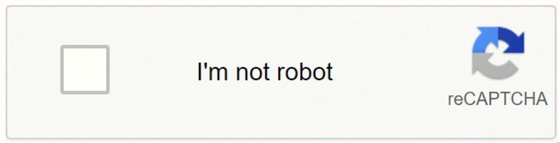

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Best book for civil engineering drawing

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From this book, students will learn how to set a scale for their drawing and their landscaping skills will also be enhanced. At the same time, students will also be able to learn about structures like railways, sewerage systems and pipelines. With the help of these drawings, a surveyor will be able to determine how much material will be required. Also, Civil Engineering Drawing K Venkata Reddy Book Pdf will teach the students about alignments in case of railways or roadways. Along with making these drawings, students will also be able to analyze them and interpret them for the construction professionals. Note: Civil Engineering Books Features: Civil Engineering Drawing K Venkata Reddy Book eBook is a book for civil engineers that teaches them how to draw structures that have to come to life on land. With the help of these drawings, much estimation can be made about the construction process. Check: Download Civil Engineerig Surveying Books Something went wrong. Wait a moment and try again. 1. Dedication To the Students With the hope that this work will stimulate an interest in Civil Engineering Drawing and provide an acceptable guide to its understanding. Regards Wahaab Siddique Student, Civil Engineering Department (Session 2018) Wah Engineering College,Wah Cantt,Pakistan. Ph: +92-3052800070 Email: baabsid99@gmail.com Department of Civil Engineering Wah Engineering College,Wah Cantt. 2. ENGINEERING DRAWING BASICS OF ENGINEERING DRAWING SECOND EDITION DR. ZAHID AHMED SIDDIQUI DR. MUHAMMAD ASHRAF ENGR. SHAHID AHMED SIDDIQUI 3. M/S TECHNICAL PUBLISHERS M/S Technical Publishers Lahore ZAHID AHMED SIDDIQUI SHAHID AHMED SIDDIQUI DR. MUHAMMAD ASHRAF Basics of Engineering Drawing ISBN: 978-969-8633-06-6 This book was composed and produced by Zahid Ahmed Siddiqui, Professor, Department of Civil Engineering UET Lahore, and published by M/S Technical Publishers, Lahore. Copyright © Zahid Ahmed Siddiqui 2011 4. About the Author Zahid Ahmed Siddiqui, Ph.D, is a Professor in Civil Engineering Department of University of Engineering and Technology Lahore. He is author of previous edition of this book published in 1992 besides various editions of four more books on the subjects titled "Steel Structures", "LRFD Steel Design Aids", "Concrete Structures, Part-I" and "Concrete Structures, Part-II". He has teaching, research and practical design experience of almost 27 years. He has vast experience of teaching to Undergraduate and Graduate Students of Civil Engineering. He is actively involved in field design of sizeable concrete and steel structures. CONTENTS 5. 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PREFACE Drawing is one of the basic subjects of Engineering and there is no challenge to its much diversified importance and use. No single book is available in our country to explain the basic concepts and principles to the students of degree and diploma concepts and principles written in a local pattern. This book is the first effort to compensate this deficiency and the subject to the undergraduate classes for any years combined with the practical needs and requirements. Due to the financial constraints, all the figures were drawing by the principal author himself besides all the typing work which may have restricted the standard of the presentation. The authors feel that this first edition may have many areas needing improvement both in terms of the concepts and the language. The readers are highly encouraged to point out any such improvement and to submit their suggestions which will be properly incorporated in the future editions. The authors are thankful to M/s Technical Publishers, Lahore for printing book in a presentable form. AUTHORS 8. CHAPTER NO.1 INTRODUCTION 1.1 THE SUBJECT Engineering drawing, also called technical drawing and engineering graphics, is the graphical representation of shape of any physical object which may be a part of a machine, a building, a dam, or any other complicated structure. The shape of some simple objects like spheres, cubes, cylinders, etc., may be described in words and sentences but ordinary language fails for complicated objects. Even if a thick book is written to describe the shape of a building, the reader will not be able to conceive the exact shape of that building with all its minor details. It can be safely said that it is almost impossible to describe the shape of an object in words and hence only three methods are left for the purpose namely camera