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EXCAVATION & GRADING HANDBOOK

Revised

ONLINE PREVIEW

by
Nick Capachi
&
John Capachi

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UNDERSTANDING ROAD SURVEY STAKES

1

This manual is a practical guide to excavation, grading, paving and pipelines. My aim in writing is to provide information on the best methods available to increase your productivity in, and knowledge of, this very important field. This book can benefit anyone in the construction trade, from beginners just starting out to contractors with years of experience — whether you work in this field, or you just need information to help you understand the process. It's written in simple terms and covers each step of the excavation and grading process, from how to read and understand grade stakes, through paving, laying pipe and cutting drainage channels.

Since the mid 1970s, when my first grading and excavation book was published, there have been many changes in construction methods and equipment. Adapting lasers, sonar, and GPS to control the equipment to carry grade is by far the biggest change I've dealt with in this field. Using sonar and slope control on graders to fine trim has greatly increased

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production in the last few years. The operator using a GPS has the precise location where he is working right on his screen, showing the parameters of the lot pad and the elevation needed. GPS is now used on dozers, scrapers and compactors, and is also used for surveying. I'll be covering GPS in detail in a later chapter in the book.

In the trenching department, the biggest change is that backhoes have replaced most trenchers, and hoes with compaction wheels have eliminated most trench jetting.

In the first four chapters of this book we'll cover the basics: reading and following survey stakes, understanding excavation plans, and how excavation contractors use contour line drawings. If you've been working in the excavation and grading business for a while, most of what you read in the first few chapters you probably know already. But if you need a brush-up on plan reading and stake markings, or if you're new in the field, these chapters explain it in terms I use throughout the book.

So let's start at the beginning — with surveying and staking. Everyone — the inspector, superintendent, foremen and grading equipment operator, needs a good understanding of how surveyors stake the job. Not under-standing the stakes is like having the specifications and not being able to read. Today, most large jobs and many small ones are excavated using GPS to guide equipment. And even fewer stakes will be used in the future, making the stakes that *are* set more important than ever to read. The basic information on the stakes has changed little in the last few years. However, the way the surveyors compute that information has changed.

Survey Stakes

Excavation for roads, buildings and pipelines begins with a survey of the area where the excavation will be done. A survey crew working for the engineering firm that's designing the project will set out stakes and *hubs* that identify points on the construction plans. When a precise distance or elevation is needed, a surveyor's tack on top of the hub establishes the point from which elevations and distances are measured.

Beside each hub there will be an *information stake* marked in surveyor's code. It explains the grades at various distances from the hub

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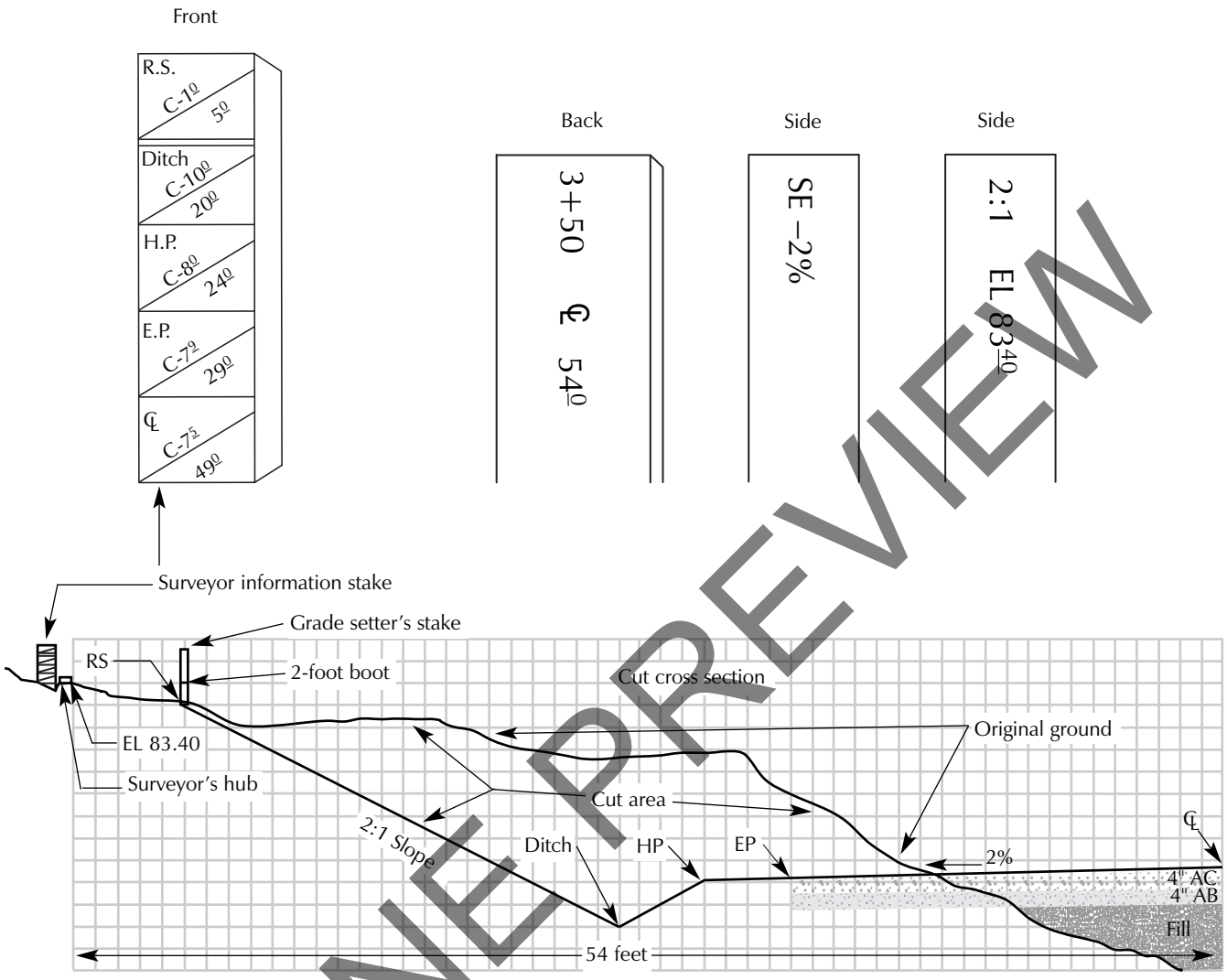

Figure 1-1 *Reading cut stakes*

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or other reference stake or point. It's essential that you know how to read the markings on these information stakes and follow the instructions they provide. The surveyor may write on one or all sides of the stake.

