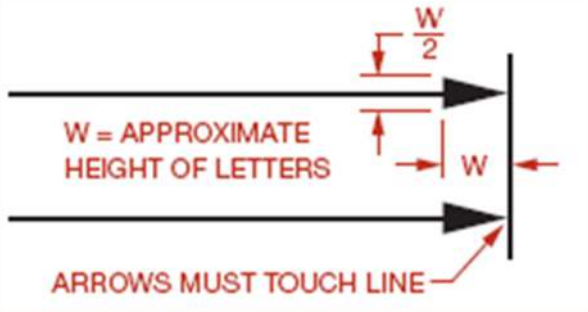
- **Dimension line terminator**

There are three common methods of representing the ends of dimension lines (See figure).

- The 'arrow' shown in figures a and d is recommended for civil engineering drawings.
- The 'dash' shown in figures b and e has particular advantages where there are a large number of short dimension lines on a drawing.
- The 'dot' shown in figure c is not recommended and should be confined to leader lines only.



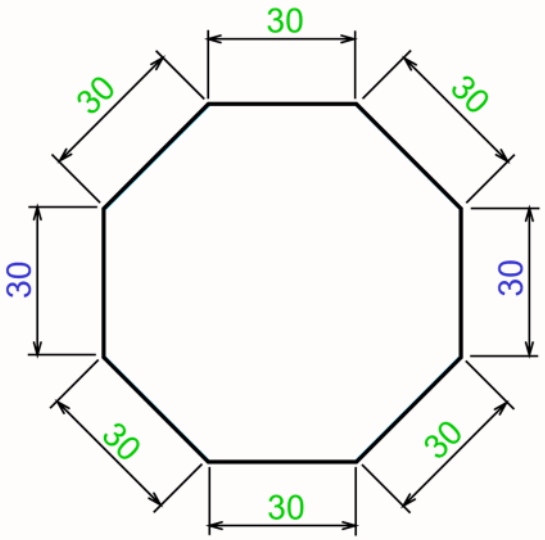
➢ Note that when arrowheads are used the sizes of the arrows shall be as shown in the following figure.



Recommended conventions & techniques

- **Orientation of dimension figures**

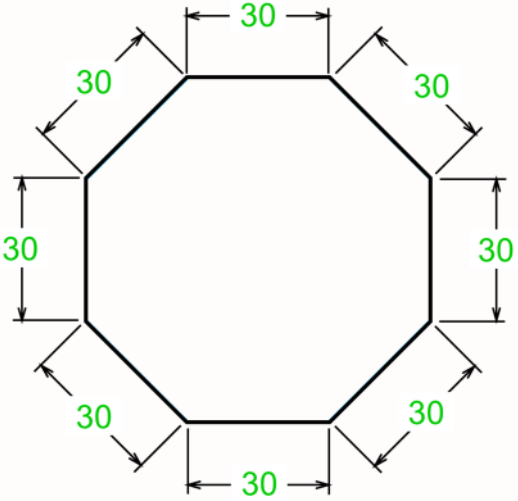
1. Aligned method: The dimension figures are placed so that they are readable from the bottom and right side of the drawing.
2. Unidirectional method: The dimension figures are placed so that they can be read from the bottom of the drawing.



Note: Do not use both system on the same drawing or on the same series of drawing