photographs, models and drawings. Camera photographs can only be used to communicate the shape of existing structures but not the shape or design still in the mind of the designer. Further these photographs do not show all the inner details and actual dimensions are not communicated. Models, usually made up of wood, polystyrene, soap, plastic, etc., are perhaps the best tool for description of the shape but these are generally used for explaining finished outer shapes of the structures to non-engineering persons. Sometimes models, made smaller in size, are also used to carry out performance study of bigger structures like canals, dams and turbines. Models require much more skill and time for their creation necessitating relatively more skilled persons employed for longer periods; also more space is required in offices for their storage. Hence, cost to describe the shape with models is usually much greater and this method for shape- communication is not generally used except only in special cases. The easiest way left to describe an object is to make drawings; simply lines are drawn nr a piece of paper according to certain fixed rules. The advantages of engineering drawing are as follows: 1. Complete shape of the object is represented. 2. Inner details may also be shown. 3. Actual dimensions may be communicated. 4. Lesser time is consumed in making the drawings. 5. Relatively lesser training is required for making and understanding the drawings. 6. Lesser space is consumed for their storage. 9. 7. Drawings may easily be transported from one office to the other. Further these are easy to be handled at the site. 8. Once drawings are made, as many copies of these as required may easily be obtained. 9. Lesser cost is involved in making drawings. Consider, for example, the construction of an ordinary house. First an architect will design the building architecturally meaning that sizes of all the component parts (like rooms, stores, kitchen, bathrooms, and almiras) and their relative positions for easy and comfortable living are decided. The ideas, called design, are represented in some drawings. These architectural drawings are then passed over to civil engineer who design the building structurally meaning that the behaviour of the building under the worst possible loads is studied and thicknesses and materials of construction are specified for beams, roof -slabs, walls and floors, etc. A civil engineer has to read the architectural drawings and, after some calculations, he has to make drawings to represent his design. No matter how knowledgeable an engineer may be concerning the highly complex technical and scientific aspects of his profession, without a command of the engineering drawing he would be completely ineffective simply because he would fail miserably in understanding the designs of others and in transmitting his designs to others. A site-engineer reads the drawings supplied to him and accordingly carries out the construction exactly as originally conceived by the engineer. From the above example, it is clear that the only way of communication among the engineers is drawing with the help of which they can understand other engineers and express themselves. Hence it may safely be said that engineering drawing is the language of the engineers. Engineering drawing may also be defined in another way, that it is a system of communication in which ideas are expressed exactly, information is conveyed completely and unambiguously and the most complicated shapes are specifically described. 1.2 DRAWING INSTRUMENTS In selecting instruments for drawing, secure the best you can afford. With reasonable care a set of good instruments will last a life-time, whereas poor ones will cause disturbance even the start and will be unusable after a very short period. 1.2.1 Drawing Board The drawing surface may be the drafting table top itself or a separate board. Drawing board is a rectangular wooden piece with two short and two long sides about 2.75’ x 2’ size. One short edge is especially made straight and is called the working edge. This edge should be tested with an already tested T-square blade and must be perfectly straight. 10. Fig 1.1 Drawing board and T-square 1.2.2. T-Square The T-square is composed of a long strip, called the blade, fastened rigidly at right angle to a shorter piece, called the head or stock. The upper edge of the blade and the inner edge of the head are working edges and must be straight. Transparent edge is recommended for top edge the blade since it permits the working person to see drawing underneath. T-square may be made up of wood, plywood ; or plastic but its size must be equal to the board size (called imperial size). 