Cut Stakes

The stakes are usually called *cut*, *fill* or *slope* stakes, depending on the type of excavation required. Figure 1-1 shows the kind of markings you'll find on an information stake. In this case, we're looking at a cut stake for a road

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excavation. The front, back and both sides of a cut stake are shown in the figure. Below the stake there's a cross section drawing of the existing grade and final road grades that are described on the stake. Refer to the drawing as I explain the markings on the information stake in the figure.

Look first at the stake labeled *front* in the upper left of Figure 1-1. That's the front of the information stake. The *RS* at the top of the stake means that there's a reference stake to be established, and that reference stake is the point from which measurements and elevations are taken. The location of the reference stake is the point that the projected cut slope meets or catches original ground, also referred to as a *catch point*. Find the reference stake in the drawing. It's labeled *RS* and it's in the upper left-hand corner of the drawing. Below the letters *RS* on the information stake you see *C-1º*. Below that you see a diagonal line and *5º*. These markings above and below the diagonal line identify the amount of cut and distance needed to establish the correct grade at the reference stake. The number above the diagonal line is the elevation and the number below the diagonal line is the distance. In this case, the information stake shows a *cut* of 1.0 foot (below the level of the surveyor's hub) to be made 5.0 feet from the hub for the RS point.

Some surveyors may use *RP* instead of *RS*. *RP* means reference point. Treat it exactly the same as the RS.

Notice that distances and elevations are measured in feet and tenths (or hundredths) of a foot, not feet and inches. The small number above the small horizontal line shows decimals of a foot. That's a little different from what you're probably used to, but you'll appreciate the difference when adding and subtracting feet and decimals of a foot rather than feet, inches and fractions of an inch. I'll explain more about this measuring system, called *engineer's measure*, later in this chapter.

The two horizontal lines below the first set of measurements are very important. All measurements above the double horizontal line are taken from the hub beside the information stake. The double horizontal line means *and then*, indicating that all measurements and elevations from that point down on the stake are taken from the RS point and not the surveyor's hub. Note this very carefully: If the double horizontal line was replaced with a single horizontal line, all measurements and elevations would be taken from the surveyor's hub rather than reference stake or hub established by the grade setter. On the other hand, if the surveyor uses a double line *after each grade*, then each cut becomes the reference for the next. We'll look at this last method shortly.

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The next information on this stake shows the elevation and location of the ditch cut (*C-10[0] / 20[0]*). It's to be 10 feet lower than the RS point and 20 feet from it. The grade falls 10 feet over a horizontal distance of 20 feet, thus creating a 2:1 slope. You can see this indicated on the drawing (about lower middle). For every foot of cut, the grade line moves horizontally 2 feet. Notice that all measurements are made from the reference stake. The ditch is cut 10 feet below the reference stake and 20 feet from that stake. Also note that the 20-foot distance is measured horizontally, not diagonally, from the reference stake. Look again at the drawing to be sure you understand how the 20-foot distance to the ditch is measured. Remember, each square on the survey drawing represents 1 horizontal and 1 vertical foot.

The next reading is the *hinge point (HP)* grade and distance. Note the hinge point on Figure 1-1. It's 2 feet above the ditch cut. The HP information on the stake shows an 8-foot cut at 24 feet, indicating the grade must come up 2 feet and move out 4 feet. By computing the amount the HP rises from the ditch and the distance it moves towards the center of the road, you can see that it's again a 2:1 slope.

Reading down the information stake, the next grade and distance is the *edge-of-pavement (EP)* point. The grade will be 7.9 feet below the reference stake hub. Notice the cut at EP is 0.10-foot less than the HP cut. The reason for this is that the road grade rises 2 percent in the 5 feet from HP to EP. Multiplying 5 feet by 2 percent gives the amount the shoulder rises in that distance ($5.00 \times 0.02 = 0.10$).

The next markings give the centerline cut. You can see that the cut is again less than the previous cut at EP. Subtracting the 29 feet at EP from the 49 feet to the centerline leaves 20 feet. So the centerline is 49 feet from RS and 20 feet from EP. The cut at the centerline is 0.40 foot less than EP cut, making the centerline 0.40 foot higher than EP. Again, we have a 2 percent slope from the centerline to EP. You can check this by multiplying the 20 feet by 2 percent ($20.00 \times 0.02 = 0.40$). These are all finished grades so the grade setter must add the thickness of the road section to the EP and centerline grade to get the correct subgrade elevation that must be excavated.

Look at the back of the cut stake. It's marked *3+50*, indicating that this station is 350 feet from station 0+00, the point from which the survey began. Below the station number is the distance from the

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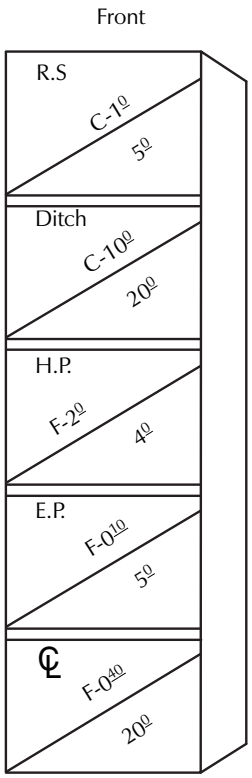

Figure 1-2 *Cut stake with double lines*

surveyor's hub to the center of the road. This includes 5 feet to the RS and 49 feet from the RS to the centerline, a total of 54 feet (54^{0}).

Now let's look at the sides of the stakes. Note the first drawing of the stake labeled *side*. This side of the stake identifies the percentage of slope from the centerline to HP. The minus sign indicates that the centerline slopes down to the HP. If it were a plus sign instead, the centerline would be sloping *up* to the HP. The second *side* stake drawing shows the rate the cut slope falls from RS to the ditch. In this case, it's 2 feet out for every foot downward. The second group of numbers is the elevation of the surveyor's hub above sea level.

Here's another method a surveyor might use to indicate measurements and elevations. I mentioned earlier that the line between each grade on the surveyor's information stake was very important. A double horizontal line means *and then*. So, if the surveyor uses a double line after each grade on the information stake, then each cut becomes the reference for the next. The information stake in Figure 1-2 shows the same information as the one in Figure 1-1, except it's written with a double line between each grade. Notice that by adding the double line, the last three distances change.

