Site Analysis and Planning

Lecture 5

Welcome to UGC lecture series, today's topic is Site analysis and Planning, Subject code - AR 6512. Unit 2 - Site Drawings, Lecture 05.

Presentation outline - The presentation is divided into three parts. First is Introduction, then we move on to look into Methods of setting out in land surveying and then we look into two types of surveying to find out right angles which are Single Prismatic Square and Double Prismatic Square. First, let's begin with Centralized planning.

Setting-Out of Buildings and Land Survey for Construction Industry

Setting-out of a building is marking of a building position, size and shape in terrain. What setting out of a building means is actually marking what the building is actually going to be on the site. Setting-out plan is the plan where a projected building is drawn and numeric values of setting out elements are written. Setting-out plan is the plan where the projected building is drawn.

Next is, Land survey for setting-out. Creation of a setting-out net means measurement, calculation and marking of survey stations which can be used for setting-out. First is creation of setting out which means the measurements, dimensions and your angles, everything that has to be measured has to be transferred from your drawings to your actual site. Setting-out of the spatial position of a building = setting-out of the building main position line = frontage which means how far is your building from the main road or how far is your setback line. Setting-out of the axis or the main points of a linear structure (road, railway, watercourse, etc). When you are making roads or rail networks, you need to make sure the line is kept straight. This type of surveying also happens in land surveying.

Detailed setting out which means setting out of a building size and shape. When you look into detailed setting out, it refers to transferring every detail, every dimension of your plan to the site is called detailed Setting-out. Setting out right angles and perpendicular lines - In survey work, it is often necessary to set out right angles or perpendicular lines on the field. In the sections that follow, a few practical methods indicate how this can be done. These methods include -

The 3-4-5 method is used to set out a right angle from a certain point on the base line. The rope method - used to set out a line perpendicular to the base line, starting from a point which is not on the base line. As you can see, now we are going to move on to studying how a perpendicular line, parallel lines can be made from your baseline. These can be done via different methods, the first one is 3-4-5 method. A brief introduction was already given to you about the same

method in the previous presentation. This is creating triangulation. This 3-4-5 method is to create right angles from your base line. This rope method is also to find perpendicular lines which are not on your base line. Say if your baseline is A and B, the point from which you need to make sure you are drawing a right angle is not from a point on your baseline AB. Next is, the single prismatic square and the double prismatic square - used to set out both right angles and perpendicular lines. In this method you need to make sure you find out both perpendicular lines as well as right angles are on the same line. This caters to two functions at a time.

At first, let's discuss in detail about the 3-4-5 method. To set out right angles in the field, a measuring tape, two ranging poles, pegs and three persons are required. The first person holds together, between thumb and finger and zero mark and the 12m mark of the tape. The second person holds between the thumb and the finger the 3m mark of the tape and the third person holds the 8m mark. As you see what we need for this method is, we need to have steel tape, we need pegs or iron or metal poles and we need a minimum of three people because it is formed by triangulation method which has three points, so we need three people to do this. As you see, this is how it has to be held. This is point is what 0,0 is. This is the third mark, the distance between the pole to this person, 5m and from this pole to this pole it is 8m and from this to this it is 4m. This is how the right triangle is made. This is formed by a trigonometric equation.

When all sides of the tape are stretched, a triangle with the lengths of 3m, 4m and 5m are formed, the angle near person 1 is a right angle. This is person 1. After forming the three triangles. The angle formed between this point and this line is a right angle triangle. This is how a right angle triangle can be determined using 3,4,5 method. This is basically a triangulation method that uses the multiplication factor of 3,4 and 5. Instead of 3,4 and 5, a multiple can be chosen. For example - 6,8 and 10m or example 9m, 12m and 15m. It has to follow the same ratio, 3,4 and 5. It can follow any number of multiplication of 3 x 2, 3 x 6 and has to fall in a rhythmic manner. Next, let's move on to the rope method.

A line has to be set out perpendicular to the base line from Peg A. Peg A is not on the base line. This method is used when you need to create a perpendicular line from a point say A and this A point is not on the baseline. How do you create this type of a line is studied under rope method. A long rope with a loop at both ends and a measuring tape are used. The rope should be a few meters longer than the distance from peg A to the base line. Usually what you need is a long rope which is more than the two baselines that you are going to measure. This is like an ancient clipart of a rope method. As you see here, this is your baseline. The point A from which you need to form a right angled triangle is not actually on the baseline. This method is followed when you need to find a right angled triangle for a point that is not actually on the baseline.

Step 1 - one loop of the rope is placed around Peg A. Put a peg through the other loop of the rope and make a circle on the ground while keeping the rope straight. As you can see in the image on the right, the rope has been tied from pole A and then there is a peg which is like a nail connected to the end of the rope. From the rope, from the baseline, a semi circle is drawn. This circle crosses the baseline twice. Pegs B and C are placed where the circle crosses the baseline. It crosses two points, called Peg B and Peg C, placed where the circle crosses the baseline. These two points in which the circle and the baseline intersect has been marked B and C. Now, what we need to do is; Step 2 - Peg D is placed exactly halfway in between pegs B and C. Use a measuring tape to determine the position of peg D. As you see, this is peg B and Peg Z which has been marked after intersecting with the rope which has been used to create a semi circle and then we measure the distance between peg B and C. After measuring peg B and C, we find the midpoint and then we mark the midpoint on the baseline and then we nail the peg at this point D that has a connection with A and creates the right angled line.