1.2.3. Drawing Sheet Imperial size (30" x 22") sheet of better quality should be used. In general, paper should have sufficient grains or teeth against which lead of the pencil may work, colour of the paper should be agreeable to the eye, the sheet should provide a hard surface not easily grooved by the pencil and erasing qualities of the paper should be good. Drawing on a good quality sheet is always easier. 1.2.4. Drafting Tape (Scotch Tape) It is a colourless sticking tape which is used to fix the sheet on the drawing board. 1.2.5. Triangles Or Set -Square Two triangles are used in drawing. For the first triangle, angles are 45°, 45° and 90° and is called 45° triangle. The other triangle has 30°, 60° and 90° and is called 30°-60° triangle. 45°-triangle should be about 10 in. (25 cm) in size, whereas, longer side of 30°60 ° triangle should be about 14 in. (35 cm). At least one side of each triangle must be graduated in inches or centimetres depending upon the units to be used for the drawing work. These triangles are made of transparent plastic material. 11. Fig 1.2 45° and 30°-60° Triangle 1.2.6. Diagonal Scale It is a 6 inches long flexible scale which is basically used for measuring very small dimensions with reasonable accuracy but, in general, it is a multipurpose scale. With decimal diagonal scale in inch units, measurements may be taken up to second decimal place. Fig 1.3 Decimal Diagonal Scale 1.2.7. Compasses And Dividers Compass is an instrument with the help of which we can draw circles; it consists of two arms hinged together at one end. One of the arms holds a metallic needle at the free end while the other arm may hold another needle, lead, pen, or a lengthening bar. Bow-type compass with opening and closing screw in-between the two arms is preferable because the compass may be opened exactly and further the opening is not disturbed while drawing the circle. If both arms and into needle points, the instrument is called a divider. At least two compasses, 12. one small and one large, and one divider should be obtained with all the accessories like extra leads, extra needles, lengthening bar, and small screw-tightner. The set of compasses and dividers is commonly available in the form of a drawing instrument box. Fig 1.4 A set of drawing compasses and dividers 1.2.8. Pencils The basic instrument for drawing is the graphite lead pencil made in various hardnesses. Hardness of the pencil is specified by its grade, 9H to 7B. - - - - - - - - 3H, 2H , H , HB and F , B, 2B - - - - - - - - - Hardness increases Softness increases For ordinary building drawing, 4H, H, HB, and B pencils are only required. 1.2.9. Small Knife And Sandpaper Pad Fig 1.5 Types of Pencils 13. Sandpaper pad is a small wooden strip pasted with a sandpaper on one side and a small foam on the other end. Sandpaper is used to make required shape of the lead and foam is used for final cleaning of the same. 1.2.10. Eraser Eraser is used to rub out extra and incorrect lines. It should be of suitable grade and of good quality. 1.2.11. Erasing Shield It is a thin metallic various plates with perforations shapes of extra completion and is used to remove of a drawing without disturbing required lines. 1.2.12. Towel Or Brush During drawing work, frequent cleaning of the sheet and instruments is needed. Hence, a towel or brush should always be available. 1.2.13. Triangular Scale This instrument is triangular in shape having six edges and usually two scales are provided over each edge, one starting from the left and the other starting from the right. The scales (in F.P.S. units) available in triangular shape are generally of three types: a) Mechanical Engineer's Scale Fig 1.6 Sandpaper Pad Fig. 1.7 Erasing shield 14. These scales are used to draw the object on the actual size, double size, half size, quarter size, or eighth size. As usually smaller dimensions are involved in machine drawing, bigger divisions represent inches which are then subdivided in fractions. b) Civil Engineer's Scale This scale is graduated in the decimal system and the set of these scales is as follows: 10, 20, 30, 40 - - - - - - On a 10-scale, inch is divided into 10 equal parts, one part is generally considered to be equal to 1 foot in survey maps. In other words, 10 ft of the actual structure will be shown by 1 inch of the line on the drawing sheet. Mechanical Engineer's and Civil Engineer's Scales are not used for the building drawing. c) Architectural Scale Full, Half, Quarter, Eighth - - - - - - - or 1, 1/2, 1/4, 1/8, - - - - - - - Architectural scale is actually an inch-foot scale and Full scale here means that one foot of the structure is represented by one inch of the drawing line; size is reduced 12 times before drawing. Similarly half scale means that one foot of the structure is represented by half inch of the drawing line, reduction factor being 24. 