
UNIT 2 INTERPRETATION

Structure

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2.1 INTRODUCTION

This unit aims to guide you in understanding the function and the interpretation of various documents which you will be required to handle as a construction supervisor. The documents comprise drawings, conditions of contract, specifications and the bill of quantities. The Conditions of Contract, Specifications and the Bill of Quantities (BOQ) form a part of the tender documents.

Objectives

Study of this Unit would enable you to:

- understand and interpret construction drawings,
- understand and interpret the Tender Documents,
- observe and note deviations from the documents, and
- set up procedures so that the work is executed in conformity with the drawings and specifications.

2.2 DEFINITIONS

- 1) **Drawing** : Pictorial representation of a structure. This usually consists of two dimensional views such as plan, elevation, X-Sections drawn to scale.
- 2) **Isometric View**: Drawing representing three dimensional of an object/structure.
- 3) **Plan**: A view of structure seen from above.
- 4) **Elevation** : A view of the structure as seen from any side. It could be a front elevation, side elevation or rear elevation depending on side from which the structure is viewed.
- 5) **Specifications** : A document accompanying drawings and estimates/ bill of quantities. They specify the quality and quantity of materials, their proportion; procedure of work, performance characteristics etc. Specifications assist the supervisor and workers in doing the field work. Specifications form an important part of the contract document.

- 6) **Tender:** It is an offer/bid submitted by an intending contractor to the owner. One of the tenders is accepted by the client.
- 7) **Contract:** This is an agreement between client and contractor. This agreement can be enforced by law.
- 8) **Contract Conditions:** These are terms which form the basis of execution of the contract work.

2.3 INTERPRETATION OF DRAWINGS

Drawings are the most important means of communication for an engineer. It is said that a single sketch is worth a thousand words. As a supervisor, you will not be required to prepare drawings at site. Nevertheless it will be very useful to learn basics of drawing preparation. So, let us understand the problems that may arise in preparation and interpretation of drawings. Basically, we are required to construct structures which are three-dimensional (structures having length, breadth and height). However, the drawings contain only two-dimensional views.

For example, in a plan you can find only length and breadth. From the front elevation view you can get length and height but not the breadth. This procedure is followed for convenience of drawing. For simple objects one could draw isometric views (three-dimensional views). But, even for a simple structure, isometric views become difficult to handle, and too complicated to dimension and interpret. The problem, therefore, basically is to visualize three-dimensional objects from their two-dimensional views such as plans, elevations and sections.

2.3.1 Organization of Drawings

Scale

Engineering drawings should always be drawn to a scale. Drawings not drawn to scale give a distorted visual impression of the structure. However, all the views in any drawing may not always be drawn to the same scale. For example, a particular element is frequently drawn to a particular scale in elevation and to a larger scale in section. If the scale used in the section is the same as in the elevation, details required for construction cannot be incorporated. The scale should be so chosen that, when necessary, dimensions may be cross-checked by scaling the view. From this point of view, scales such as 1:100, 1:50, 1:20, etc. are convenient and should be used. Scales such as 1:30, 1:75 etc., are, normally, best avoided.

Size

Drawings should be prepared on standard size sheets. The Bureau of Indian Standard stipulates the following sizes:

A ₀	841 mm × 1189 mm
A ₁	594 mm × 841 mm
A ₂	420 mm × 594 mm
A ₃	297 mm × 420 mm

Drawings for a particular job should preferably be prepared using the same size for the entire job. Drawings of different sizes make filing and handling them at site, rather difficult.

Type

Broadly, drawings may be grouped into the following categories:

- i) Architectural drawings,
- ii) Structural drawings, and
- iii) Service drawings.

Architectural Drawings: These drawings provide necessary information for obtaining all the dimensions of the structure. They also provide information regarding the floor finishes, plaster work, doors and windows, etc.

Structural Drawings: These drawings provide all the information regarding structural (load bearing) aspect of construction. Structural drawings may be grouped as follows :

General Arrangement Drawings (GA Drawings): These drawings provide necessary information for defining the structural framing. These drawings are also sometimes called 'Framing Plans'. For reinforced concrete construction, these plans provide all the information regarding the sizes and spans. For structural steel drawings they show the complete arrangement of the structural system with member sizes.

Detailed Drawings: These drawings provide construction details of various members described in the GA drawings. For RCC construction, reinforcement details are shown in these drawings. In case of structural steel drawing, enlarged views showing the connection details are shown in these drawings.