- **Units of dimension figures**

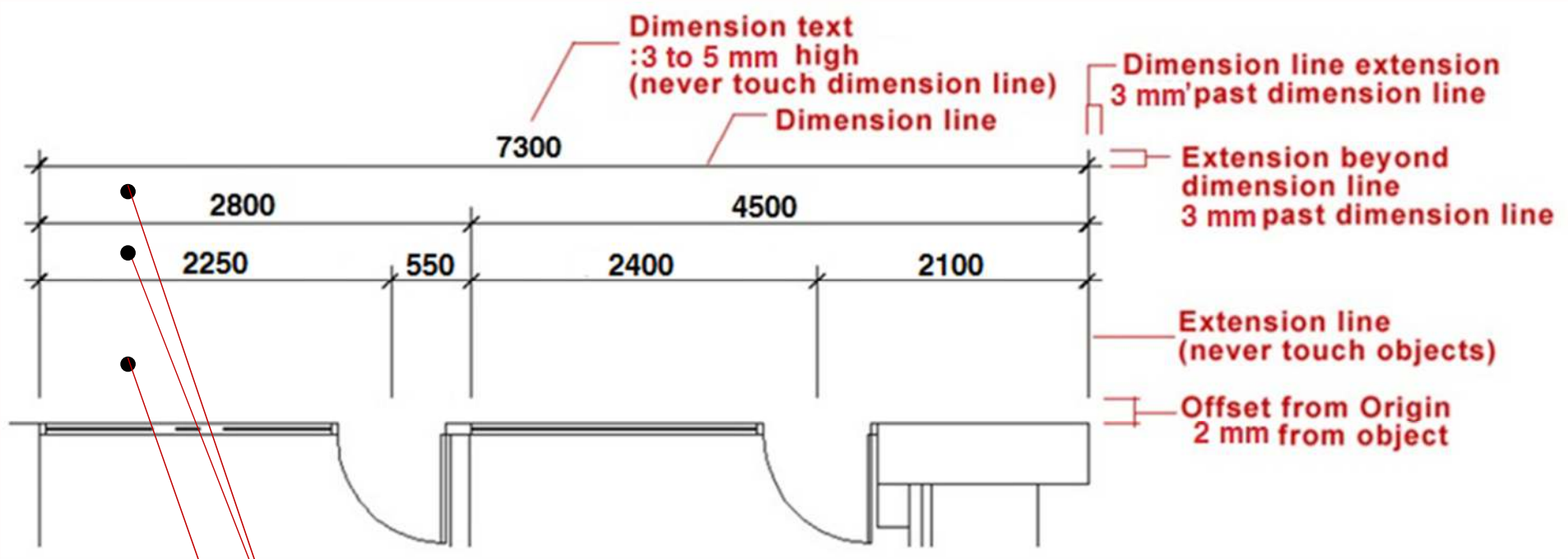
Generally, dimensions should be given in millimeters if less than 1 m, and in meters and decimals of a meter if greater than 1 m. Dimensions on reinforced concrete and structural steelwork details are generally shown wholly in millimeters.



- Where drawings are dimensioned in one unit, the unit abbreviation may be omitted provided the drawing carries a note stating which units are used.