15. Architectural triangular scale should be obtained for building drawing. 1.2.14. Set Of Circles (Circle Template) This is a thin sheet of plastic having circular openings of various sizes and is especially useful to draw circles of very small radii. It may also be used to draw curves tangent to other circles or straight lines. 1.2.15. French Curves Fig 1.8 Triangular Scales Fig 1.9 Circle template 16. These are made of plastic sheets with edges lying in irregular curves. Suitable curves may be fitted for the already plotted points and freehand curves may be changed into smooth curves. 1.2.16. Flexi-Rod It serves nearly the same purpose as the French curves do. First the flexi-rod is shaped according to the required curvature, it then retains its shape and is used to draw smooth curves. Fig 1.10 Irregular or French curves 17. CHAPTER NO.2 USE OF INSTRUMENTS AND LETTERING 2.1 CLASSIFICATION OF LINES Lines may be classified according to their thickness, darkness and shape: 2.1.1 Classification According to Thickness a)Very thick lines drawn with chisel-shaped pencil Fig. 2.2 are used to show reinforcing steel bars and position of beams etc. in structural working drawings, see Fig. 2.1 (A). b)Relatively thicker lines drawn with cone-shaped pencil Fig. 2.2, are used to show ground level in elevation of buildings, plastered surfaces of walls in plans, etc., see Fig, 2.1 (B). c) Lines of common thickness show usual features of the object see Fig. 2.1 (C). d)Thin lines are used for center-lines, construction lines, extension lines, and dimension lines, etc. 2.1.2 Classification According to Darkness Line of a given thickness may be dark and bright or it may be dim depending upon grade of the pencil and the pressure applied. a) Thick and common lines should be of greater darkness and brightness keeping their thickness in the required range. Generally try for greater brightness increases the thickness of the line. 18. b) Center -lines, extension lines and dimension lines should be of moderate darkness, see Fig. 2.1 (D) c) Construction lines and guide lines should be very light or dim. Just liable to working person. 2.1.3 Classification According to Shape a) Full line of common thickness shows visible outline of the object, Fig. 2.1 (C), H- Pencil is generally used for the purpose. b) Full lines of lesser thickness and brightness are used as extension and dimension lines. See Fig. 2.1 (D), 2H-Pencil may be used for the purpose. c) Full lines of very dim quality, drawn with 4H-Pencil, are used as construction lines and guide-lines. d) Dotted line consists of a series of dots, as in Fig. 2.1 (E), and is not generally used in engineering drawing because lot of time is consumed in drawing a dotted line. e) Dashed line consists of a series of dashed lines as shown in figure 2.1 (F), the dashes should approximately be equal in length and in gap between two dashes should roughly be equal. Where dashed lines are in continuation of full lines, these should be started from a gap, otherwise, these should be started with a dash. These lines indicate hidden outlines in mechanical drawing but in civil drawing, these lines, in plan, show the features above the cutting plane like beams, sunshades and ventilators. f) Center-lines consist of a series of alternate long and short dashes, as in Fig. 2.1 (G). These lines are used to locate centers of central parts and axes of cylindrical features. g) Cutting plane symbol is series of one long and two small dashes using relatively thicker line, see Fig. 2.1 (H). h) Break lines have different shapes, two of which are shown here, see Fig. 2.1 (I). These lines are used to end a part of the structure to indicate the continuity of structure in same pattern. i) Section line or cross hatching consists of lines drawn at 45° 1/16" to 1/8", as in Fig. 2.1 (J). It is used to indicate solid portions in section. 19. Fig. 2.1 Types of Lines. 