Fabrication Drawings: These are required only for steel construction. These drawings show the actual fabrication details such as cut lengths, gusset plate sizes, etc. and are accompanied by a material list. These are usually prepared by the fabricator. These drawings are required to be approved by the Consulting Engineer.

Bar Bending Schedules: These are required for reinforced concrete construction and contain the fabrication details of reinforcing bars such as cut lengths bending dimensions, radii of bends, etc., accompanied by a material list. These are usually prepared by the Site Engineer and handed over to the Fitter. For major jobs, they may be supplied by the Consulting Engineer.

Service Drawings: Service drawings provide necessary information about plumbing for water supply and drawing of wiring for electrification etc.

Notes

The information given in the drawing is usually supplemented by "Notes" which appear at the right hand bottom corner of the drawing. Notes include a list of reference drawings, grades of materials to be used and some other typical guidelines-useful for construction.

Revisions

The drawings may need revision during the course of construction. Usually an alphabet is added at the end of the drawing number. Dwg. no. XY-200 becomes XY-200A on first revision, XY-200B on second revision, etc. Sometimes the revision is indicated by adding R1, R2 etc. at the end of the number. For example, we may have XY-200-R1, XY-200-R2, etc. The nature of revisions carried out should be clearly spelt out on the drawing. When a new revision arrives at site, it is a good practice to stamp the earlier drawing 'SUPERSEDED'. The date on which the drawing is so stamped should also be entered. This will avoid future usage of that drawing through oversight. However, all the drawings including those superseded should be carefully preserved. These will prove very useful records for resolving any differences/dispute that may arise in future.

Scaling of Missing Dimension

If any dimensions are missing on a drawing, it is best to request for a clarification from the Engineer who has prepared the drawing. Scaling of dimensions is usually discouraged, since this may lead to serious mistakes, especially if the drawing has not been prepared to scale. The shrinkage of paper on which drawing is prepared may also lead to erroneous dimensions.

Conflicting Dimensions

If the same dimension is repeated elsewhere with a different value or if the dimensions are inconsistent, it is best to bring this to the notice of engineer who has prepared the drawing. While revising drawings, mistakes are frequently committed when one view is revised without revising the other associated views, which get affected by the revision. For instance, beam depth is altered in elevation but may remain unaltered in section. If a particular dimension appears in different drawings, during revision the person concerned may revise the dimension in one drawing and forget to do so in another. In all such cases, it is best to check with the concerned person issuing the drawings.

2.3.2 Coordination

While preparing drawings the Architects, Structural Engineers and Service Engineers interact and sort out any interferences. Even so, it is good practice to study the drawing and recheck that there is no conflict. For instance, the service drawing shows a pipe which cuts into a beam but the structural drawing does not show any opening in that beam. Either the beam has to be redesigned or the pipe relocated.

SAQ 1

- i) How can a three-dimensional structure be represented by a drawing on a paper ?
- ii) What are the common sizes of drawing paper ?
- iii) Explain the following :
 - a) Fabrication Drawing
 - b) Bar Bending Schedule.

2.4 INTERPRETATION OF SPECIFICATIONS

Drawings convey the dimensional aspect of the structure and some essential information about the member such as materials, finishes etc. But the actual construction requires more information. Some of the information will be:

- i) What kind of materials to use ?
- ii) What is the basis for acceptance or rejection of works ?
- iii) What are the procedures to be followed in achieving good workmanship ?

All these are described in detail in the specifications. Specifications, therefore, form the most essential and valuable guidelines for ensuring good quality work.

2.4.1 Reference to Indian Standard Code of Practice

Indian Standard Specifications, Codes of Practice are published by the Bureau of Indian Standards. These cover various aspects of construction. Most of the specifications which form part of documents concerning construction of structure make reference to the Indian Standards. This helps avoiding rewriting what is available in these standards. Besides, Indian Standards cover a wide variety of situations, many of which may be redundant for a particular construction site. It is a good practice to have at the site office a set of all the Indian Standards which have been referred to in the specifications. This requirement is essential in the Contract work.

Organization of 'Specification' in the Tender

The specifications are grouped into a number of sections according to the type of work e.g. Earthwork, Concrete work, Formwork, Reinforcement etc. Without unnecessarily repeating everything that is contained in Indian Standard Codes of Practice following information is provided in a concise manner.

Materials

The Indian Standards to which the materials are expected to comply.

Storage and Handling Materials at Site

Methods of storage, handling and issue of materials at site so that no materials gets outdated having regard to its shelf-life etc.

Fabrication, Production and Assembly

Methods to be used for fabrication, production and assembly; precautions to be taken.

Testing

Tests to be performed on materials and finished products.

