

## **1108 STAKING STRUCTURES**

### **1108-1 General**

Considerable preliminary paper layout work and computing can be performed in the construction field office before ground layout of structures is started. The extent of the preliminary work will depend on the complexity of the structure.

Generally speaking, there are three distinct types of structures which will require staking. They are pipe culverts, concrete box culverts, and large bridge type structures. The following subsections are guides which may be used in the layout of these structures.

### **1108-2 Pipe Culverts**

A study of the normal flow of the drainage should be made before staking is done. It is always possible that the normal drainage pattern may have changed between the time of design and construction which may require a change in the location of pipe culverts.

If possible, all pipe should be staked with length and alignment verified prior to the Contractor placing his order for the pipe.

In staking pipe culverts, in order to attain proper placement of the pipe, it is often necessary that the roadway sections adjacent to the pipe be slope staked. If this practice is employed, no error should occur in length or proper placement of the pipe. In the event that the slope staking cannot be done, the distance that the pipe should extend each side of centerline may be determined by plotting the pipe and the road, the cross-section at the structure location, and scaling the distance from centerline to each end of the pipe.

The centerline station through which the centerline of the culvert pipe will pass is located and marked with a stake or guinea. Set the instrument on this point, take a sight tangent to the centerline and turn the required angle for the centerline of the pipe. Along the line thus established, measure off the culvert lengths right and left of centerline and place a hub at each end of the pipe location.

After the two ends of the pipe are established, references to these points are set. If there is an inlet or outlet channel, or both, the pipe should be referenced to the sides. If no channel excavation is necessary, it is possible to reference straight out from the ends. With an elevation from the nearest bench mark, determine the elevation of the top of each reference hub, and compute the cut or fill from it to the flow line point at each end of the pipe. Behind each reference hub, set a guard stake on which has been marked the hub's identity, the offset distance, and amount of cut or fill from the reference hub to the flow line point.

Take necessary notes and make structural excavation diagrams in order to compute structural excavation. If drainage excavation is required, the inlet and outlet channels should be slope staked at the time the pipe is staked. (See Exhibit 1108-2-1.)

When elevations are provided to the Contractor for setting of pipe, or for any points on any structure, the level notes should record the bench mark elevation. The level circuit notes should always show closure on the same, or another, B.M. The purpose obviously is to reduce the chance of error.

In addition to pipe culverts, long horizontal pipe runs will also be staked for construction. These runs may go from manhole to manhole or to catch basins. These grades must be checked using manhole or catch basin inverts as the control and figuring the grade in between the structures. Pipe should be staked on an

appropriate offset line at no greater than 50 foot (15 meter) intervals. Where flow is critical, such as in sanitary sewer installations, then pipe should be staked with a cut to flow line of pipe every 25 feet (7.5 meters). A guard lath should be provided indicating cut to flow line, offset to the centerline of the pipe and station.

### **1108-3 Concrete Boxes and Bridge Culverts**

The size and type of box culvert to be staked will be designated on the plans. Particular attention must be given to the type of wing walls called for on the plans.

Since concrete culvert stakes are used for more precise measurements than in the case with pipe culverts, the layout points are marked with hubs and tacks. Wingwalls are staked according to the standard drawing or special details designated in the plans.

Basically, the same method is used in staking box culverts as for pipe culverts. Additionally, stakes must be set to locate the intersection of the barrel and the back face of the wing and the end of the wing. Reference control lines for each wing wall and wing to barrel intersection point should be set using two tacked hubs appropriate distances outside of the construction area from the end of the wing, 15 to 25 feet (4.5 to 7.5 meters) are usually satisfactory. All tacked hubs shall be referenced as to the fill or cut to the bottom of the footing elevation.

Guard stakes shall be well marked. Box culverts should be checked for necessary revisions to meet drainage requirements. (See Exhibit 1108-3-1.)

### **1108-4 Large Structures (Bridges)**

Prior to commencing the actual field layout of a major structure, considerable preliminary work is necessary. The first step should be a complete check of all distances and elevations shown on the plans. Likewise, all survey instruments should be checked and any necessary adjustments made.

It is always sound engineering practice to be certain that elevations given for bottom of footings and other elevations shown on the construction plans are computed correctly from finished grade down or from bottom of footing to finished grade.

