
6 Slope Stakes

Definitions

Control Point

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CHAPTER SIX:

SLOPE STAKES

Slope staking is a special form of leveling to determine the point at which the proposed slope intersects the existing ground. Since these stakes define the actual construction limits, they are set in the early stages of a contract and as such require preservation for later use.

Information that is required to be known before the setting of slope stakes may proceed is:

- 1) The profile grade for each station
- 2) Typical cross section for each station
- 3) Original cross section with elevations

Scaling the distance from plots of original and proposed cross sections is a graphical method for establishing the slope stake location. While this method is widely used, the procedure may not be advisable for the following reasons:

- 1) Incomplete or incorrect information at needed stations
- 2) Original survey of sections may not be accurate, especially in rough terrain
- 3) Changes in the original ground, due to farming, erosion, etc., may have occurred if the time from design to construction is extensive

The Trial and Error method using the centerline as the reference is the proposed method discussed in this chapter.

DEFINITIONS

CONTROL POINT

The control point for a fill section is the shoulder break, and for a cut section the control point is the bottom of a side ditch (Figure 6-1). The elevation of these points and the distances from the centerline are required.

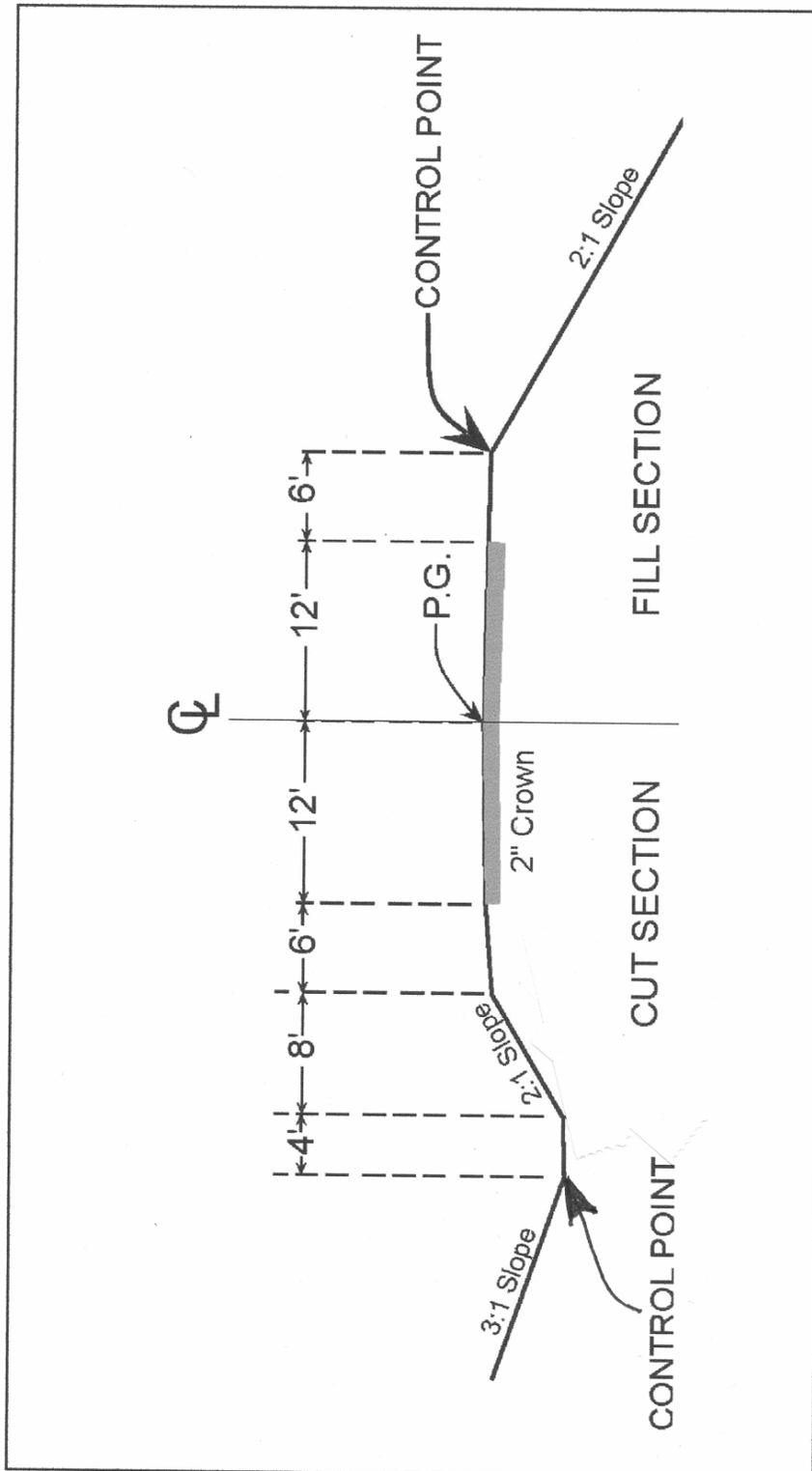


Figure 6-1. Control Points

GRADE ROD

A grade rod is defined as the height of instrument (HI) minus the control point elevation.