2.2 SHARPENING THE PENCIL Lead of a pencil should always be kept sharp, only a sharp lead is capable of producing clean black lines that sparkle with clarity. For wooden pencils, lead is opened approxiately 1/2" in length and then required shape of is made over sandpaper pad. For cone-shaped lead, pencil is rotated in hand while sharpening and a very fine cone is made having at least 3/8" length and ending in a perfect wedge point. For chisel-shaped pencil, grinding of lead is done from the two opposite side and for the lead to be used in compass, grinding is done from one side. Fig. 2.2 Lead points 2.3 HORIZONTAL AND VERTICAL LINES ON THE BOARD For right-handers, board should always be placed in such a position so that its working edge is on the left of the working person.This working edge of the drawing board serves as a reference vertical line. All vertical lines on the drawing sheet should be parallel to the working edge and all the horizontal lines should be perpendicular to it. The head of the T-square can be slided over the working edge of the board as shown in Fig. 2.3 (A). When the working edges of the board and head of the T-square are in close contact throughout the length, the working edge of the later becomes vertical. As blade of the T-square is at right angle to the head, the working edge of the blade comes in the horizontal direction when working edge of the head is made parallel to the reference vertical edge. By sliding the T-square upwards or downwards on the board, a set of horizontal lines may be drawn. Following steps may be taken while using a T-square: 20. i) Only one point is marked on any vertical line on the sheet from where horizontal line is to be drawn. It is not a good practice to mark points at the two ends which are later on joined with any straight edge. ii) While using a T-square, working edge of the board and head of T-square must be in close contact throughout the contact-length. To draw a horizontal line, hold the head of T-square with the left hand, as shown in Fig. 2.3 (A), and apply a slight but uniform lateral pressure over the T-sqaure of the board. Slide the left hand until the working edge of blade just passes through the already marked point. Chang your hold sothat fingers remain on the T-square and the thumb is placed on the board, making sure that the position of the T-square is not changed, Fig. 2.3 (B). Draw horizontal line as shown.in Fig. 2.3 (C) with the right hand. Fig 2.3 (A) Figure 2.3 (B) Fig 2.3 (C) iii) While sliding the T-square, the blade should be allowed to move freely. If it is touching with the right hand, note or the instruments, either the angle of the Tsquare will be disturbed or the T-square will lose its connection with the working edge of the board and the lines drawn will not be horizontal. To draw vertical line, place any of the triangle on the T-square with the vertical edge on the left as shown in Fig. 2.4. Slide the T-square up or down until the combination is vertically in the required range. Slide the triangle towards the left or the right until working edge 04 the triangle passes through the marked point, the triangle and blade of the T-square being in full contact. Hold the combination with the left hand and draw line with the right hand. 21. Fig. 2.4 (A) Drawing a Vertical Line. Fig. 2.5 (B) Using a Combination of Triangles. Lines at other angles available on the triangles may be drawn in the same way. In some cases, combination of triangles may also be used as in Fig. 2.5. 2.4 FIXING THE DRAWING SHEET Drawing sheet should be fixed on the board in. such a way that its upper longer side is truly horizontal. First of all the sheet -is placed on the board such that approximately equal spaces are left on all the sides. T-square is placed over the sheet and is held in the correct position with the left hand as described before, so that, its blade comes in a horizontal line. It is then slided up until its working edge comes very near to the top edge of the sheet. The drawing sheet is now adjusted from below with the right hand without disturbing the-T-square until its top edge becomes parallel to the working edge of blade of the T-square. The T-square is then slided a little downwards and the sheet is fastened to the. board on the two upper corners with the help of drafting tap. The T-square is then slided up and edge of the sheet is again checked. If it is exactly horizontal, the T-square is slided down until it is just above the bottom of the sheet and tape is applied over the lower corners. Drafting tap is preferred for fixing the sheet on the board because it does not damage the board and it will not damage the sheet if it is carefully removed by pulling it off slowly towards the edge of the paper. 22. Fig. 2.6 Fixing the Sheet and Drawing Border Lines. 