Recommended conventions & techniques

- **Layout of extension and dimension lines**

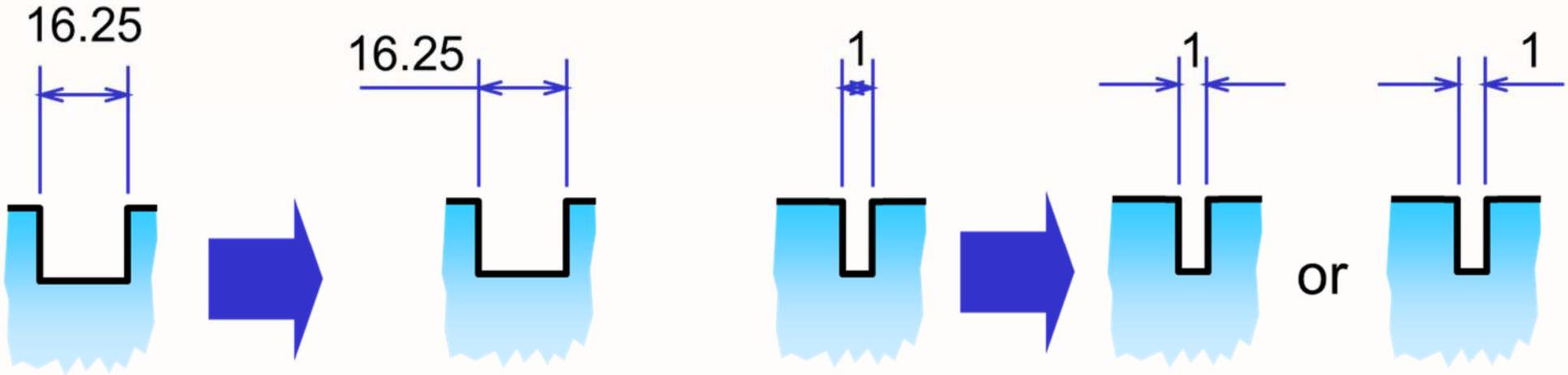


Recommended conventions & techniques

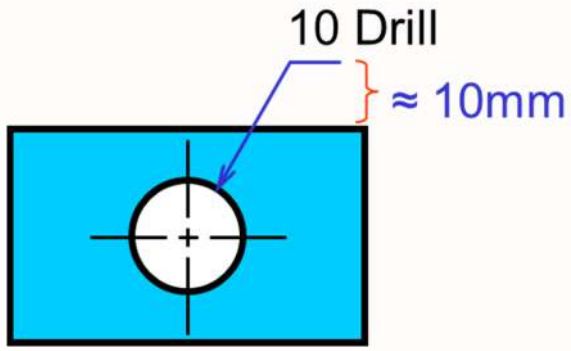
- **Dimension of small features**

Not enough space for figures

Not enough space for ***arrows***



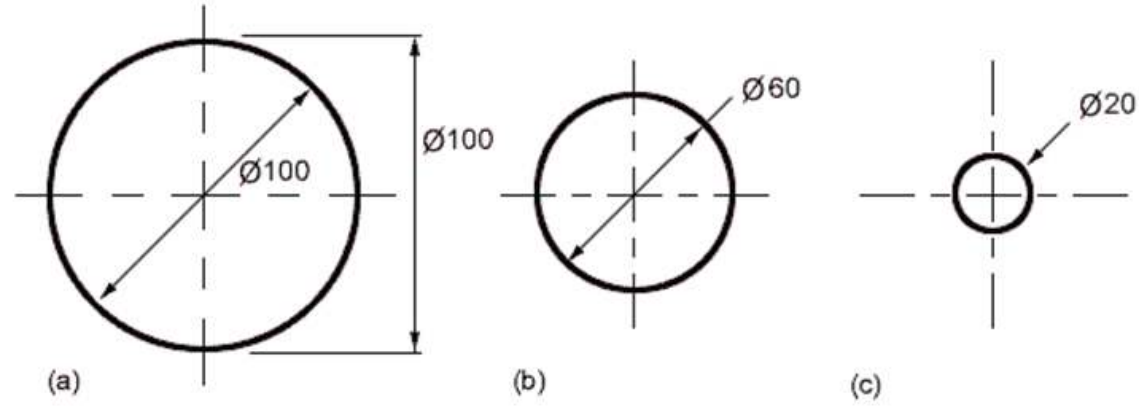
- **Leader lines**
  - Place the notes near to the feature which they apply, and should be placed outside the view.
  - Leader lines used to dimension circles and arcs should be radial



Recommended conventions & techniques

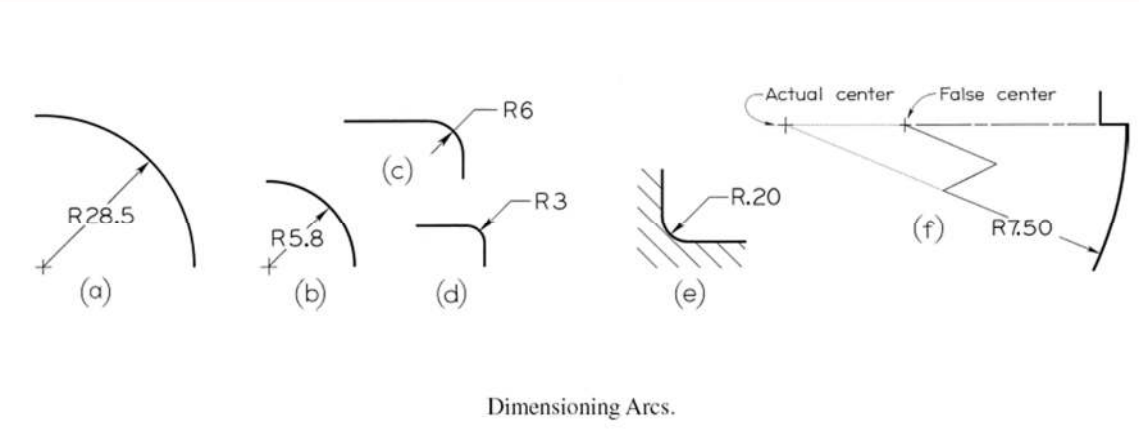
- **Dimensioning Circles**

All dimensions of circles are proceeded by this symbol Φ. There are several conventions used for dimensioning circles as shown bellow.