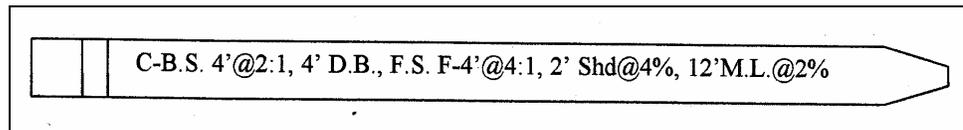
GROUND ROD

The ground rod is the actual rod reading during a trial. The grade rod reading minus the ground rod reading designates whether the section is a cut or fill section.

READING SLOPE STAKES

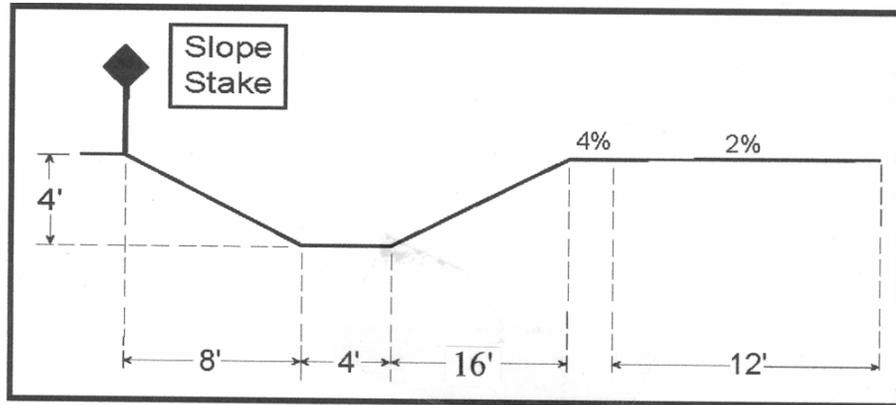
Slope stakes are necessary to determine if the roadway is being built to the required lines and grades. The slope stake is the tool that is used to ensure that slopes are graded correctly and fill or cuts are made to the required elevations. The following example explains how to read a typical slope stake.

Example:



Starting at the slope stake, the following steps are taken:

- 1) Cut the back slope 4 ft deep at a 2:1 slope
- 2) Grade a 4 ft ditch bottom
- 3) Go up the foreslope 4 ft at a 4:1 slope
- 4) Go 2 ft at a 4 % slope for the shoulder
- 5) Go 12 ft at a 2 % slope to the centerline



SETTING SLOPE STAKES

Setting slope stakes may be done in the office or with actual measurements in the field. Both methods are trial and error procedures that determine the control point elevations and distances from the centerline for each station.

FIELD PROCEDURE

The field procedure for determining the location of the slope stakes is as follows:

- 1) Set up the level and determine the HI
- 2) Determine Grade Rods: $\text{Grade Rod} = \text{HI} - \text{control point elevation}$
- 3) Take a trial ground rod reading at a measured distance from the centerline
- 4) Using the grade rod, ground rod, rate of slope, and standard distance, determine the computed distance to the slope stake from the centerline
- 5) Compare the measured distance and the computed distance. If they differ by more than ± 0.5 ft, a new trial is required.

