

CHAPTER THREE

Staking Structures

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3

STAKING STRUCTURES

PURPOSES AND RESPONSIBILITIES

As an Inspector, you must understand the Contractor's staking methods before the stakes are placed. Different staking methods are used, but the purpose of staking is always the same: to establish and maintain controls for construction.

There are two basic controls necessary -- layout and grade. Layout control refers to the horizontal alignment of the structures, while grade control refers to the elevations or vertical location of the structures.

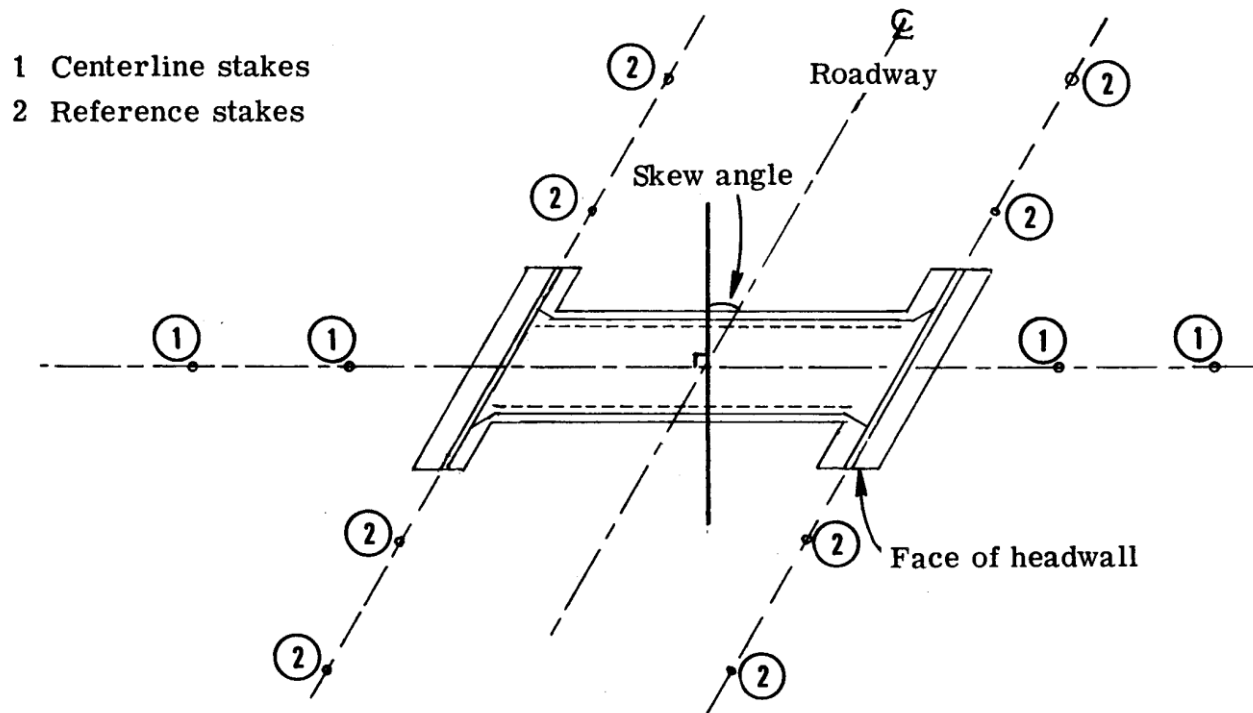
The Contractor has the responsibility of building the structure according to the alignment and elevations shown on the plans. To help the Contractor transfer the layout information from the plans to the construction site, the Department locates and references the centerline given on the plans. Also, the Department establishes bench marks for the grade control of the project. The Contractor's survey crew will then make all the necessary calculations, do the layout, and grade the stakes.

Methods of staking vary from survey party to survey party. This chapter discusses a typical method, but it is not the only one. It is important for you to meet with the Party Chief beforehand to discuss proposed methods of staking.