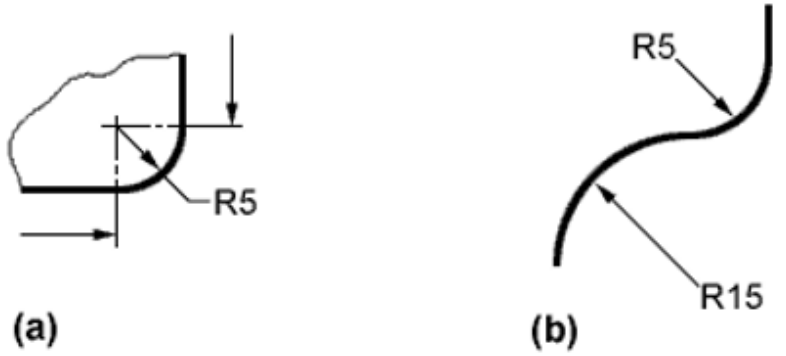
- **Dimensioning Radii/ Arc**

All radial dimensions are proceeded by the capital R. All dimension arrows and lines should be drawn perpendicular to the tangent so that the line passes through the center of the arc.



Dimensioning Arcs.

All dimensions should only have one arrowhead which should point to the line being dimensioned. There are two methods for dimensioning radii.



Basic rules for Dimensioning

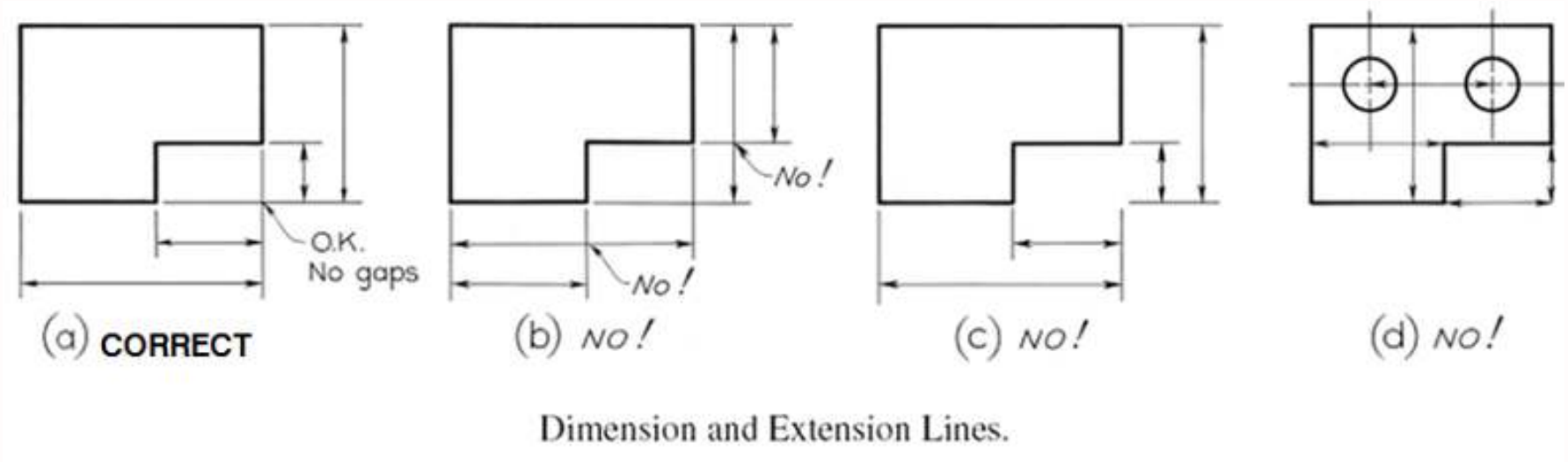
- Dimensioning Principles are not an infallible rule set, especially for the civil engineering drawings. Accordingly engineer always need to apply good judgment.
- However the overriding principle of dimensioning is **CLARITY**, in addition to completeness and the ability to facilitate the measurement and construction process.
- The least number of dimensions for the complete definition of the finished product should be shown, but each should generally appear only once on the drawing.