In Figure 1-2, if you add the distances on the stake to centerline together (the distances indicated under the diagonal lines), you'll get 54 feet from the surveyor's hub to centerline. Now look at the back of the stake in Figure 1-1. It also reads 54 feet to centerline from the surveyor's hub. By using the double lines between grades, the last three cuts in Figure 1-1 become fills in Figure 1-2. The reason is because the HP grade must now be computed from the ditch grade, which is 2 feet lower, creating a fill of 2 feet. This method is also used to determine the centerline grade. The EP grade is 0.10 foot higher than the HP, and the centerline is 0.40 foot higher than EP.

If you encounter a stake marked like the one shown in Figure 1-2, for better control and accuracy you should set a hub at each point as a reference to shoot your next grade from. If you study Figures 1-1 and 1-2 carefully, you'll notice each distance and elevation are exactly the same. Only the methods for computing them are different.

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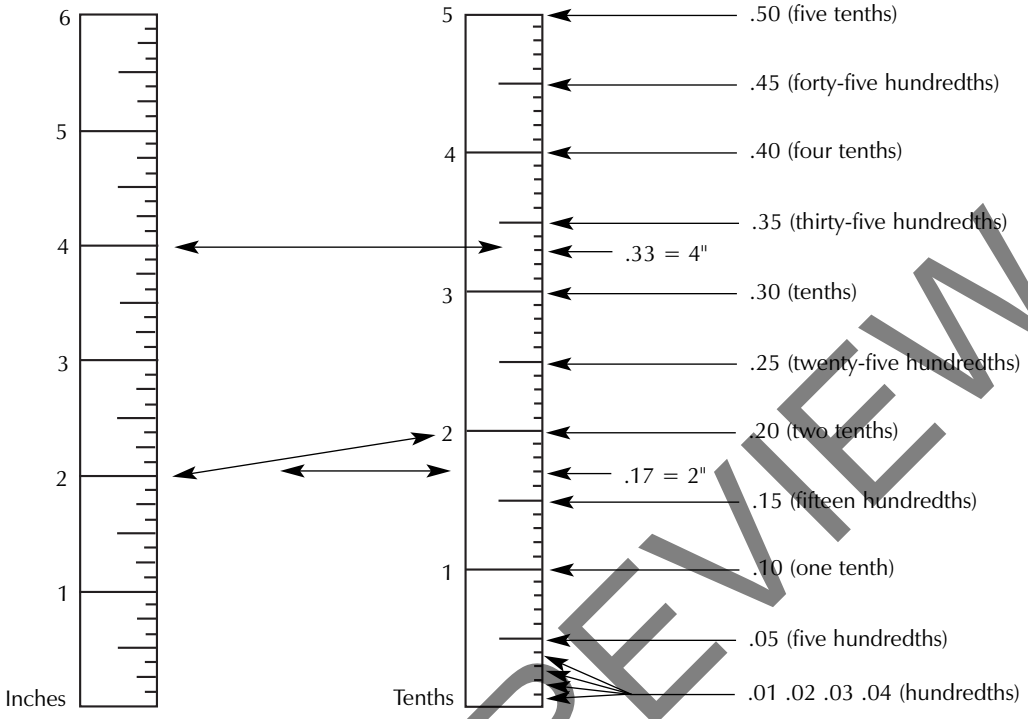

Figure 1-3 *Compare inches with decimals of a foot*

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Comparison of Inches and Decimals of a Foot

Setting grades requires many additions and subtractions. Using decimals speeds the work and makes errors less likely. Figure 1-3 compares inches with decimals of a foot. If you're uncomfortable reading distances in tenths and hundredths of a foot, think of one foot as being like a dollar bill. One dollar is the same value as 100 pennies; one foot is the same distance as 100 hundredths of a foot. One dollar is the same value as 10 dimes; a foot is the same distance as 10 tenths of a foot. Pennies are hundredths. Dimes are tenths.

Fill Stakes

We've looked at a cut stake where material must be excavated to reduce the existing grade to the finish grade (Figure 1-1). Figure 1-4 shows a typical fill situation where soil has to be deposited to build up the existing grade. Again, the illustration shows four sides of the stake and the road cross section. The *RS* at the top of the stake means that the

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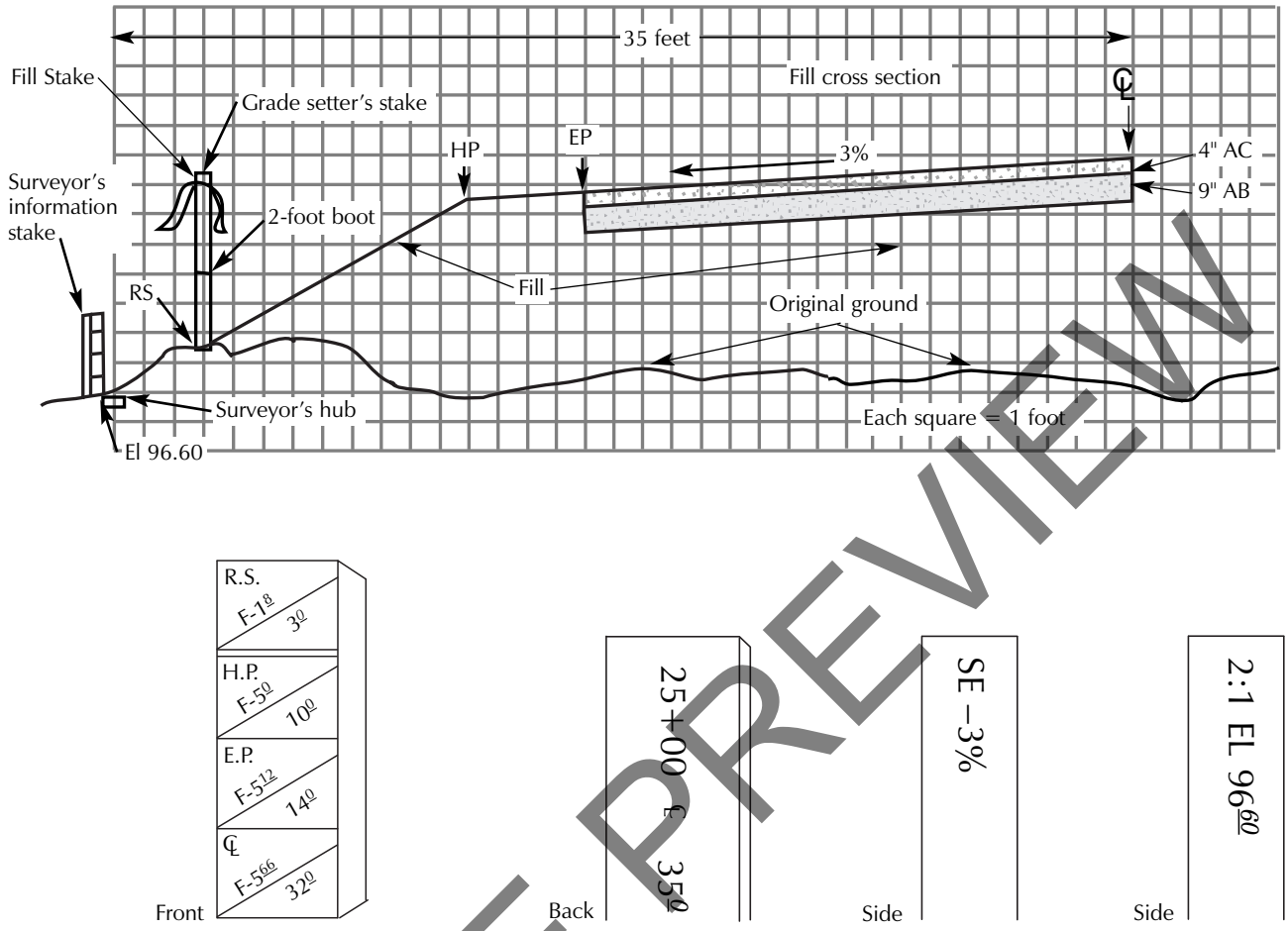