Measurement

For all unit-rate contracts works have to be measured and paid for. The Mode of Measurement is specified in this section.

Deviation from Indian Standards

There are situations where some specifications which do not conform to Indian Standards have to be introduced. In such situations, the stipulations contained in Tender Specifications take precedence over Indian Standards.

Proprietary Specifications

There may be work with factory-made products, work not covered by the Indian Standards. Sometimes, though these products are covered by an Indian Standards some specific manufacturer may be given preference. This usually happens for instance, in the case of door fittings, sanitary fittings, electrical fittings, etc. In all such cases the Brand name "or equivalent" is specified in the bill of quantities. It must be noted that these are exceptions. In general, specifications should avoid reference to any particular manufacturer. Specifications have to be of general value and should not promote one particular brand name but should specify the details—size, colour, weight, strength, etc.

Implementation of Specifications

It is very important that work be executed in conformity with specifications. You as a supervisor should make sure that the concerned manufacturers are certified by the Bureau of Indian Standards (BIS). Necessary tests should be performed at regular intervals so as to ensure compliance. All cases of non-compliance should be promptly reported to the Engineer. For all Architectural items and also wherever possible it is a good practice to display samples at site and seek the approval of the Consulting Engineer/ Architect. These samples become points of reference throughout the construction period.

Similarly, it is a good practice to make a sample of works or 'mock up' pertaining to formwork or finishing work, to get the approval regarding method of construction or the quality of finished work that is to be achieved.

2.5 INTERPRETATION OF BILL OF QUANTITIES (BOQ)

The Bill of Quantities (BOQ) describes various items of work and the quantity of work under each item that is required to be executed for completing the job. While quoting, the Contractor is expected to have read the specifications in working out his unit rates. Sometimes, this is also called Schedule of Quantities (SOQ).

Frequently, the specifications are not studied very carefully and hence some very important aspects may be highlighted in the BOQ itself so that such points are not missed. BOQ is subdivided into a number of sections according to the type of work. The numbering and order is the same as that followed for the Specifications.

2.5.1 Organization

The wording of the BOQ has to be simple and concise but should specifically convey what it item covers. For further clarification specifications should be referred to. It is therefore important that the specification for an item of work includes a brief note on mode of measurement, inclusions and exclusions. For instance the rate for reinforcement includes not only the cost of cutting, bending, tying etc. but also the cost of binding wire and cover blocks. Binding wire and cover blocks are not paid for separately.

2.5.2 Extra Items

During the course of construction, certain items of work not mentioned in the tender documents may have to be carried out. These are called extra items of work. The rates, mode of measurement, and the specifications for such work should be determined before taking up such work. Usually, the Contractor is asked to submit a rate analysis for such items of work. The rate analysis includes the cost of materials, labour, plant, machinery, overhead and the profit margin of Contractor. These rates and specifications known as Extra Item Rate List (EIRL) has to be mutually accepted and forms a part of contract.

2.6 CONDITIONS OF CONTRACT

The General Conditions of Contract contain the legal and administrative aspects of the contract. It defines various parties to the contract, their powers, responsibilities etc. The relationship between the Owner, Contractor and Consultant/Architect is clearly defined. The

Consultant / Architect is essentially an agent of the Owner and is expected to conduct himself in an impartial manner. Reference is made to statutory provisions regarding minimum wages payable to workers, provisional dwellings, insurance, etc. Usually, these are standard documents published by the Institution of Civil Engineers (UK), FIDIC, the Indian Institute of Architects, PWDs, Municipal Corporations etc.

2.6.1 Special Conditions of Contract

These are specially made for a particular job and supplement the General Conditions. Clauses describe some general features such as location of the site, access roads, climatic conditions, etc. If any materials are supplied by the owner, these are also listed here. For instance, some clients may like to supply cement and steel to the Contractor at a certain fixed price or free of cost. The time for completion, bonus, if any, for early completion or penalties applicable for delays are also stipulated here. Clauses pertaining to escalation (that is enhancement of the rates) due to increase in the price of materials of construction, wages and the cost of fuel/energy due to change in market prices, the terms and conditions pertaining to supply of services like water and electric power are also defined. You should carefully study all these aspects before the commencement of works.

SAQ 2

- i) Why specifications are necessary ? What are the requirements of good specifications ?
- ii) What is an Extra Item Rate List ?
- iii) Explain the importance of Conditions of Contract to a Supervisor.