BOX CULVERT STAKING LAYOUT

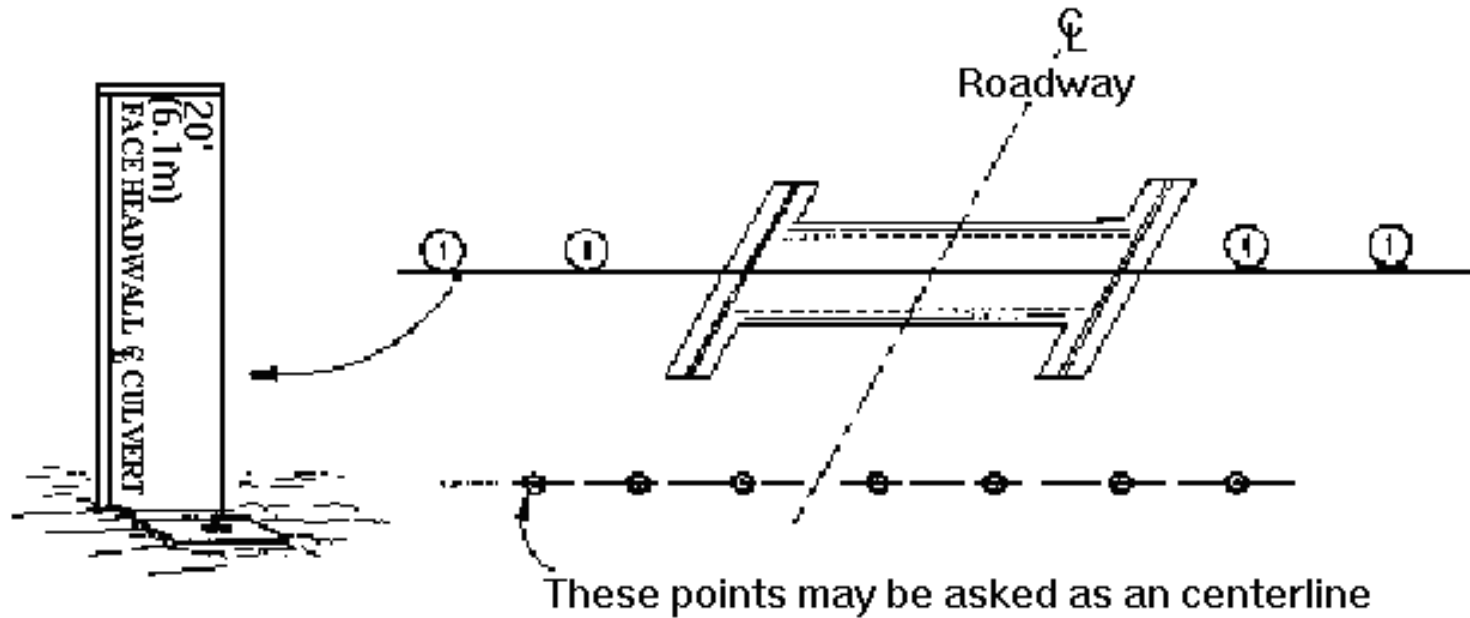
The Contractor's survey party will be responsible for laying out the box culvert to be constructed. The survey party will usually set two types of stakes, as shown below. From these basic control points, other stakes may be set by the Contractor. Stakes may be set along a line offset to the culvert centerline, from which elevations may be controlled.

CENTERLINE STAKES



Centerline stakes are offset from the ends of box culverts and aligned to mark the location of the centerline of the culvert. These stakes usually are set only if the stakes can be set in dry ground. If the

area is under water, you will have to rely on the reference stakes, or offset centerline stakes, like the ones described below.



In addition to marking the centerline of box culverts, centerline stakes also help control the alignment and grade of forms for the barrel and ends of the box culvert. As you can see in the diagram above, offset centerline stakes are set parallel to the culvert centerline.

QUIZ

Points of known elevation used for vertical control are called _____.

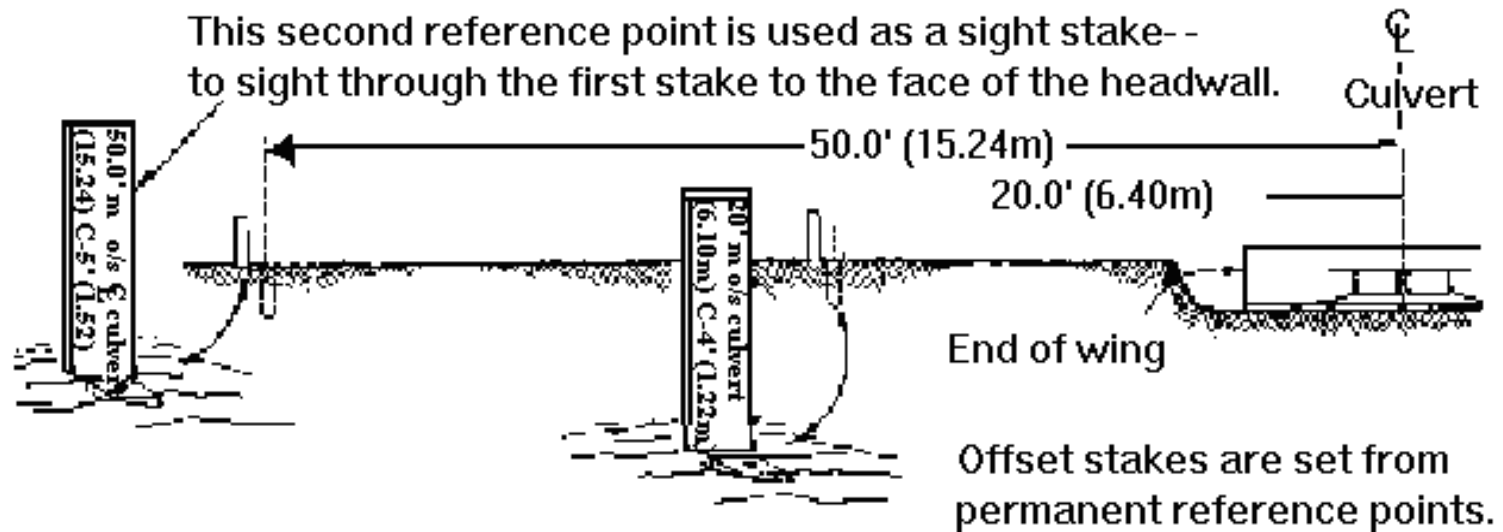
Stakes that control horizontal alignment and elevations are also known as _____ and stakes.