Figure 1-4 *Reading fill stakes*

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reference stake (to the right of the hub) is the starting point and the place from which all measurements and grades are measured. Cut or fill information given for the RS point will be measured from the surveyor's hub. Here, the RS is located 1.8 feet above the hub and 3 feet from it. The grade setter will have to set the reference stake at the indicated horizontal distance from the hub and draw a horizontal line on the stake at the elevation given on the surveyor's information stake. If the ground hasn't been disturbed at that point, his line will match the existing ground.

The grade setter should add a boot to his stake with a horizontal line 1 foot above his RS grade. Because this is a fill, if the fill is made correctly, the overfill will cover his finished grade line. By placing a 1-foot boot above his finished mark, he'll save the time it would take him to dig it out

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later. So when the grade setter returns to set a second slope stake at HP, he can use the 1-foot boot to compute the next vertical grade needed. He'll just subtract his 1-foot boot from the vertical grade he wants.

Reading down the surveyor's stake, the two horizontal lines mean *and then*, indicating that the grade setter must measure from the RS point for the next fill and distance, instead of measuring or shooting grades from the original surveyor's hub. For the *hinge point (HP)*, measure 10 feet from the RS hub or lath. At this point, a fill of 5 feet must be made to obtain the required grade. The hinge point is the place where the fill slope stops and the road grade begins. A stake won't be set at HP until the fill reaches that point. It would be in the way. The operator will get that grade from the RS stake set by the grade setter. It'll show the fill needed 10 feet out, and that the fill slope should be 2:1 for the HP grade. If the fill were to be 20 feet high (rather than 5 feet), the grade setter would set slope stakes every 5 feet the fill rises to HP.

There are times when the grade setter must offset the reference stake. Let's look at how he would do this. We'll say that the grade setter set his reference stake 5 feet out from the surveyor's hub. It often happens that the ground level is disturbed during clearing. What if, during the clearing operation, 1 foot of the existing ground is removed and the grade at the RS no longer matches the surveyor's information stake? When there is a 1 foot difference in grade, the grade setter working a 2:1 fill should move the reference stake back 2 feet. He must then mark his RS lath to reflect the change. His new fill and distance to HP will be F-6⁰ / 12⁰. By moving the RS 2 feet back, once the fill is made 1 foot high at a 2:1 slope, it will match the grade and distance on the original RS set at 5 feet. If he didn't do this, the slope would be off line with the remaining RS points that were not undercut during clearing.

On a cut slope, you may have to offset the RS for the equipment. You'd again move the RS back 2 feet to provide clearance for the grader's blade. This will keep the grader operator from having to slow down and adjust his cutting edge in from its normal grading position to avoid the stake. The grader would use the same cut and fill given for the 5-foot RS distance, but the grade setter would mark a *2* in a circle at the top of his lath to indicate the actual RS point is offset 2 feet. He should also mark the actual RS point with a paint line for the grader operator to follow. It's very important to set the RS point precisely because it controls the entire cut or fill elevation and alignment.

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Let's return to reading the information stake in Figure 1-4. The next point referenced is the *EP*. This is the edge of the pavement and it shows a fill of 5.12 feet *(F-5^{12})* at 14.0 feet from RS.

Below the EP data is the *centerline*, represented by a C and an L (one overlapping the other). From the RS, you measure 32 feet and fill 5.66 feet. This will put the centerline 18 feet from the EP and 0.54 foot higher.

The back of the stake has *25+00*. That signifies that this stake is 2,500 feet up the line from the point where the measurements started (the beginning of the road construction in this instance). The point the surveyors start from is most likely marked 0+00. These are station numbers. The number *35.0* below ℄ means that the center of the road is 35 feet out from the surveyor's hub (not RS). Look again at the front of the stake and notice that when the RS distance of 3 feet is added to the ℄ distance of 32 feet, the total is 35 feet, the same distance as that marked on the back of the stake.

The first stake labeled *side* is marked *SE –3%*. This is the percentage that the roadbed slopes from the centerline to the hinge point. On the right-hand stake marked *side*, the first reading is *2:1* (2 to 1). This is the rate the fill slope will rise from RS to HP. Notice that the front of the stake shows HP with a 5-foot fill over a 10-foot distance. This is what the 2:1 indicates. The next item on the side stake is *EL 96^{60}*. This is the elevation of the hub at the surveyor information stake. The surveyors computed all cuts or fills from that hub.

What I've described so far in this chapter is more or less standard procedure for indicating elevations and distances on road stakes. However, surveyors in some counties and cities follow slightly different procedures. Some surveyors provide more information on the stakes and some less. The surveyor stake in Figure 1-5 shows what you might see on some county or city road stakes.