2.5 BORDER LINES AND SEAL Border line is usually drawn with HB-pencil leaving 1/2" spacing from all the sides except on the left where it is kept one inch away from the edge for the reasons of binding of the drawings at the end in the official documents. Seal or title is a block usually left at bottom-right corner of the sheet to have the following information: i) Name of the department or the firm which is preparing the drawing. ii) Name of the client for which the drawing is beinr prepared. iii)Heading of the sheet showing the purpose and the of the project for which the drawing is made. iv) Scale used, date of drawing, drawing number, etc. , are also mentioned. v) Name and signatures of the designer, the checker, the draftman, the approving person, and the client in some cases. The design of seal is always fixed for a particula-organization and, in some cases, it is printed on the blamv sheets. 2.6 MEASUREMENTS IN FRACTIONS OF AN INCH By any fraction x/y (of any quantity or unit), we mean that the given quantity is divided first into 'y' equal, parts and then 'x' parts out of these will be x/y of that particular quantity. To measure fractions like 3/16", 6/16", 8/16", etc., an inch has to be first divided into 16 equal parts and then 3 parts will have a dimension equal to 3/16' and so on. The division of an inch into 16 equal parts is, usually available on most of the stales and directly we cen measure the fractions by counting the number of divisions. Fractions like 3/8, 1/2, 3/4, etc, can be converted into fractions having a denominator 23. equal to 16 by multiplying the numerator and the denominator by an appropriate number. Fig. 2.7 Inch Divided into 10 and 16 Equal Parts The measurements upto first decimal place can be measured from those scales where an inch is divided into 10 equal parts. For example, 0.3" means 3/10" or 3 parts out of 10 parts of an inch; if we measure a length equal to 3 small divisions from that inch which is divided into 10 equal parts, it will be 0.3". 2.7 LETTERING ON THE DRAWING Generally all the lettering on the sheet is carried out in capital letters and following points should be kept in mind while carrying out the lettering. 2.7.1 For writing letters, naturally upper and lower guide lines are required sothat all the letters are of equal height and they are arranged in a single row. The guide lines should be thin upto such an extent that these are just visible to the working person; 4H pencil with much lesser pressure may serve the purpose. The spacing between two guide lines should be equal to the height of the letters required. These two guide lines alongwith the space inbetween becomes a lettering line. A space slightly greater than the height of the letters should be provided nbetween two lettering lines sothat these are reasonably seperated. 2.7.2 After drawing the guide lines, no instrument is to be used for the lettering, the Lines should be drawn freehand and the proportions should be approximately guessed. 2.7.3 Letters should be written firm with 'H' or 'HEM' pencil depending upon the natural pressure which one applies on the pencil. 2.7.4 The procedure of writing as given in Fig. 2.9 must be followed without any change. In the figure, each letter is divided into different strokes and a graph is provided in the background for providing idea about the proportions of height and width. One stroke means a single fluent line drawn without releasing the pressure on the pencil inbetween. Each stroke is numbered to represent the order of strokes and 24. the same order must be followed while carrying out lettering. Starting and ending points of the strokes are clearly marked by arrows. Always start from the tail and move towards the head. Starting or ending marks should not be placed for any stroke and no stroke should be doubled because, in this way, the line will become a multi-stroke line. If there is any mistake during lettering, erase whole of that. letter and start again. Fig. 2.8 Guide Lines for Lettering Fig. 2.9 Vertical Letters and Numerals (Internet S°urce) 2.7.5 The proportions between width and height for each letter should be as accurate as possible. The height for each letter is 6 divisions in Fig. 2.9 and the letter may be assumed to be enlarged or reduced so that its height becomes equal to the spacing of the guide lines. The width of some letters are 5/6th of the height (five spaces wide), others occupy a square (six spaces wide), letter 'W' is eight spaces wide and letter 'I° has width just equal to the thickness of the line. 2.7.6 In case of I-H-T-L-E-F group, all the strokes should be as vertical and as horizontal as possible. For N to W group, inclined strokes are also used while in 0-0C- 0 group, circular strokes are used. For all other letters, irregular curves are to be used 25. which require muchmore practice because the proportion ofwidth and height is to maintained at the same time while drawing the line in single stroke. 