The survey crew usually sets _____ stakes and _____ stakes.

If the area is under water _____ or _____ stakes must be used.

REFERENCE STAKES

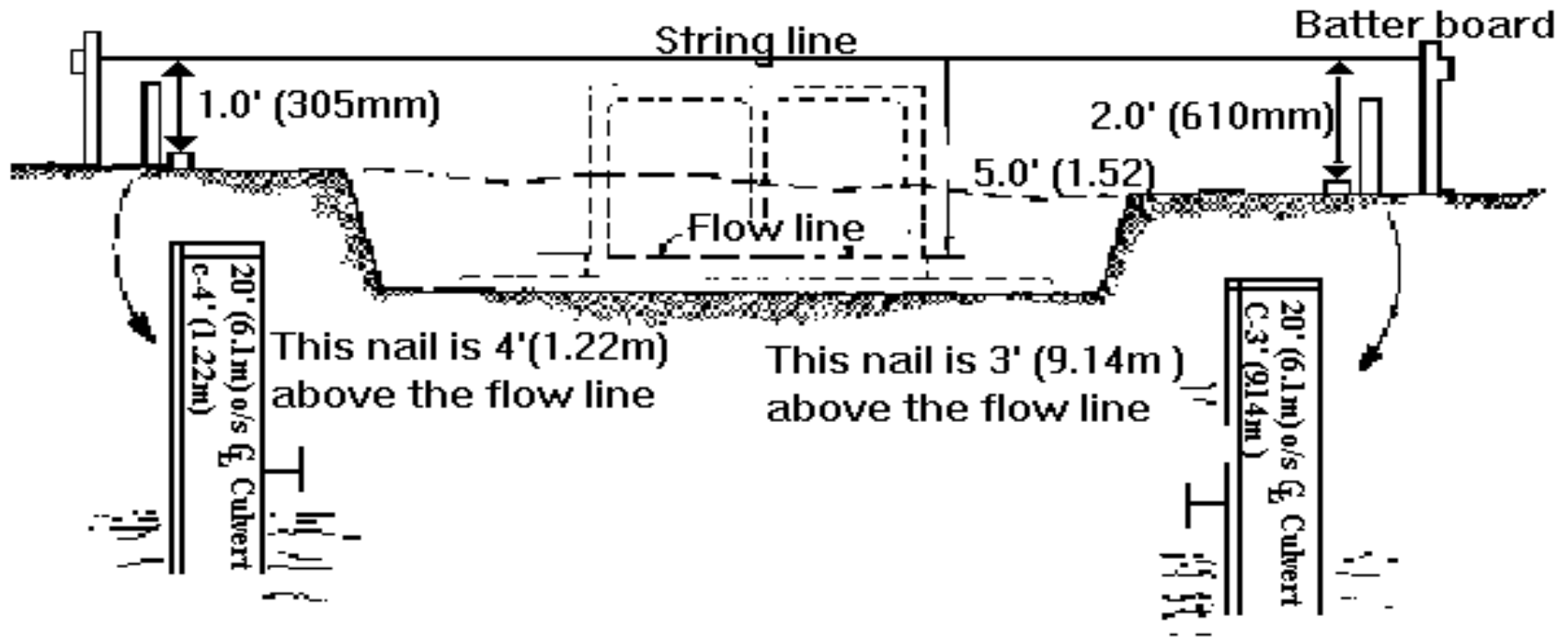
Reference points are indicated by offset stakes as shown in the diagram below:



Offset stakes can be used for horizontal and vertical alignment. The tacks in the hubs are used to set the line along the wings. The hubs and tacks are offset from the culvert centerline. The nail in the side of the guard stake is graded to the flow line.

As an Inspector, you are responsible for checking the culvert layout and determining that the stakes are adequate in number and position, and that they appear to be accurate.