An example of the procedure for determining slope stakes is shown in Figure 6-2.

Example:

Left Side

Control Elevation = 499.0 ft
Standard Distance (L_c) = 22 ft
HI = 497.5 ft
Grade Rod (G.R.) = $497.5 - 499.0 = -1.5$ ft

1st Trial:

Measured Distance (L_m) = 32 ft
Ground Rod (R) = 3.0 ft

Compute:

Grade Rod - Ground Rod = $-1.5 - 3.0 = -4.5$ ft (fill)
 4.5×3 (slope) = 13.5 ft
 $13.5 + 22 = 35.5$ ft
Compare 35.5 and 32.0 (does not compare so another trial is required)

2nd Trial

Measured Distance (L_m) = 35.5 ft
Ground Rod (R) = 3.0 ft

Compute:

Grade Rod - Ground Rod = $-1.5 - 3.0 = -4.5$ (fill)
 4.5×3 (slope) = 13.5 ft
 $13.5 + 22 = 35.5$ ft

The fill is 4.5 ft at 35.5 ft from the centerline using a 3:1 slope.

Right Side

Control Elevation = 497.0 ft
Standard Distance (L_c) = 29 ft
HI = 503.5 ft
Grade Rod (G.R.) = $503.5 - 497.0 = +6.5$ ft

1st Trial:

Measured Distance (L_m) = 38 ft
Ground Rod (R) = 1.5 ft

Compute:

Grade Rod – Ground Rod = $6.5 - 1.5 = +5$ ft (cut)
 5.0×2 (slope) = 10 ft
 $29 + 10 = 39.0$ ft
Compare 39 and 38 (try 39 ft)

2nd Trial:

Measured Distance (L_m) = 39 ft
Ground Rod (R) = 1.5 ft

Compute:

Grade Rod - Ground Rod = $-6.5 - 1.5 = +5.0$ (cut)
 5.0×2 (slope) = 10 ft
 $10 + 29 = 39$ ft

The cut is 5.0 ft at 39 ft from the centerline using a 2:1 slope.

Figure 6-3 gives an example of the notes required for determining the slope stakes. For this example, the readings were not within the allowable difference of ± 0.5 ft and therefore another trial is required.