After determining that the plans are correct, it is good practice to make a rough paper layout of how you intend to stake and reference the structure at the construction site. Exhibit 1108-4-1 will illustrate one acceptable method of laying out and referencing a structure of this type. Remember that all centerlines and bearing lines must be staked and referenced so that a minimum of time and effort are necessary in replacing any disturbed control lines as construction progresses.

After staking of the structure has been completed, a thorough check of all measurements, angles, and elevations should be made to make certain that no errors exist. This checking should, if possible, be done by a different party than the one which performed the original staking. Checking should be by a different method if practical to do so. An example of using two methods of staking the centerline of piers, bents, or abutments is:

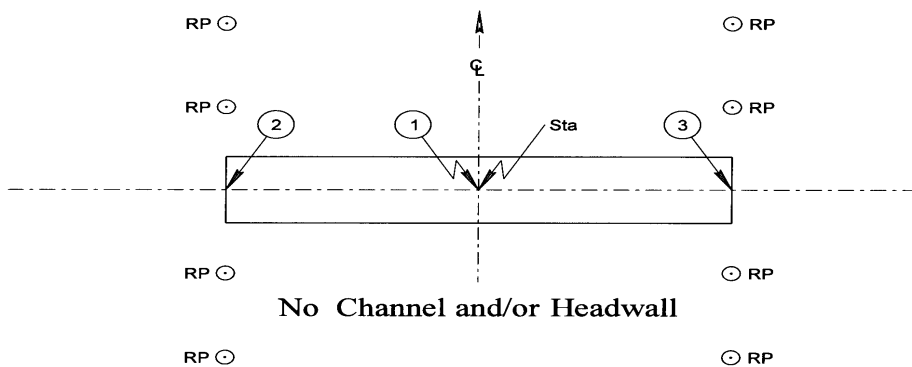
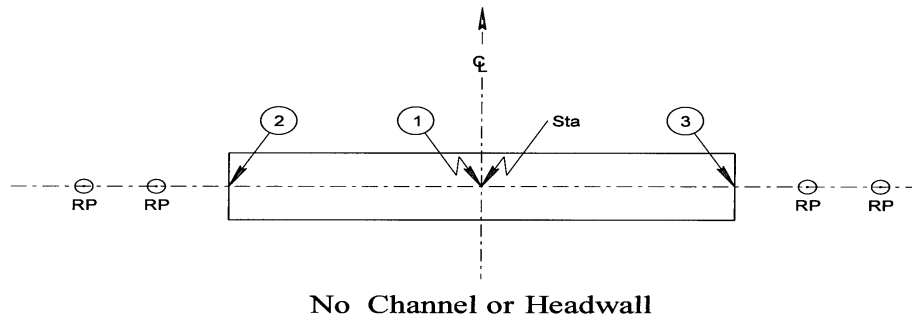
1. Stake the original layout using the dimensions between the substructure units as shown on the bridge sheets of the plans.
2. Compute the station distances for the centerline of each substructure unit and locate them by stationing. Always make certain that the staking is correct, never take anything for granted when staking a bridge.

If the least doubt arises, consult the plans and double check. Verify the staking carefully and be certain that all distances, angles and elevations are correct, then go over the structure layout in detail with the Contractor to make sure he or she knows the purpose and location of each stake. Sufficient RP's shall be provided for such items as caissons so that drilling and cage placement may be checked throughout the installation process.

### **1108-5 Structures On Curves**

Extreme care must be exercised in staking structures on curves. A very thorough study of the plans should be made before staking begins. In all cases, a layout of the structure should be made on paper. In some cases, it is also advisable to make an actual layout of the structure on level ground where measurements, staking, and checking of chords, angles, etc., are facilitated.

After being completely satisfied as to the controls needed and all measurements, angles, and elevations have been checked, and double checked, you are better able to proceed with an accurate layout of the structure. Layout staking of bridge structures must be checked by another method such as with rectangular coordinates which can indicate whether all the angles and distances close and provide diagonal dimensions.