The diagram on the previous page shows how reference stakes offset from a box culvert can control horizontal alignment. But, reference stakes can also be used to control vertical alignment. A different look at the field situation on the previous page shows how this is done.



Batter boards with a string line may be set by the Contractor, so that the flow line elevation can be checked. According to the stakes, the flow line is 4 feet below one nail and 3 feet below the other. The stringline is set 1 foot above one nail and 2 feet above the other. This means that the flow line must be 5 feet below the string line. You can check this with a rule and tape, or level rod.

After the foundation is prepared, the floor slab of the box culvert can be constructed. To control the floor elevation, the Contractor will set hubs at the working points and grade to the elevation of the floor. From string lines stretched between these hubs, the foundation can be fine graded and the footing and slab forms placed. As an Inspector, you must be familiar with the method the Contractor uses.

Footing forms are set by measuring from string lines stretched between working points and from working points to wingwall reference points. Grade nails are then set on the forms by leveling from the string line. Once the grades are established on the forms, the hubs are pulled out.

After the slab concrete has been placed set, the survey crew will mark the slab at the working points. Then the wingwall and barrel forms can be graded.

POINTS TO REMEMBER

Staking a box culvert for grade is not complicated. Just remember these points:

- The initial excavation is controlled by cut or grade stakes that show the amount of earth to be removed.
- The foundation prepared as a bed for the box culvert bottom slab must be graded to the bottom of the slab elevation. This is controlled by stakes set in the foundation at the working points.
- The flow line grade is controlled by offset hubs.

With these points in mind, try the quiz on the following page.

QUIZ

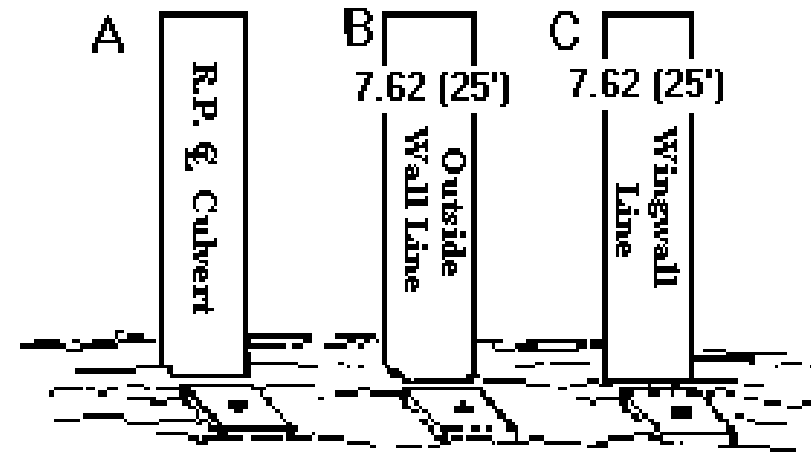
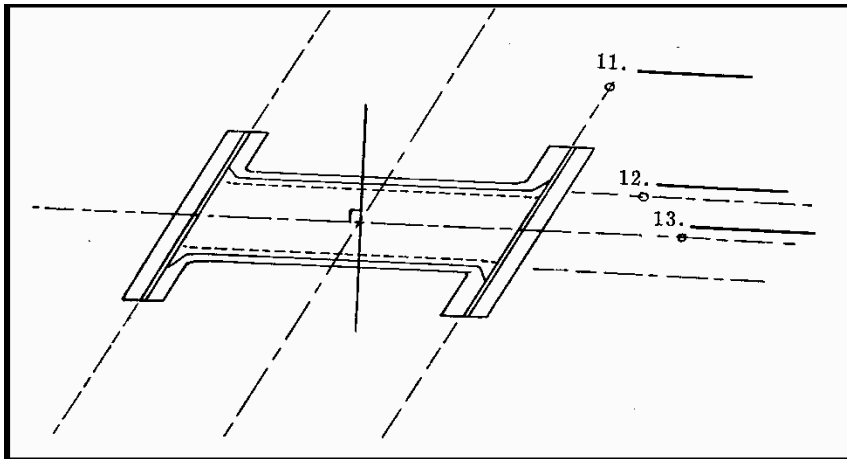
What stakes are used to make the centerlines of box culverts?

Which stakes act as reference points for the wingwalls and barrels of box culverts?

The flow line grade is controlled by _____.

Do offset stakes help to control horizontal form setting?

Place the stakes at the right in their proper locations below.



