Chapter 8

Chapter 8-Construction and Fabrication

Joint Connections

Pipe arches are fabricated by first constructing a circular pipe than deforming the pipe till it forms an arch shape. Because of length limitation, the pipes are deformed in short sections. Ideally, the sections will match each other perfectly but in practice this never happens. Pipes arriving on the projects would never join properly and with a great deal of effort a poor compromise was reached. We often had to fill two to three inch gaps with everything from concrete to manhole sealer. Joining the pipes would take hours and lead to numerous contract concerns over quality of products. Bands would never fit properly because the corrugations were deformed in the arching process. Re-rolling the ends was proposed by one supplier. The results were a negligible improvement.

This past summer we tested a new type of connection which is presented in the photos below. The pipes using this connection were connected together with minimum delays and the baffles and pipes aligned perfectly.

A construction detail of the joint connection is included in the drawings at the end of this chapter. The following process is used by Pacific Corrugated Pipe for fabrication of the joint connection.

1. The pipe arches are first fabricated and baffles installed within the sections.

2. The pipe sections are aligned and trimmed. The spacing of the section cuts are determined by the manufacture from the construction drawings.

3. A 4-inch wide, 10 gage galvanized flange plate is welded to the ends of the pipe.

4. The ends of the pipes are then factory aligned and clamped together. Holes are drilled after the pipes are butted and clamped in position with the baffles aligned.

5. The pipes are than marked, and delivered with flat bands and gaskets. A gasket is placed under the band and between the connecting flange for water-tightness.

Connecting flange welded to outside edge of pipe.

The connecting flange is designed to come up to the top of the haunches on each side. This provides adequate room for adjustment for misalignment. A gasket is placed between the flanges for water-tightness. The flanges do not significantly affect the flow capacity of the pipe.

An additional advantage of the connecting flange is with the bands. The bolted flange connection allows the use of flat bands rather than corrugate. Flat bands are shown in the photo above.

Bedding and backfilling Concerns

Construction of weirs or baffles into pipes affects the bedding and backfill of the pipes. With three-dimensional structures as baffles or weirs the structure becomes semi-rigid. Good quality backfill materials and methods are essential to prevent deflection and possibly tearing of the welds. If improperly installed the welds will tear along the edge of the pipe.

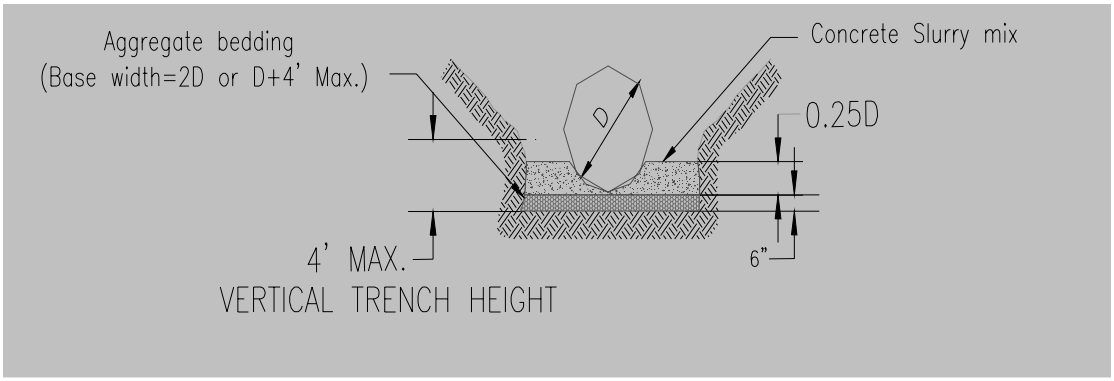
The traditional method for culvert installation details specified adding **camber** in the grade under high fills to balance settlement. Camber **is not** recommended for culverts installed with weirs or baffles. In lieu of camber the foundation of the culvert must be constructed with sufficient strength to prevent deflection.