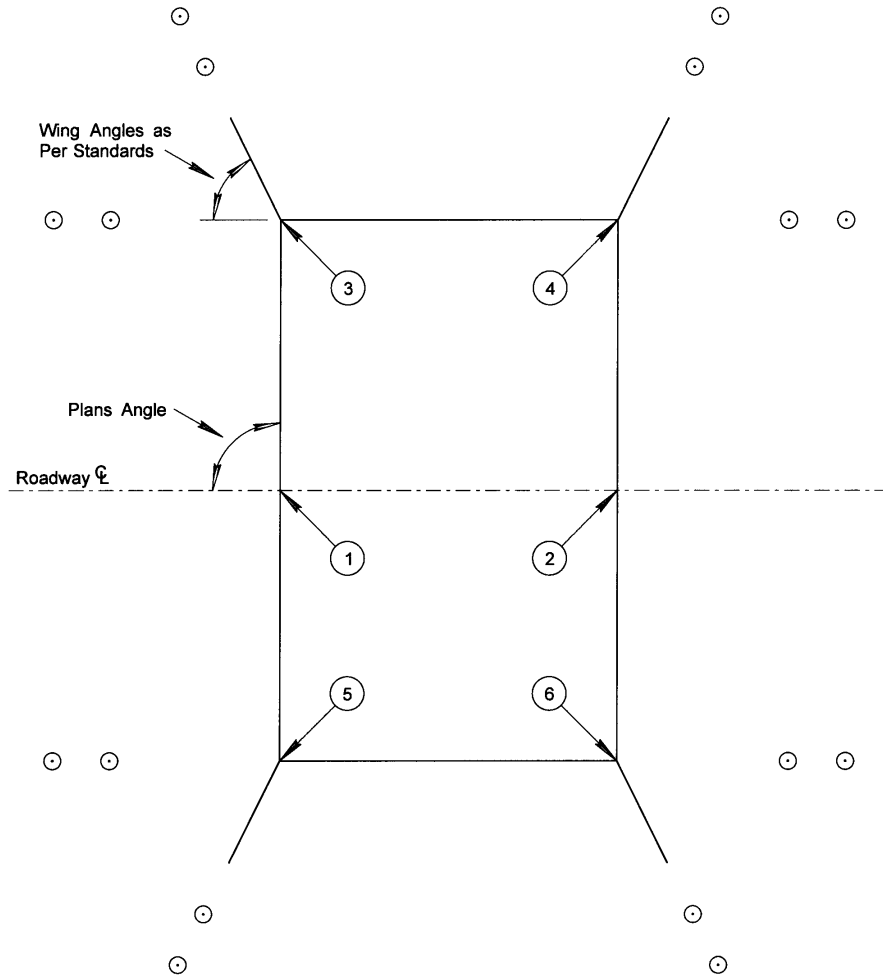


⊙ RP - Hub & Tack with Guard Stake & Lath

**Directions:**

1. Establish station location at point where survey centerline and centerline of pipe intersect (point 1). Mark this point with stake and tack or nail.
2. Occupy point 1 with an instrument and backsight or foresight to control point on centerline. Clamp vernier and turn angle that pipe line forms with centerline of roadway. Chain Distances right and left of centerline as per plans or modified pipe lengths and set stake and tack at both ends of pipe (points 2 and 3). If pipe has no channel or headwall, references may be set to ends of pipe on this same line.
3. If pipe has channel and/or headwall the following reference procedure should be used: Occupy point 2 and sight point 3. Clamp vernier and turn 90 degrees. Set reference points with hub and tack at 10 feet (3 meters) and 25 feet (7.5 meters). After these references are set, re-sight point 3, turn 90 degrees to the opposite side and set similar references.
4. Move the instrument to point 3 and repeat procedure using point 2 as a backsight.