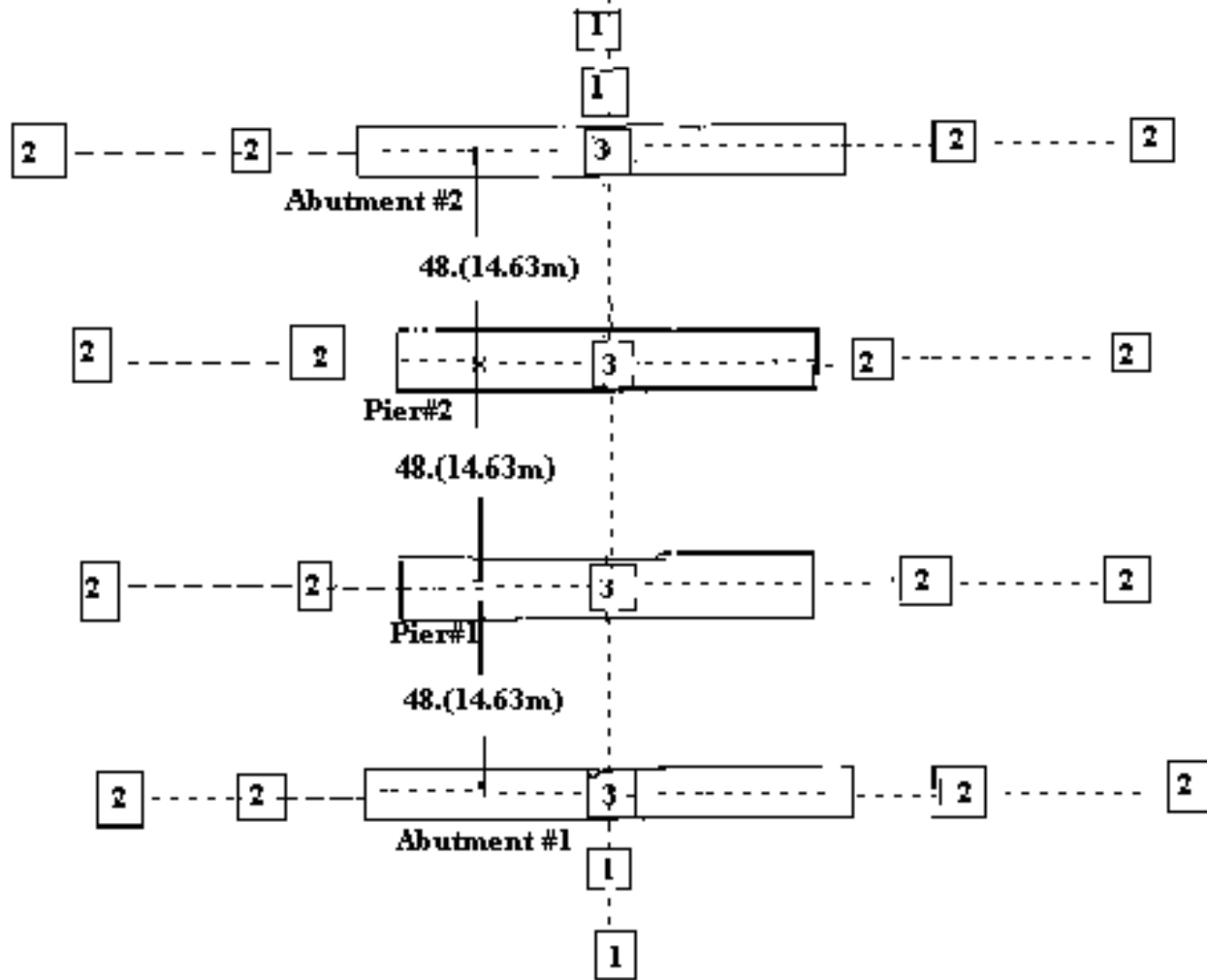
BRIDGE LAYOUT CONTROL STAKES

A typical bridge layout is shown on the next page. These types of stakes are shown:

1. Bridge centerline stakes -- established from centerline control points and are set by the survey crew.
2. Reference control stakes -- (offset stakes), set by the survey crew from the bridge centerline.
3. Substructure centerline stakes -- set by the survey crew to locate the centerlines of the piers, bents or abutments.

Each type of stake is numbered on the next page. The following pages explain the stakes in detail.