The front of the stake begins with a *2* with a circle around it. This indicates that the first cut starts 2 feet out. The next markings indicate that the ditch cut is 4 feet at a distance of 10 feet from the stake. The slope will again be 2:1 because the first 2 feet aren't cut and the cut over the next 8 feet is 4 feet. Look at the figure again. Notice that there's no double *and then* line. This means that you must take all measurements and grade shots from the hub set by the surveyors rather than from an RS or RP point, as on the previous stakes we've looked at.

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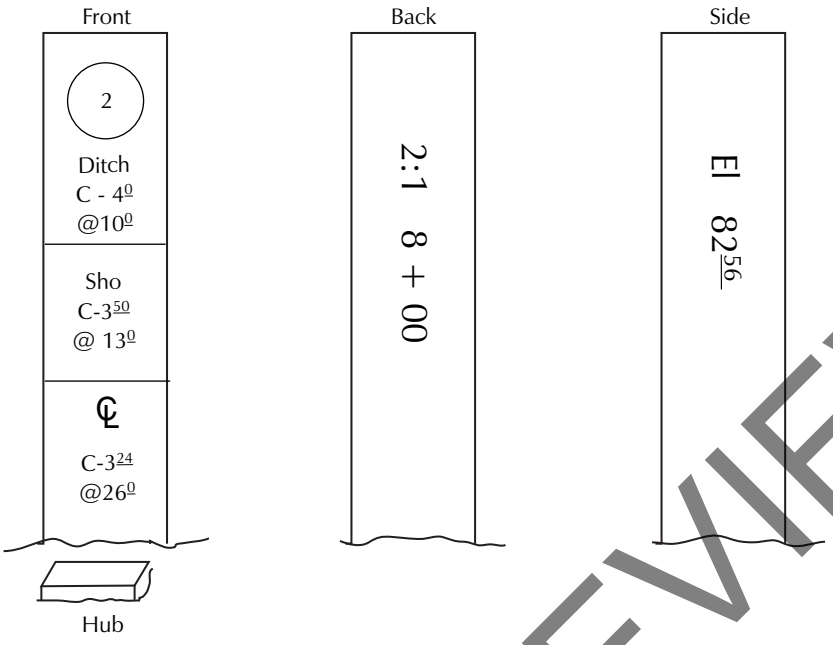

Figure 1-5 *Surveyor information stakes*

Reading down the stake, we find a second group of numbers that show the top of the shoulder cut *(Sho)*. This is the HP, or hinge point, referred to on previous stakes. Notice there's no EP distance or elevation on this stake. You must look at the plans for the distance from the shoulder to the edge-of-pavement, and the elevation. Notice that there's only 13 feet from the shoulder to the centerline, which indicates a possible aggregate shoulder. In this case the shoulder would be brought up to subgrade and not finished grade.

Engineering companies follow different conventions when marking their stakes. But the plans should clarify what's intended and which points are actually indicated. If something isn't clear, don't guess. Call the engineering company that created the drawing and marked the stakes. They should be eager to help.

The second drawing in Figure 1-5 is the back of the stake. It shows the rate of fall of the cut slope *(2:1)* and the station number *(8+00)*. It doesn't have the centerline distance because all the front measurements are from the hub and not an RS or RP point. Many stakes have just the details required to allow you to set the grades. Even though other information may be absent, they always have the station number on the

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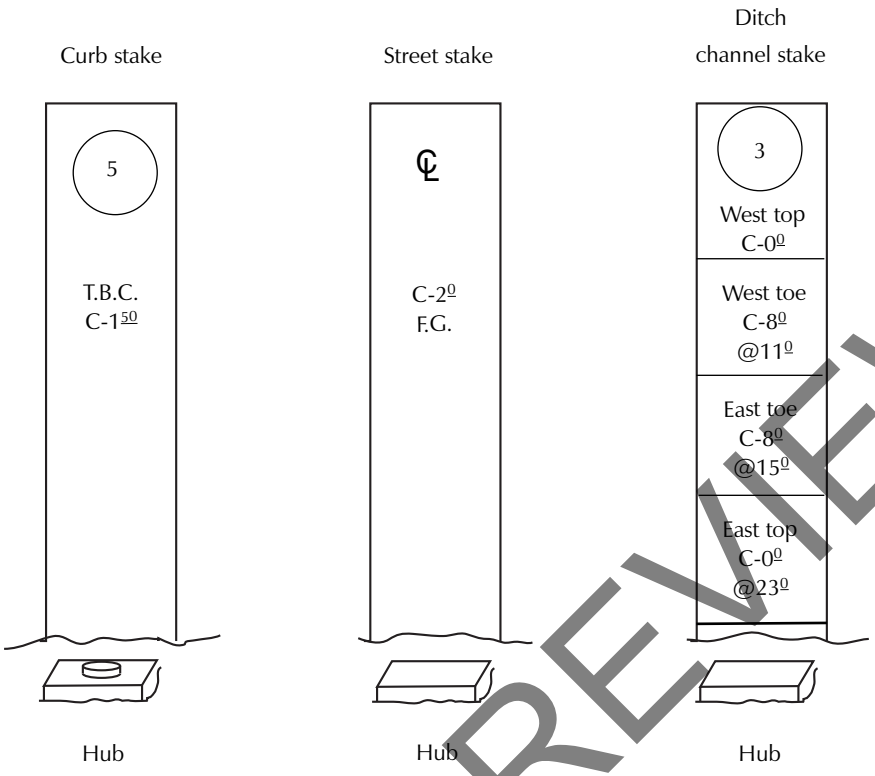

Figure 1-6 *Miscellaneous information stakes*

back. The side of the stake is shown in the right-hand illustration. It gives the elevation above sea level *(EL 82 56)*. In some cases the hub elevation won't be on the stake at all. It may be replaced with the percentage of slope for the road, or both may be omitted entirely.

Miscellaneous Information Stakes

Curb stake — Now look at Figure 1-6. The stake at the left is what you'd expect the surveyor to set for cutting and setting curb grades. From the hub at the base of this information stake, you'd move out 5 feet and down 1.50 feet to the *top-back-of-curb (TBC)* to set the curb forms or for the top of the concrete pour.