Basic rules for Dimensioning

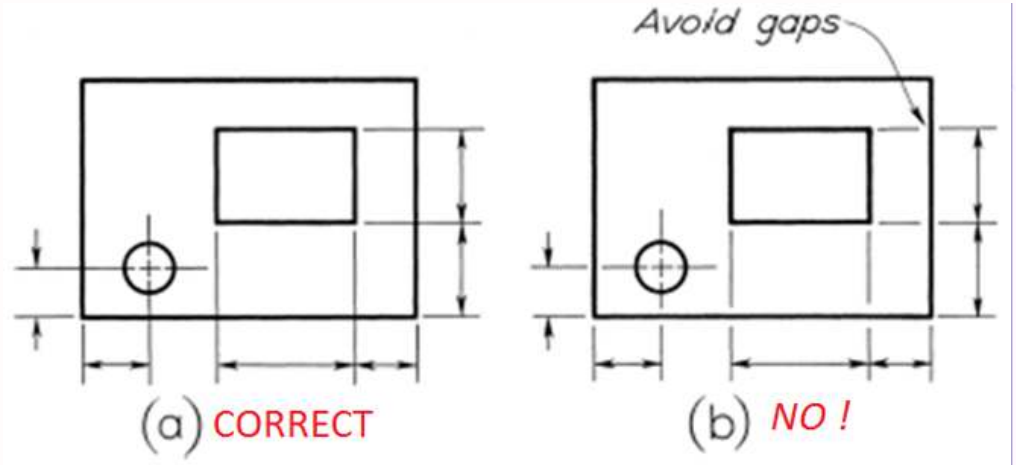
- Figures and letters should be placed near the middle of (except for running dimensions) and above and clear of, the dimension line, and in such a way that they are not crossed or separated by any other line of the drawing. Figures should be placed so that they can be read from the bottom or from the right of the drawing.
- If the dimension is less than one a leading zero should be used before the decimal point. (e.g. 0.5 instead of .5)

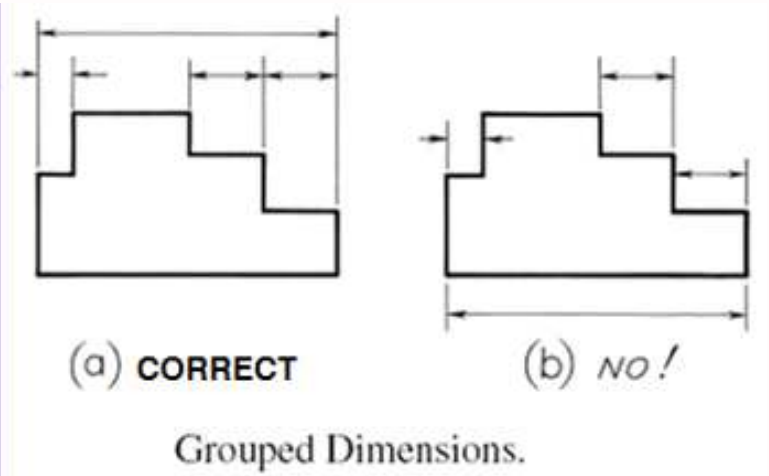
Good and poor practice

Stay off the object and avoid crossed dimension lines (extension lines may cross).



Dimension and Extension Lines.