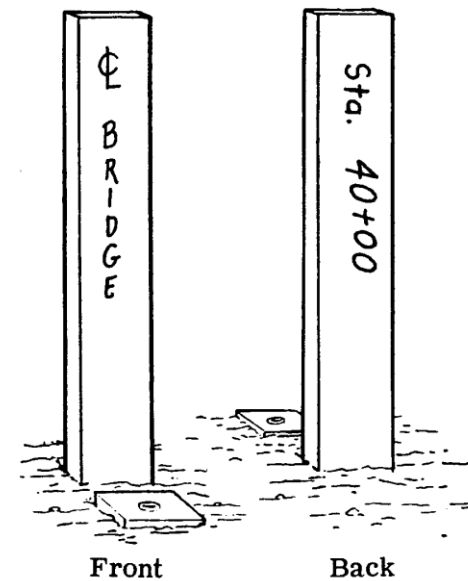
Roadway and Bridge §



1. Bridge Centerline Stakes

Bridge centerline stakes mark the centerline of the structure. The stake below is one way to mark the centerline. In other cases the centerline may be marked by a nail or tack driven into asphalt pavement or by a cross etched into concrete pavement. In any case, the essential information should be the same:

- "⌘ Bridge or Roadway"
- A definite, marked point
- The station number



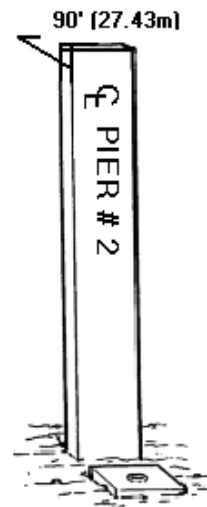
The stake above is located on the bridge centerline at Sta. 40+00.

2. Reference Control Stakes

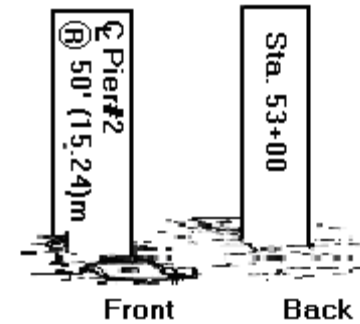
Reference control stakes -- like the ones below -- are offset from the substructures along the substructure centerlines. These "offset" stakes are used to control the location of the substructures and the alignment of forms.

For each interior offset stake, a second one is placed farther out from the structure. That way if the first is damaged during construction, a reference is still available.

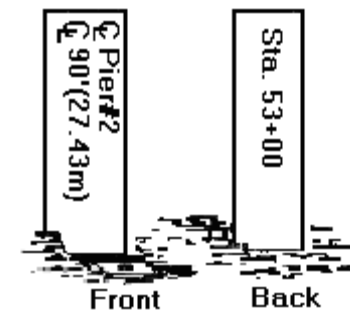
The offset is noted by the symbols below or by a double line.



An offset can be noted by a double line.



This stake is offset 50' (15.24) from the intersection of the bridge and pier centerlines at station 53+00.



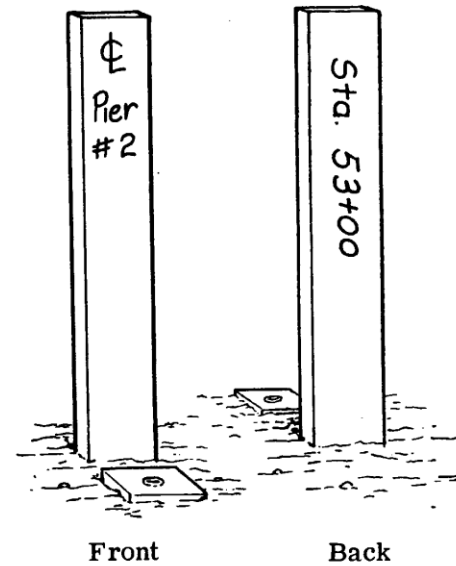
This stake is set 40' (12.19m) beyond the first stake.

3. Substructure Centerline Stakes

Substructure centerline stakes are set at the intersections of the bridge centerline and the abutment, bent or pier centerlines.