Pegs D and A form the line perpendicular to the base line and the angle between the line CD and the base line is a right angle. As you see here, this point D, the line which connects D and A is formed by a right angle is completely perpendicular to the baseline B and C.

Let's move on to the Optical Squares. Optical squares are simple sighting instruments used to set out right angles. They can be provided either with mirrors or with one or two prisms. Because of practical difficulties in using squares with mirrors, they have been replaced by squares with prisms 'prismatic squares'. This is for a more precise measurement to create right angles because when you consider 3,4,5 method, it is a triangulation method. If your site is not geometrical in shape or if your site has a lot of contours, using this type of a method is not possible. Also, if you consider rope method, it can be used for a short distance because while you need to create a longer perpendicular line, there are a lot of possibilities for the angle to get deviated as you extend the line. To avoid such type of accuracy issues, we need to opt for optical squares.

There are two major types of prismatic squares - single prismatic squares and double prismatic squares.

Now, lets discuss in detail about both, the single prismatic square method and the double prismatic square method.

Single Prismatic Square

Now, coming to single prismatic square method. The prism of the single prismatic square is fitted in a metal frame with a handle. Attached to the handle is a hook to which a plumb bob

can be connected. As you see, this the single prismatic square with an instrument, with which a hook is being provided. Under the C-shaped hook, a plumb bob is going to get fitted. Without deviation when it stops, it stands in a straight angle. The special construction of the prism enables to see at right angles when looking through the instrument. When you look through the instrument, you can see two different lines which has been going across, going straight, when everything aligns, you can find the right angles. The single prismatic square or single prism can be used to set out right angles and perpendicular lines. It is used to find out 90 degrees and also to create perpendicular lines to the base lines. Setting out of right angles - let's consider one example of how to find right angles or perpendicular lines, say from point C as you see in this figure from the baseline A and B. This A and B has been marked by placing ranging rows. There is point C, from point C we need to arrive at a perpendicular line.

In figure, peg C is on the base line which is defined by poles A and B. A right angle has to be set out starting from the Peg C. This is an instrument tripod in which we keep the prismatic square and then the sponge is hung from the C metal point from down here. The procedure to follow is, Step 1 - The prismatic square has to be placed vertically above peg C. This can be achieved by using a plumb bob. The instrument can be hand-held by the operator but even better is to install the instrument on a tripod. With this instrument, it can also be hand-held but to increase accuracy and reduce errors, what we can do is set up a tripod in which we can place the single prismatic square which does not move and then from the C metal, you can hook the plumber which is connected to point C down.

Step 2 is the instrument is slowly rotated until the image of pole A can be seen when looking through the instrument. As you see, this is pole A. As this surveyor is looking through this prism, he can actually see the line. The distance is what you see when looking through the instrument. This is your prism line and this is point A.

Step 3 - An assistant should hold poleD in such a way that it can be seen when looking through the opening just above the prism. There is an opening above the prism. This is the point D, we are trying to create a right angle from point C. The assistant is made to stand at point D, who can adjust what the surveyor is seeing in such a way that this point D comes in the same line. When looking through the instrument, when there is no right angle, it does not align. When there is right angle, when you see here, it aligns completely. This is when the right angle is being formed.

At the indication of the operator, pole D is slightly moved so that the pole D forms one line when looking through the instrument with the image of pole A. The line connecting pole D and peg C forms a right angle with the baseline. What we see here, when the pole A and the pole D

is being seen as a straight line through the prism. There is small opening in the single prismatic square, through which we can see two lines come on the same line, that's when a right angle is being formed. When you connect the poles C and D, a right angle as well as a perpendicular angle is being formed.

Setting out Perpendicular lines - Now, we have understood how to set out a point from the base i.e if we need to create a perpendicular line or a right angle from the baseline. What if you need to create a perpendicular line that is not on the baseline? Say the pole is C and you need to create a right angle from this point and you don't have any baseline here.

The baseline is defined by poles A and B. A line perpendicular to the baseline has to be set out from pole C, pole C is not on the baseline. Now it is just the reverse of what we studied earlier. From point C we need to create a perpendicular or a right angled triangle.

As you see here, the operator should stand with the instrument on the baseline connecting A and B. To check this, the assistant, standing behind the pole A or B makes sure that the plumb bob attached to the instrument is in line with poles A and B. As you see, this is the plumber who is attached to the single prismatic square and the assistant is made to stand either behind pole A or pole B. With his eye accuracy, he can see the pole and he can be sure that both pole A and the connected spring box is on the same line. The operator then rotates the instrument until the image of pole A can be seen. What the surveyor sees through the single prismatic square is here.