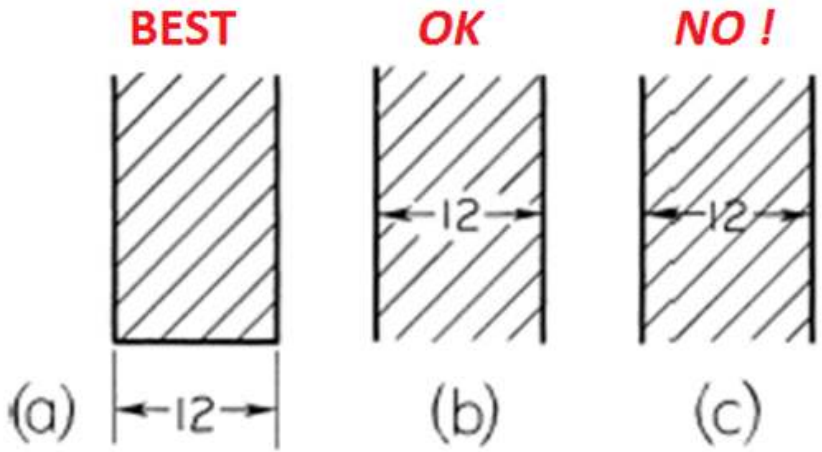




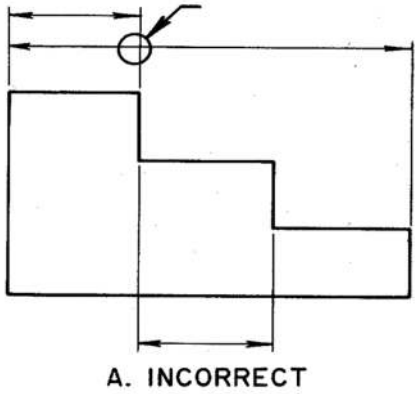
Grouped Dimensions.

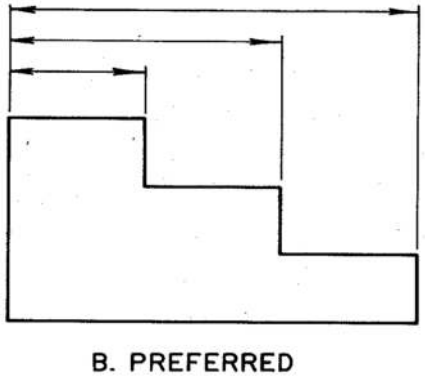
Good and poor practice

Dimensioning Through Hatches

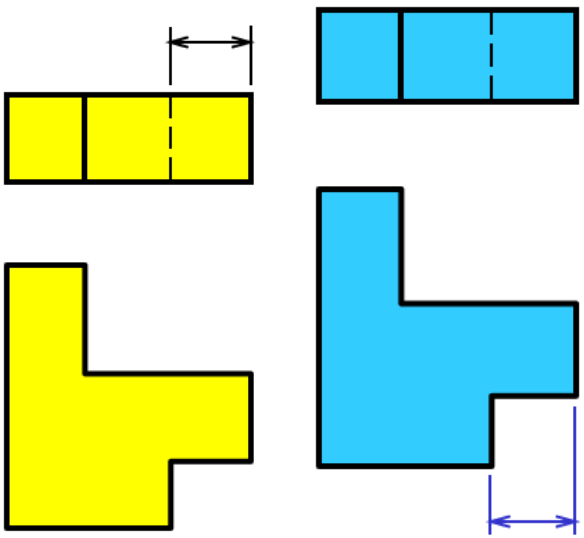


Dimension lines aligned and grouped to promote uniform appearance

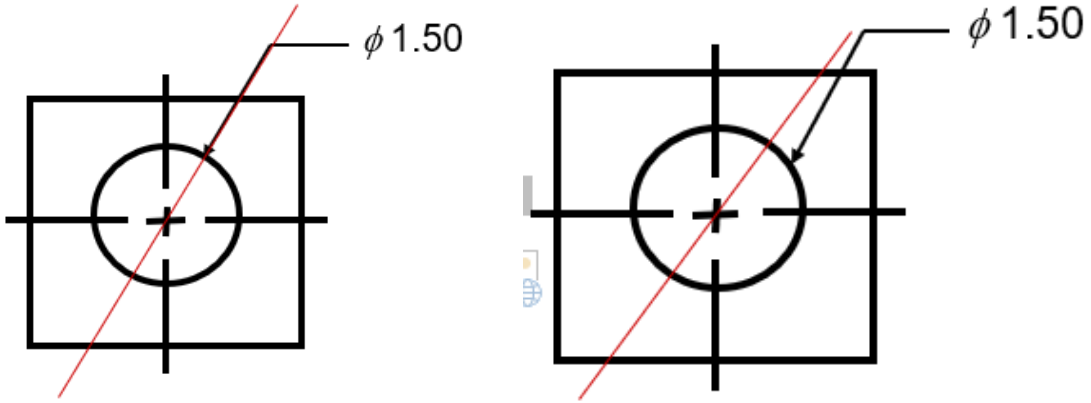




POOR GOOD



GOOD POOR



Good and poor practice