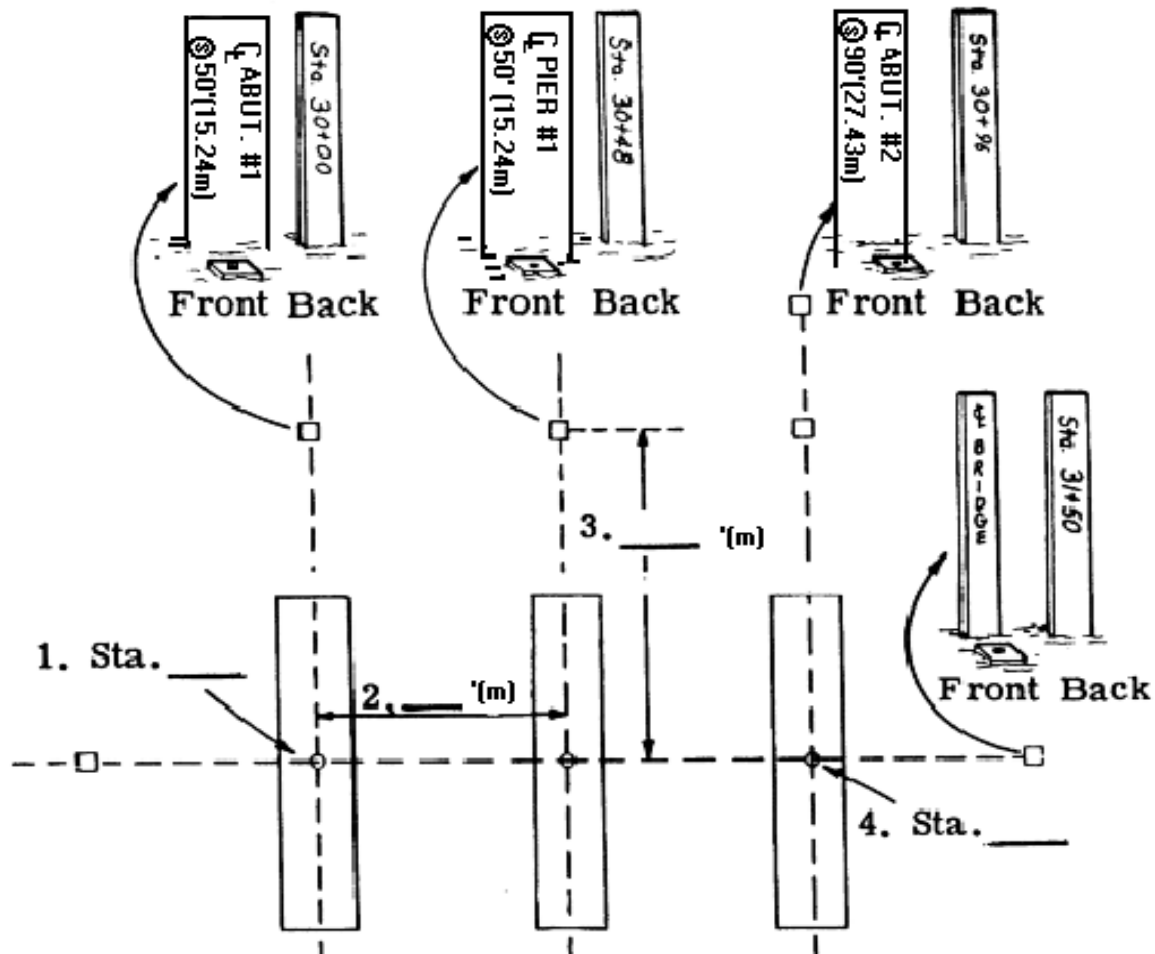
These stakes are similar to bridge centerline stakes -- they name the centerline, mark a point and give the station number.

The stake at the right is set at the intersection of the bridge centerline and the centerline of Pier #2 at station 53 + 00.



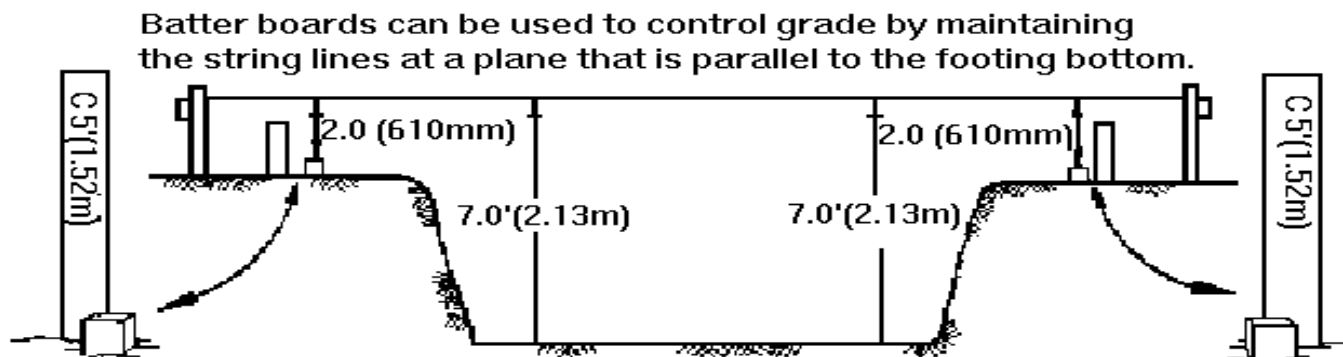
QUIZ

Use the information on the stakes to complete the diagram below. Complete the numbered blanks with distances or station numbers.