2.7.7 To write fractions, total fraction height is mate twice the height of the integer. Two extra guide lines ar drawn at a distance equal to half the height of the integer from the top and the bottom guide lines as shown in Fig. 2.10. The numerator is then written first having height about three-fourth the height of the integer and the letter should be started from the top most guide line. Now horizontal bar is drawn in the center of the guide line having length equal to the maximum width of the numerator the expected width of the denominator. Denominator is no written making sure that a clear space is left above below the horizontal bar. Heights of the numerator and t!denominator should be made equal to eachother. Fig. 2.10 Procedure and Guide Lines for Fractions Proper spacing of the letters to form words and of words to form sentences is more important than the shape - the letters themselves for the appearance of a block lettering. Actual spacing between the letters is not ma constant in a word, instead the letters are so arranged th approximately equal areas are left between them producing spacing which is visually uniform. Spacing between two wor. should approximately be equal to 3 to 4 times the average spacing between the letters in a word. 2.7.9 To write a line of letters in a given space, height letters is so selected by experience that all the letters are properly accomodated maintaining the width/height rat for the individual letters. 2.8 METHODS OF DIMENSIONING No dimension should be written inside a view. The length to be dimensioned should be extended on any side of the view with the help of extension lines drawn perpendicular to the length having at least 1/8” gap from the view. A line parallel to the length is then drawn called dimension line with starting and ending points of the length properly marked as shown in Fig. 2.12. The dimension may then be written within the dimension line or on top or bottom of the dimension line. Two guide lines for writing the dimensions should be used. First and second methods in Fig. 2.12 are used for bigger dimensions, the first being 26. Fig. 2.11 Spacing between Letters in a Word Fig. 2.12 Methods for Dimensioning preferable. However, for small dimensions, any of the other methods may be used. Smaller dimensions are placed nearest to the outlines of the parts to be dimensioned while larger dimensions are written outside the smaller dimensions. Numerals should be written so that they may preferably be read from the bottom or from the right hand side of the drawing. For circular dimensions, draw radial dimension lines starting from the curve to be dimensioned not going upto the center. Mark long and narrow arrow at the curve and bring the tail of the line outside the view on any side where., space is available and Fig. 2.13 Circular Dimensions. 27. write the dimension there. If radius is mentioned, write ‘R’ at the end but if diameter is given, write ‘D at the end of the dimension. 2.9 APPLIED GEOMETRY 2.9.1 To Join Two Lines at Right Angle by a Quarter Circle There may be two methods to locate centre of the curve so that it intersects the lines tangentially. First method is shown in Fig. 2.14 (8) in which two center-lines are drawn parallel to the lines to be joined at a distance equal to the radius of the circular curve. Point of intersection of the center-lines will be the centre from where the quarter circle may be drawn. In the other method, shown in Fig. 2.14 (C), intercepts are taken on both of the lines to be Joined with the help of a compass considering center at the point of intersection of the given lines (point 0) and radius equal to the radius of the required circle. With the same opening of the compass, two center-lines are drawn from points ‘A and ‘D, the point of intersection of these center-lines defines the centre from which the required circle may be drawn. 2.9.2 To Join Two Parallel Lines by a Half Circle To join two parallel lines ‘x’ distance apart by a half circle, the diameter of the circle should be x’ making the radius equal to ‘x/2. Draw one center-line exactly in the middle of the two lines and another at a distance ‘x/2 from that point where the circle must end. Point of intersection of the two center-lines will be the centre from which the half circle may be drawn with a radius equal to ‘x/2’. Fig. 2.14 Center for Quarter Circle. 28. Fig. 2.15 Center for Half Circle. 2.9.3 To Join Two Lines at Any Angle by a Smooth Curve Draw center-lines parallel to both the lines at a distance equal to the given radius of the curve ‘Re, the point of intersection will be the centre from which the curve may be drawn from one line to the other. 