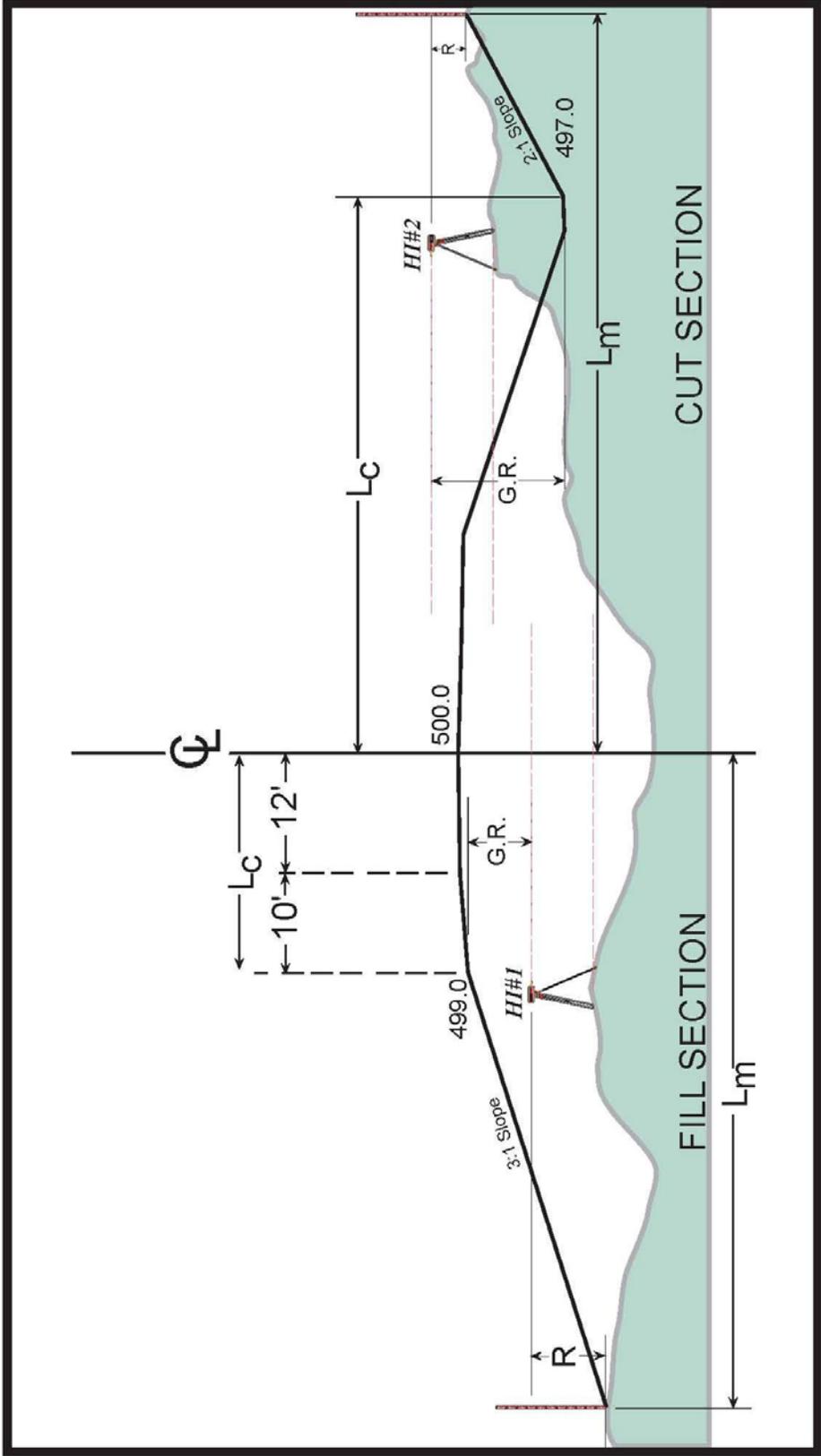


Figure 6-2. Slope Stake Problem

| Station | + | HI | - | | BM Elev. | Grade | Rod | Actual | Plan | C.L. | Plan | Actual | Grade |
|---------|-------|--------|----------|--------|----------|-------|-------|--------|-------|-------|-------|--------|--------|
| | Ditch | Grade | Shoulder | Grade | Grade | Left | Right | Left | Dist | Elev | Dist | Right | Stake |
| | Left | Right | Left | Right | Stake | | | Left | Left | | Right | Right | Right |
| | | | | | Left | | | | Slope | | Slope | | |
| BM "C" | 5.63 | | | | 576.15 | | | | | | | | |
| | | 581.78 | | | | | | 10.8 | | | | 8.5 | |
| | | | | | | | | 4.5 | | | | 5.6 | |
| 36+00 | | 573.31 | 577.31 | | 570.38 | 4.5 | 8.5 | 6.3 | 31 | 575.7 | 37 | 2.9 | 576.73 |
| | | | | | | | | 2 | 2:1 | 3:01 | | 3 | |
| | | | | | | | | 12.6 | | | | 8.7 | |
| | | | | | | | | 18 | | | | 29 | |
| | | | | | | | | 31 | | | | 38 | |
| 37+00 | | 579.31 | 583.31 | | 574.96 | 1.5 | 2.5 | | | 575 | | | 581.87 |
| | | | | | | | | | 2:1 | | 3:1 | | |
| | | | | | | | | 7.5 | | | | 9.5 | |
| | | | | | | | | 5.2 | | | | 1.1 | |
| 38+00 | | | 589.31 | 589.31 | 577.23 | 7.5 | 7.5 | 12.7 | 43 | | 35 | 8.6 | 581.4 |
| | | | | | | | | 2 | 2:1 | | 2:1 | 2 | |
| | | | | | | | | 25.4 | | | | 17.2 | |
| | | | | | | | | 18 | | | | 18 | |
| | | | | | | | | 43 | | | | 35 | |

Figure 6-3. Slope Stake Notes