In some cases, the surveyors may also give the front lip grade or even the flow line grade. If not, you'll have to determine the distance from the back of the curb to the lip. This information is available in the plans or job specifications. When setting curb subgrade, determine the thickness of the

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curb plus any aggregate base, if it's called for under the curb. The thickness of one or both must be added to the cuts and subtracted from the fills to find the subgrade rather than the finished grade level. Notice that there's a tack in the hub in front of the curb stake. The tack marks the exact spot from which the surveyor took his measurements. Without this marker, the measurements could be as much as $1^1/_2$ inches off (using a 2×2-inch hub). The tack provides greater accuracy.

Street stake — The center stake in Figure 1-6 is a street stake you'd expect to find on a rural road first cut. The front of the stake indicates the centerline of the street and the cut or fill to the finished grade. In this case, there's a 2-foot cut to the *finished grade (FG)*. The plans should show the road width, percentage of slope or crown, and the thickness of the road section. Remember to add the thickness of the road to this cut. The station number may be on the back or front of the street stake. Surveyors rarely stake the street centerline. The stakes are usually offset behind the back of the curb or a roadside ditch and will carry enough information for the grade setter to establish a centerline grade. Those are the common methods for staking roads.

Ditch channel stake — The stake at the far right in Figure 1-6 is a grade stake for a ditch or small channel. The *3* in the circle (read *3-foot offset*) is the distance from the hub where the first cut starts (which would be the catch point or top-of-slope). The *west toe* grade indicates the first slope and the bottom of that slope. The *east toe* is the bottom of the slope on the opposite side of the ditch. Both toe cuts are the same, so the bottom is flat. The *east top cut* is where the cut will be started on the opposite side. Subtracting the 3-foot offset from the 23-foot distance to the east top cut gives the distance across the top of the ditch, 20 feet. Subtract the small toe distance from the larger. This gives the width of the ditch bottom, 4 feet.

To find the rate of slope from the top cut to the toe of the channel, subtract the distance given to the top cut from the distance given to the toe cut. The 3-foot offset must be subtracted from the west side distance of 11 feet. This will make the distance 8 feet from top cut to toe on each side. Dividing the cut of 8 feet into the 8-foot horizontal distance gives an answer of 1. This indicates that for every foot cut vertically, the slope moves out 1 foot horizontally. That's a 1:1 slope.

A stake with only a few markings will usually provide all the information you need to do the excavation. If something is still unclear, the plans should have the answer you're looking for.

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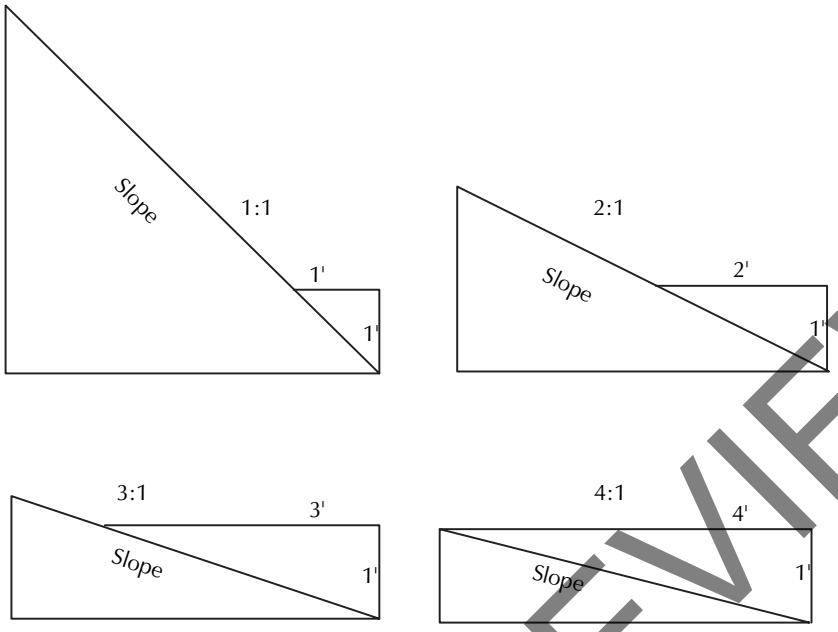

Figure 1-7 *1:1 to 4:1 slopes*

In this chapter we've described grades by either a ratio of run to rise, or as a percent above the horizontal. Most grades in excavation work are expressed as a ratio of horizontal distance (run) to vertical distance (rise), or run to rise (run:rise). Figure 1-7 illustrates the four most common slope ratios, and should help you visualize most of the slopes you work with in excavation.

If you're still confused about the work required after reading the surveyor's stakes and checking the plans, ask the survey crew about it if they're still on the job. If they've left, call the engineer and have him clarify the problem or send the survey crew out for a field meeting. *Be sure you know what's required before beginning the work*. Earthmoving is far too time-consuming and expensive for you to be taking your best guess and hoping you're right!

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CHAPTER 1 QUESTIONS

1. What does RS stand for?

A) Rate of slope
B) Road surface
C) Reference stake
D) Rear station

2. What do the markings above and below the diagonal lines on a cut stake indicate?

A) "And then"
B) The amount of cut is above the diagonal and the distance is below
C) Take all measurements below the diagonal from the next cut
D) The amount of cut is above the diagonal and the fill is below

3. What other abbreviation means the same as RS?

A) PG
B) IS
C) EP
D) RP

4. If the RS distance is followed by a double line, where must the remainder of the grades and distances be established from?

A) The surveyor's hub
B) Grade setter's RS hub
C) Each following cut or distance
D) The HP

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5. How much will a 2 percent slope rise or fall in 20 feet?

A) 0.20 foot
B) 0.30 foot
C) 0.40 foot
D) 0.60 foot

6. Where is the elevation on the side of the surveyor information stake taken from?

A) The survey hub
B) The centerline
C) The reference stake
D) The catch point

7. What does it mean to the grade setter if every distance on a surveyor's stake is followed by a double line?

A) He must take the next grade and distance from each preceding point
B) He must measure back to the survey hub for distance and elevation
C) He must measure back to the survey stake for distance only
D) It indicates that all the following measurements are cuts

8. Which of the following is equal to 4 inches?

A) 0.16 foot
B) 0.20 foot
C) 0.33 foot
D) 0.40 foot

9. What is the purpose of a second horizontal line on a fill stake located 1 foot above the finished grade?

A) To locate the hub set by the surveyor
B) To indicate the overfill point to the equipment operator
C) To help the grade setter set the next fill stake
D) To help the grade setter establish the elevation at the projected centerline grade

10. What do the west and east toe grades on a ditch channel stake indicate?

A) The distance across the channel
B) The amount of fill required at the base of the west and east slopes
C) The slope of the channel from west to east
D) The bottom of the slope on each side of the channel

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PLAN READING

2

The markings on survey stakes are a shorthand way of expressing what's on the plans. You need to be able to read and understand both the survey stakes and the plans to develop a picture in your mind of how the finished job will look.