Exhibit 1108-2-1. C.M.P. OR Pipe Culvert Staking Layout

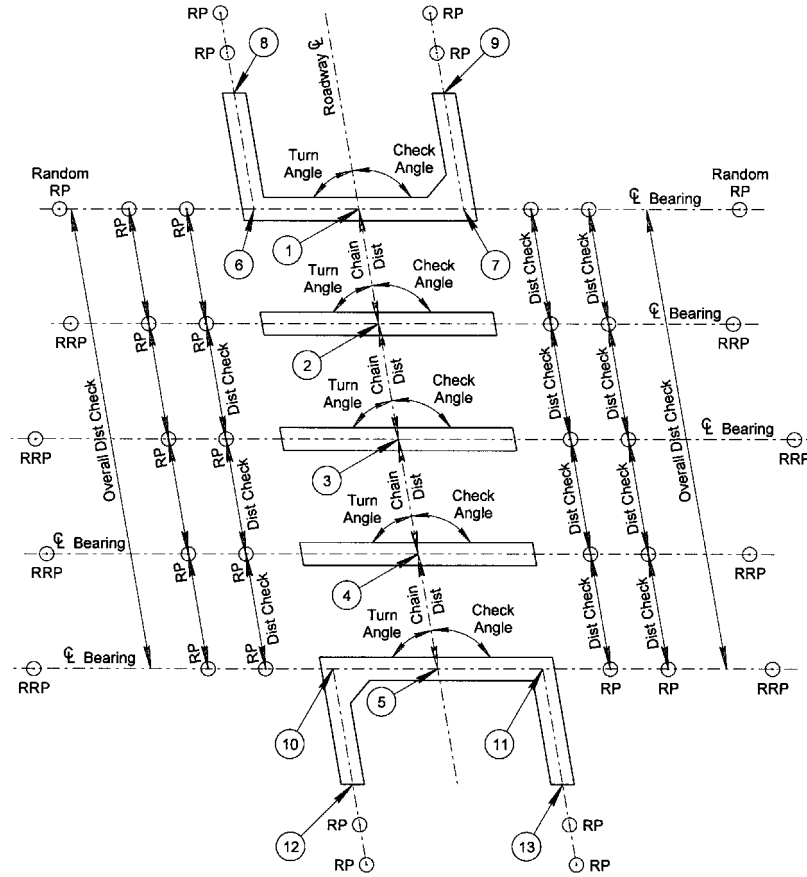


○ Reference Hub - Normally set at 10 & 15 feet from Point being referenced. 2"x 2" 14" hub and tack with reference stake & guard.

Directions

1. Locate by stationing the point at which barrel line intersects with roadway centerline (1). Mark this point with 1 in. X 2 in. X 14 in. (2.5 cm X 5 cm X 36 cm) stake and tack.
2. From this point, establish other barrel line intersection (2) and set stake and tack.
3. Set transit over point (1), sight back to centerline control point and turn plans angle. Chain off required distance and establish points (3) and (5) with stake and tack.
4. Follow same procedure occupying point (2) and establishing points (4) and (6).
5. Having established points (3), (4), (5), and (6), the transit is moved to point (3) or (4) and the unoccupied point (3) or (4) is sighted upon and the vernier locked. Indicated references are then set to points (3) and (4). This procedure will be repeated with points (5) and (6).
6. Assume above occupancy was at point (3). After setting references required, the wing angle as indicated on the plans shall be turned and the end of the wing will be established with stake and tack and referenced with hub and tack. This procedure will be repeated occupying points (4), (5), and (6).
7. A quick measurement check of the layout should be made to make certain that structure is properly staked.

Exhibit 1108-3-1. Concrete Box Culvert Layout



Directions:

1. Complete careful check of plans for dimensions and grades.
2. Establish point (1) by stationing. Occupy this point with transit. Sight transit on centerline control point and clamp vernier. From this, setup chain in and establish intersections of survey centerline and centerline of piers and other abutment. (Points 2, 3, 4, and 5.) These points should be set with 1 in. X 2 in. X 14 in. (2.5 cm X 5 cm X 36 cm) stake with tack. Carefully check the chained distance obtained from the plans each time. These distances must be to the nearest 0.01foot (3 millimeters).
3. After centerline intersection points of each abutment and each pier have been established, the centerline of each of these substructure units must be located and referenced. While occupying point (1), sight transit on point (5), or a chosen centerline control point, and turn angle as indicated by the plans. After turning angle measure and set stake and tack for each end of abutment points (6) and (7). Turn back to original sight point (5) or control point and turn check angle (difference between 180 degrees and plans angle). If this does not hit the tack set for each of the abutments, repeat procedure until points can be hit by turning either angle. After being satisfied that line is good, set 2 in. X 2 in. X 14 in. (5 cm X 5 cm X 36 cm) hub and tack references to each end of abutment.
4. After setting and referencing points (6) and (7), they must be occupied and the end of each wing set and referenced. The same procedure is used, checking angles and distances each time.
5. Continue ahead occupying points (2), (3), (4), and (5) repeating the same procedure.
6. After completion of staking layout, a check should be made. First, check distance between reference points to centerline of piers and abutments. These reference distances should not vary more than one one-hundredth (3 millimeters) from the chained distance at centerline. Next, chain the overall distances on each side of structure layout. This should be within one to two one-hundredths (3 to 6 millimeters) of plans length of the structure.
7. All reference points must have guard stake and flagged lath.
8. Caisson layout will have RPs in both directions so Contractor can set rebar cage with string lines.

Exhibit 1108-4-1. Large Structure Layout