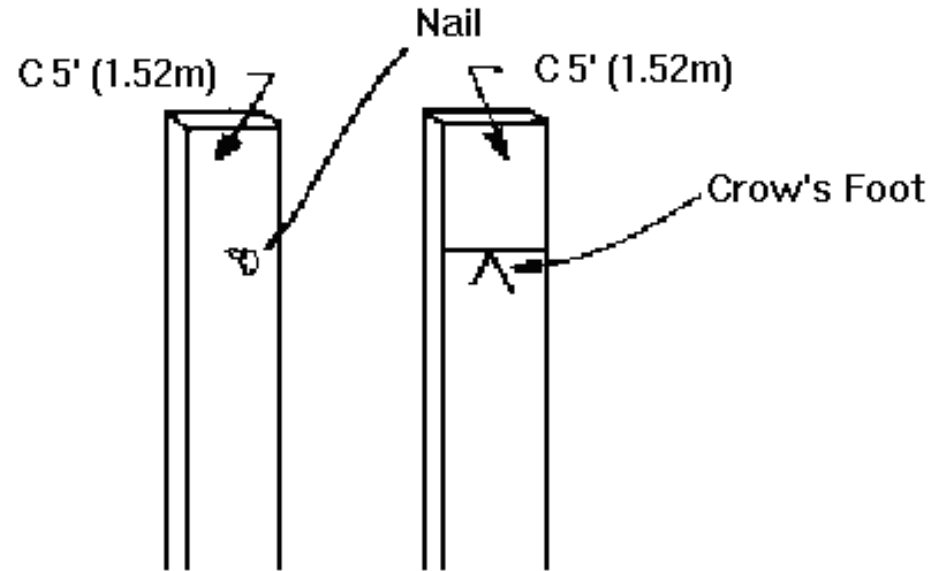
BRIDGE GRADE CONTROL STAKES

Grade or cut stakes are set near footing excavations to control the grade of the bottom of the excavation as shown below. Batter boards can be used to control grade by maintaining the string lines at a plane that is parallel to the footing bottom.



These stakes tell the Contractor to excavate 5.00 feet (1.52 m) below the elevations of the hubs.

Other types of stakes can be used. Sometimes only a single stake will be used -- without hubs -- and the top will be painted blue. In these cases, the elevation is taken from the top of the stake.



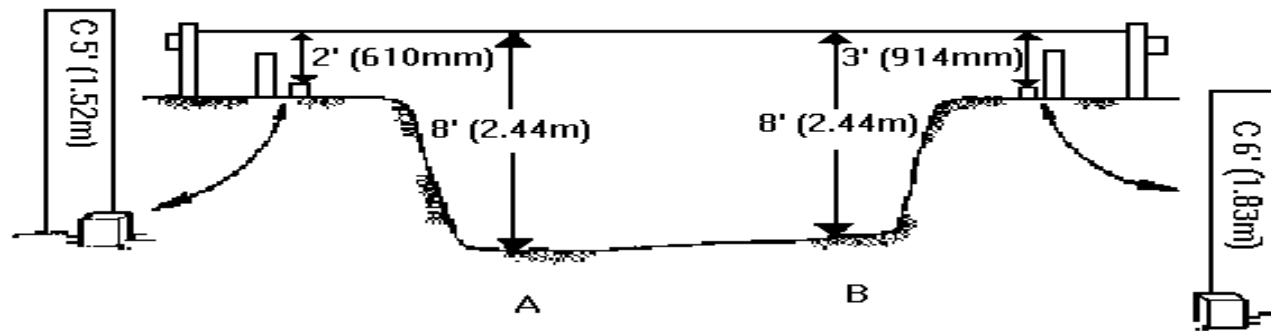
Other types are shown at right. One has a nail to mark the reference point, while the other has a "crow's foot" marking the reference point from which the cut distance is measured.

Once the footings have been excavated, the forms will then be built and the footing concrete placed. You will still need to use the bench mark of the set grade for elevation, but you can use the tops of the footings or any other permanent substructures as references for checks.

As an Inspector, your job will be to check all stakes often -- to watch for damage or movement -- and to measure and verify the distances indicated by the stakes.

QUIZ

Indicate what is wrong at A and B below.



- A. _____
- B. _____

SUMMARY

Before going on to the next chapter, review some of the important points about staking:

- Stakes mark the reference points that control the dimensions and elevations of the structures shown in your contract plans.
- Be sure that the information on your plans is the same as the information on the stakes. You will use this information later, to verify dimensions and elevations of structures as they are built.
- Be sure that all stakes remain in place during construction. If stakes are damaged or moved, the survey crew should be called in to replace the stakes.

ANSWERS TO QUESTIONS

Page 3-5

- bench marks
- line, grade
- centerline, reference
- reference, offset centerline

Page 3-9

- centerline stakes
- offset stakes
- offset hubs
- yes
- 1. C
- 2. B
- 3. A

Page 3-15

1. 30+00
2. 48 feet
3. 50 feet
4. 30+96

Page 3-18

- A. The footing excavation has been graded 1 foot too deep
- B. The footing excavation has been graded 1 foot too shallow

centerline stakes
offset stakes
offset hubs
yes

12. B
13. A

30+00