This chapter covers how to read survey drawings of street and subdivision plans, including grading plans and contour lines, underground pipelines, profile sheets, road sections and cross sections and detour plans. During the course of a project you'll frequently be referring to the plans. It's essential that the grade setter and foreman understand the plans completely in order to do the work correctly. Any time a surveyor uses an unfamiliar abbreviation or notation on a stake, the foreman or grade setter will have to check the plans to see what it means. We'll look at the most common notations so you'll recognize them when you see them on plans you're reading.

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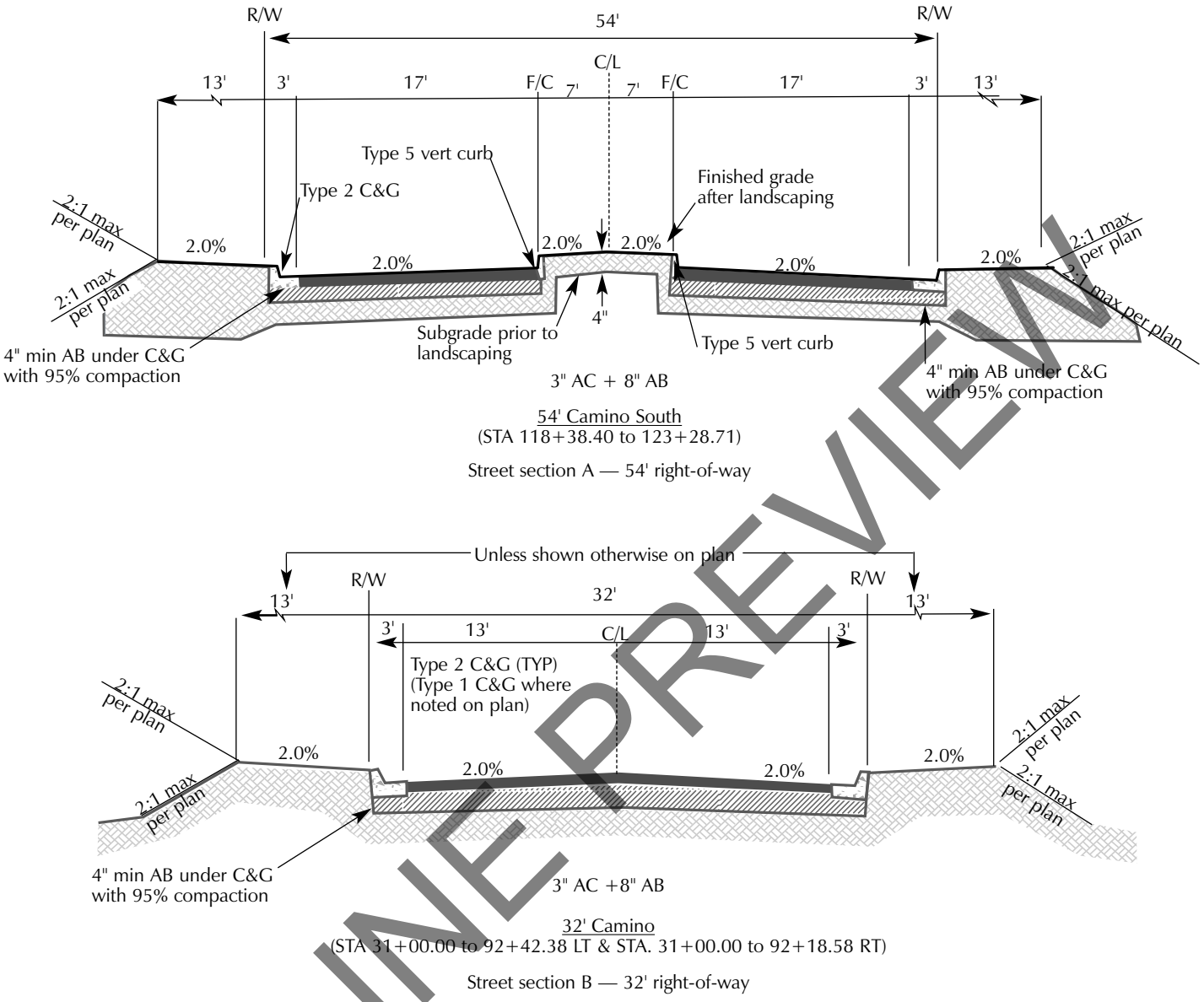

Figure 2-1 *Typical street sections*

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Subdivision Plans

Figure 2-1 shows two street cross sections. These street section drawings, usually referred to as the "typicals" are found in the front section of the subdivision plans. The engineer may elect to draw only half of each street, as that's all you need when both halves are exactly the same. However, the engineer who drew the typicals in Figure 2-1 chose to draw the full width of the street section.

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If there's a gap in the stationing on the typical street sections, it's because there's a transition area from one street section detail to another. Always check the station numbering closely to avoid a mistake. If the numbers indicate a missing section, you must look for the street section or sections that complete the distance. For example, if the stationing marked under the street section reads 31+00 to 36+00 — 40+00 to 68+00, you must locate the section that covers the 400-foot gap between station 36+00 and 40+00.

The two street sections in Figure 2-1 are part of a plan with a total of eight street cross sections for the same job. We selected these two because they show the greatest change in street width. Notice that the station numbers in street section A represent 490.31 feet of the street (subtract 118+38.40 from 123+28.71 or 11,838.40 from 12,328.71). Also notice that in street section B, the information provided covers a longer section of the left side of the street (31+00.00 to 92+42.38 = 6,142.38 feet) than the right side (31+00.00 to 92+18.58 = 6,118.58 feet). *LT* indicates the left side of the street and *RT* indicates the right side. That tells you that the change on the left side of the street goes 23.8 feet beyond the change to the right side.