2.9.4 To Join Two Circles by a Smooth Curve Suppose the two circles to be Joined are of radii R1 and R2 with their centers already located on the sheet denoted by the points A and B. These two circles are to be joined tangentially by a third circle or curve of radius R3 whose center, C, is to be properly located. If two circles intersect tangentially, then, the point of intersection, and the two centers should be in a single straight line meaning Fig. 2.16 Center for a Circular Curve Joining Two Straight Lines. 29. Fig. 2.17 Center for a Circular Curve Joining Two Circles. that distance AC and BC should be equal to (R1 + R2) and (R2 + R3) respectively. To make these distances equal to the required values, draw one center-line from point A with a radius equal to (R1 + R3) and another center-line from point B with a radius equal to (R2 + R3). The point of intersection will be the required centre, C, from which the curve may be drawn in the required portion. 2.9.5 To Draw Line Parallel to a Given Line There are two methods to draw lines parallel to any line at a given distance, first is shown in Fig. 2.18 (A) while the second is shown in Fig. 2.18 (8) to (D). In the first method, compass is opened equal to the required distance between the two lines and construction curves are drawn from any two points on the given line. Common tangent of these curves is then drawn to get the required line. In the second method, one construction curve is drawn from any point on the given line with a radius equal to the required spacing between the two lines. Triangle-1 is then oriented in such a way that one of its edges becomes parallel to the given line while triangle-2 is placed on the other side of the triangle-1 such that the later can slide over it. Triangle-1 is then moved until its edge becomes tangent to the already drawn construction curve 30. 2.9.6 To Divide Given Length of Line into 'n' Equal Parts 2.9.6.1 Using Divider: It is a hit and trial method in which some tries are made starting from certain approximation, adjusting the difference after each try and ending when the line is exactly divided into the required number of parts. To divide a given line AB into any number of equal parts, first open the divider approximately equal to one part just by guess. Place the divider with one needle at point A and the other on the line. Swing the divider considering the second needle as pivot without making any permanent depression in the sheet. Repeat the process for the number of parts required. Some difference will be there at the end after the first try. Open or close the divider by an amount roughly equal to nth part of the difference and make a second try. After second try, the difference at the end will be reduced and about 3 to 4 tries will be sufficient to exactly divide the line into the required number of equal parts. Now put marks on the sheet with the help of the divider in the form of very small and just visible depressions by the needle; large holes in the sheet are not desirable. 2.9.6.2 Using Triangle and a Scale: To divide a line AB into ‘n equal parts, draw a construction line -From the point A at any suitable angle, as shown in Fig. 2.20. With a scale or a divider, mark ‘n’ equal spaces each space being approximately equal to and the required line is drawn with it. Fig. 2.18 Drawing a Parallel Line. Fig. 2.19 Dividing a Line with Divider. 31. the nth part. Join the last point marked, C, with point B and draw lines from all the marked points parallel to BC. By intersection of these lines with the line AB, required equal parts are obtained. Principle for this method is that when a line intersects at any angle to a series of equally spaced parallel lines the intercepts are always equal. For line AC, we make the intercepts equal and hence the parallel lines become equally spaced. Line AB now intersects equally spaced parallel lines and the intercepts must become equal to each other. 2.9.6.3 Using Angles Available on the Triangles: Basically there are two different methods by which we can divide a given length of line into 2 or 3 equal parts and by using a combination of these two methods, we can divide the line into 4, 6, 8, 9, 12 and 16, etc., parts. Fig. 2.20 Dividing a Line by Parallel Lines. Fig. 2.21 Dividing a Line Using Triangles. 32. In -first method, construction lines are drawn from the points A and of the given line AB at equal angles. From the point of intersection, C, vertical construction line is then dropped to divide the line AG into two equal parts, see Fig. 2.21 (A). PROOF

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