2.7 SITE INSTRUCTIONS

These instructions are given in writing by the authorised person supervising the construction. These instructions generally bring to the notice of the Contractor aspects of non-compliance of work with the drawings or specifications. The Contractor has to make good such lacunae so that the work may proceed in conformity with the drawings and specifications. The site instructions also include a variety of situations not clearly defined in the drawings such as :

- a) actual excavation and founding levels as approved by the Engineer,
- b) deviations from the drawings as approved by the Engineer,
- c) instructions for rectification or demolition of substandard work, and
- d) unusual observations such as collapses during excavation, problems of dewatering, etc.

2.8 INSTRUCTIONS BY THE OWNER / CONSULTANT

The drawings, specifications and bill of quantities generally provide the guidelines to the field staff and supervisor. In spite of these documents (or sometimes in addition to them) it is necessary to give instructions to the supervisor. They are given by the owner generally through the Engineer appointed by the owner or his Architect and / or the Consultant employed by the owner. The situation in which such instructions are necessary are:

- i) the work is not proceeding according to the drawings and specifications either due to ignorance or negligence of the supervisor and / or workers,
- ii) foundation levels or strata vary from those shown on the approved drawings,
- iii) the intermediate stages (foundation preparation, formwork erection, placement of the reinforcement of RCC work etc.), and
- iv) removal (dismantling) the substandard work which, being not in accordance with the approved drawings and specifications.

The instructions given by the owner/consultant must be in writing.

It is a general procedure to maintain a work order book on the site and the owner's Engineer, Architect or Consultant records the observations of his visits to the site. Particularly the instructions to be given to the Site Staff must be in writing. The Engineer must ensure that these instructions are noted by the concerned Supervisor and complied with. The Engineer must ensure that the Field Staff reports compliance with the instructions given by him.

2.9 INSTRUCTIONS TO THE CONTRACTORS

The procedure followed is generally the same as described in the section 2.8 above. A work order book is maintained on the site of works. Instructions given to the Contractor are recorded in the Work Order Book. Contractor or his authorised representative has to sign the work order in the acknowledgement of receipt of the instruction.

The owner's Engineer takes out three copies of the instruction / work order. One copy is sent to the Contractor's office, one copy is sent to the owner's office and one copy is retained by the Engineer in his office file. This precaution is necessary as a safeguard against any possible misplacement of the work order book.

2.10 SUMMARY

In this Unit, we have covered the various aspects that will assist you in understanding and interpreting the drawings, specifications and other contract documents. We have also provided you guidelines for a systematic use of the Contract Documents for ensuring good workmanship. The importance of written instructions under various circumstances has also been highlighted.

2.11 ANSWERS TO SAQs

SAQ 1

- i) A view of drawing (plan, elevation or cross-section) shows only two-dimensions while a structure has three dimensions. To get a complete idea of the three dimensions it is necessary to see (read) two related views viz. plan & elevation or plan and a cross-section.
- ii)

Size	Dimensions in mm
A ₀	841 × 1189
A ₁	594 × 841
A ₂	420 × 594
A ₃	297 × 420
- iii)
 - a) **Fabrication Drawing:** This shows the details which help in fabrication. This is useful particularly in steel structures. Fabrication drawing shows a list of materials such as gusset lengths, rivets, cut sections etc.
 - b) **Bar Bending Schedule:** This schedule is a very useful aid in RCC work. It shows the fabrication details of reinforcing bars such as their length, shape, spacing etc. Bar Bending Schedule is useful for bar benders and fitters who place the reinforcing bars in position and tie them together.

SAQ 2

- i) Drawings mainly show the dimensions though it may contain some brief information about a member of structure. This information is far too inadequate. This is supplemented by specifications to help the supervisors, field workers.

A good specifications should be very precise, unambiguous. It should contain the details of materials, their sizes, qualities (test to be performed). Process details such as tools and equipment used, procedure and sequence of operations. Intermediate stages and their requirements; finishes or workmanship to be achieved etc.

- ii) **Extra Item Rate List (EIRL):** During the course of construction (particularly in contract work) it may be necessary to carry out items of work which are not included in the contract. These items are known as **Extra Items**. It is desirable to work out details of the extra items such as quantity, rate, specifications. These details constitute an **Extra Item Rate List** and should be accepted by both the parties client and contractor.
- iii) **Conditions of Contract:** Specifications indicate the technical conditions governing the Contract work but the administrative requirements are specified in the **Conditions of Contract**. They indicate the responsibilities and obligations of the parties to a contract particularly of the Contractor. Some conditions for example:
 - a) advances payable to the Contractor,
 - b) running account / interim payment to the Contractor, and
 - c) procedure for Certification etc.