Reading Station Numbers

Let's take a closer look at how to read station numbers. We'll use the last station in Figure 2-1B, 92+18.58, as our example. The first number to the left of the + is a 2. That indicates 200 feet. The second number to the left of the + is 9, which indicates 9,000 feet. So, the numbers to the left of the + represent 9,200 feet. Now let's look at the numbers to the right of the +, 18.58. They represent feet and hundredths of a foot, just as they appear, 18.58 feet. The number to the right of the + can only go to 99 feet before it moves to the left and becomes 100 feet (represented by a 1), just like the numbers after the decimal point can only go to 0.99 foot before they become 1.0 foot. All station numbers begin at 0+00, so when you see station number 92+18.58, that tells you this point is 9,218.58 feet from the first station at 0.00.

To better understand this numbering system, let's read some other station locations:

Station 7+00	=	700.00 feet
Station 12+05.30	=	1,205.30 feet
Station 25+19	=	2,519.00 feet
Station 130+42.10	=	13,042.10 feet

Remember, these are all distances from the first station at 0+00.

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Street section A in Figure 2-1 indicates that it may be found on the plans from *Station 118+38.40 to 123+28.71*, and there's 54 feet from right-of-way line to right-of-way line. Notice that each right-of-way line is indicated at the back-of-curb. This is important for the grade setter. He needs to check the cross section to be sure that the back-of-curb and the R/W are the same distance. A street *cross section* shows details of the street in 50-foot sections, and will show any deviations in widths not shown on the typical. The surveyor may only give the distance to back-of-curb with a cut or fill to the top-of-curb. The surveyor's stake would be set 4 feet back-of-curb, so the front of the stake would read *4* (the 4 is circled) *R/W & BC* with a grade for the curb and centerline. If it were a subdivision street, the surveyor would set a stake at the lot setback line with distance and grades for back-of-curb, centerline and lot grades, but not for right-of-way.

The note directly under the curb tells the grade setter that 4 inches of aggregate base (AB) are required under the curb. He'll have to add the thickness of the curb and the 4 inches of AB together to compute his subgrade elevation. The ideal subgrade situation occurs when the curb subgrade and street subgrade are the same and there's no need for a notch to be cut up or down from curb grade. Looking at the street section, you can see that this is the case here. There's a line drawn the width of the street for subgrade with no notch, indicating that the subgrade and curb grade match.

Below the right-of-way line (R/W) measurements, you'll see the measurements for a 13-foot dirt shoulder, 3-foot curb, 17 feet of pavement and 7 feet of island from the face-of-curb to the centerline (CL). The same measurements are shown for the other side of the road as well, with both sides matching.

Now let's look at the finished slope grade, starting at the far left. First you'll see *2:1 max / per plan* on one line slanting up and one line slanting down at the same angle. This indicates you must build a two-in-one (2:1) slope from the dirt shoulder, regardless of whether it's a cut or a fill. This is the same on the right side slope as well; the slope moves 2 feet horizontally for every 1 foot of rise or drop.

Next you see *2.0%* above the shoulder. That tells you that the 13-foot shoulder slopes 2 percent from the slope hinge point (HP) to the top-back-of-curb. Continuing towards the centerline, there's a notation saying that a *Type 2 C&G* (curb and gutter) is required. The grade setter will then have to find a cross section of the Type 2 curb. Usually it's in the agency's specifications rather than on the plan. The specifications will show the

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height from the top of the curb to the bottom, and the thickness of concrete required. It will also show the rate of slope of the curb pan, the flat or gutter portion of the curb and gutter.

Continuing to read to the centerline, you'll see the percentage of fall for the pavement from the island curb to the curb and gutter. Notice that the island curb is a vertical curb, not a curb and gutter. The rate of fall is shown as *2.0%* and the distance is 17 feet. So the grade setter will compute the fall rate by multiplying 17 feet by 2 percent. Using a calculator, enter 17 × 2, and then press the percent key — the result will read 0.34. The 0.34-foot fall is from the front of the island curb to the lip of the curb and gutter. To cut subgrade, the curb width on each side must be added to the 17-foot pavement width. An island curb is usually 8 inches wide and the curb and gutter 3 feet wide, for a total of 3.67 feet. So the distance would then be 20.67 feet. Multiplied by 2 percent, that gives you a 0.41-foot fall across the entire subgrade.

The street detail shows a minimum of 4 inches of aggregate to be placed under the curb. The street section calls for 3 inches of asphalt concrete (AC) plus 8 inches of aggregate base (AB) for a total depth of 11 inches. This information is located on the drawing just above the street name, Camino South. Cutting the subgrade 2 percent, which is a 0.41 drop in 20.67 feet across from the back of both curbs, would make the subgrade and the curb subgrades the same. The curb grade is often steeper than the street grade. If you cut 2 percent to back-of-curb, it'll add more than 4 inches of aggregate under the front lip-of-curb. These are items the grade setter and foreman must take into consideration when excavating to subgrade elevations.

The next item we come to is the barrier curb at the island. The note above indicates a *Type 5 vertical curb*. Again, the grade setter must check the specifications for the height and width of the Type 5 curb. The *2.0%* indicated on the top of the island is the amount the finished landscaping will fall from the centerline to the back of the island curb. Again, the specifications or notes on the plans will specify what material is required for the island section and how much below top-of-curb the subgrade should be.

There are two important things the grade setter must pay attention to: first, that the aggregate road base runs to the back, not the front, of the island curb; and second, that the subgrade between island curbs must be left 4 inches below the finished landscape grade. This is indicated by the note under the island on the street detail sheet and the

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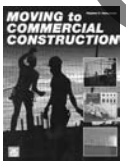

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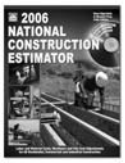

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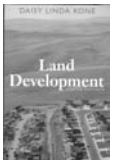

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This is the only book of its kind for public works construction. Here you'll find labor and material prices for most public works and infrastructure projects: roads and streets, utilities, street lighting, manholes, and much more. Includes manhour data and a 200-city geographic modifier chart. Includes FREE estimating software and data. **450 pages, 8½ x 11, $95.95**

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Constructionary

A unique pocket-sized dictionary of up-to-date construction words and phrases in English-Spanish and Spanish-English. Here you'll find over 1000 construction terms and 70 commonly used on-the-job phrases. This dictionary includes phonetic pronunciation, tool section, commonly used sentences, and conversion tables.
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