Step 2 - the operator then moves the instrument along the baseline until he finds a position when looking through the instrument pole C which is in line with the image pole A. As you see here, he did not find the right angle on this line and the pole C is not actually on this line. Moving from this point, we move straight until the two lines match. When these two lines match, a right angle is formed or the perpendicular line has been determined. While searching for the right position, the operator must keep the instrument always in line with poles A and B. This is done under the guidance of the assistant standing behind pole A. Since the plumb bob is being attached to the hook of the single prismatic square, you need to make sure you are moving along the baseline. When you are moving, there is a lot of possibility that you are moving out of the line. This has to be assisted or moved in guidance with the assistance standing behind the boards.

Step 3 - when the correct position of the instrument is found, peg D is placed right under the plumb bob. After you find the right position, a peg is being placed and it is being nailed to the ground to mark the location and to make it finite. The line connecting pole C and peg D is a line

perpendicular to the base line. Now, a line is being drawn from Peg C to Peg D. The line which is forming is called perpendicular line and the angle formed between the two lines is called Double prismatic square.

Double Prismatic Square

Let us see what are the uses of Double Prismatic Square, a.k.a two prisms. The two prisms are placed in such a way that it is possible to look at the same time at right angles to the left and the right. In single prismatic square, we have only prison and we are seeing one more line that connects with the already existing lines. Here, we can see either side of the pegs and also the vertical lines. This is the difference between the single prismatic and double prismatic square. It is possible to see the baseline and the perpendicular line at the same time. Here we can see both the perpendicular line as well as the baseline. No assistant is needed to check if the operator is standing on the baseline, as is the case with the single prismatic square. One assistant can be reduced. The assistant who makes sure that the surveyor is actually on the baseline can be let go of in this method.

Let's see how we can find out right angled triangle using double prismatic square method. Setting out right angles - the same method as we saw in the first case. This is the baseline, line connecting point A and B. Point C is somewhere in between point A and B. We need to find right angle or a perpendicular line to the point C. In figure, peg C is on the baseline connecting poles A and B. A right angle has to be set out from C. What we see here is, the observer holds the instrument vertically above peg C on the base line. This can be checked with the plumb bob. The setup of this whole instrument is very similar to the single prismatic square. Just that it has two prisms. There is again via which the plumb bob can be connected and it can be held just above point C to which you need to find the perpendicular lines. As you see in this figure, the surveyor is holding a double prismatic at this point and the plumb bob is being attached and it attaches the point C through which you can see both the lines. As you can see, this is looking through the instrument, this is point A and point B. The instrument is slowly rotated until the image of pole A is in line with the image of pole B. Here, these two images are not in line. It is rotated until these two come in line. As you see here, step 2 - the observer then directs the assistant holding pole D in such a way that when seen through the instrument, pole D forms one line with the images of poles A and B. As you see here, these are poles A and B and these are the lines formed in line with poles A and B. The one that you see here, is made from pole A and the one you see on the right is made from point B on the baseline. When these two come together, that's when a perpendicular line or a right angle is being formed. The line connecting pole D and peg C forms a right angle with the baseline.

Setting out Perpendicular Lines - The baseline is defined by poles A and B. A line perpendicular to the baseline has to be set out from pole C which is not on the base line. It is similar to what we saw in the previous exercise. Step 1 - when looking through the instrument the observer moves slowly trying to find a position on the baseline. When the images of both poles A and B appear, the observer stops and rotates the instrument slowly until the images of poles A and B form one line. The instrument is then in line with poles A and B of the baseline. As you see here, this is the point from which he is trying to make a right angle to this pole C. He moves until he finds poles A and B in line with each other. Step 2 - The observer moves along the baseline towards pole A or pole B. He stops when pole C can be seen through the instrument and forms one line with the images of poles A and B. After he finds he is actually in line with the baseline, then he moves along the baseline to find the pole C that is inline with these two poles inside the prismatic instrument. When he sees everything in line, that's when he knows that is the point from which a right angled triangle or a perpendicular line is created. Step 3 - When the correct position of the instrument is found, peg D is driven into the soil right under the plumb bob. Peg D and the pole C form the line perpendicular to the base line.

Let's summarize what we have learnt from the entire presentation - At first we looked into setting out land and building plan for construction industry. 3-4-5 method, rope method, single and double prismatic square method. We also discussed what are the benefits of using 3-4-5 and rope method when compared to single prismatic and double prismatic square methods. The accuracy increases as we proceed along these methods. Setting out right angles from the base line. Setting out right angle from a point away from the baseline. These two have been discussed for both rope method, single and double prismatic methods. Questions - What is setting out of land and building plan mean in land survey? Explain 3-4-5 method and rope method in detail. What is the difference between single and double prismatic square method. How to mark right angle from baseline? Explain in detail of setting out perpendicular line from points away from the baseline. You can explain this question along the lines of single and double prismatic square method as well. Thank you!