Assuming the foundation of the pipe is placed on firm material the foundation needs to be totally compacted to at least 95% of T99 prior to placing the bedding materials. Grades are set with a laser level to achieve tolerances of +- .01 feet.

Concreting under Haunches

Pressure in the haunches of pipe arches are particularly high because of the small radius of curvature of the conduit at those locations. The backfill at those points must meet design specifications for density or the pipe may deform and the welds break.

This past summer we required that all pipes be concreted with a low strength, high slump concrete under the haunches. Details and specifications are attached. The contractor was able to pour the concrete and within 24 hours continue backfilling operations. The result was a high quality bedding for the pipe with only a minor increase in cost to the whole project. I recommend this procedure in lieu of manually compacting material around and under the haunches.



Concrete Inlet Protection

All large culverts are installed with riprap at the inlet to prevent scour and erosion of the back-slopes. The riprap is placed on a 1-1/2:1 slope and normally not grouted or concreted. Pipes are steps beveled at the inlet to improve their efficiency to handle debris flow during high events. Anchors are often added to secure the pipe arch to the grouted riprap slope. A typical anchor involves attaching the cut ends of the pipe to the head walls or ring beams with 3/4 inch bolts spaced at about 18 in. (Ref. one, page 325). A more elaborate collar is detailed for large span structures and arches. Anchoring can be as simple as placing bolts into grouted riprap or as complex as constructing a concrete slope collar that ties the end walls to the foundation. The selection of the anchor type is a judgement of the design engineer. The engineer should consider the span of the pipe, potential debris loads to the inlet, headwaters to depth ratio, and stream dynamics at the site.

Grouting riprap with anchors are recommended for the following conditions.

1. Use a collar or anchor when there is a potential for debris plugging the entrance to the culvert. A pipe arch or arch is not the recommended structure for streams with high debris loads. Arch structures are easily damaged if the fill washes out and water flows directly over the pipes. An acceptable compromise is to place grouted riprap along the entire slope of the inlet and outlet. During high flows debris will to rise up on the slope and potentially even onto the road. These sites often are constructed with a paved roadway.

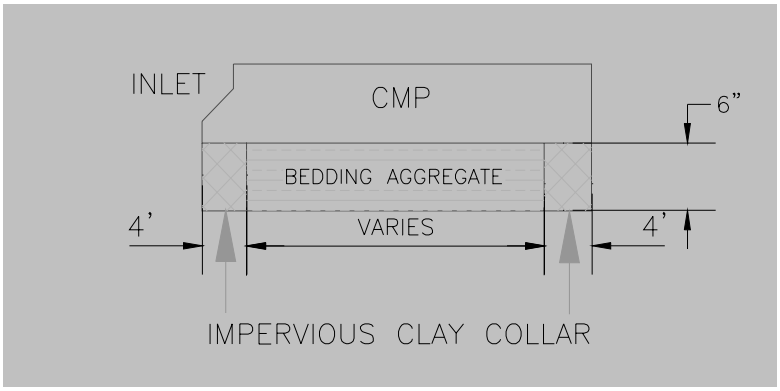
2. The steel drainage handbook gives limits for beveled or skewed pipes beyond which a collar or anchored structure is required. Figure 4.22 in the handbook compares spans to skews and the need for an anchored sidewall. Table 4.7 in the handbook does the same for gage, corrugation type, and span. Always anchor the pipe when the skew exceeds 15 degrees or the bevel exceeds 2:1.

Gage of Pipe	2-x ½ Corrugations	3 x 1, 5 x 1, Corrugations	6x2 Corrugations
12	60	96	156
10	66	108	168
8	72	114	180

Piping around or under Culvert

Culverts are bedded with a 6-inch thick layer of bedding aggregate below the invert of a culvert. A four (4) linear foot impervious clay collar is placed at the inlet and outlet of the culvert to prevent piping. The clay collar may be omitted at the outlet at the discretion of the engineer. The goal is to prevent water from piping under the pipe from the inlet. See Typical detail at the end of this report. If a spring or subsurface water flow is found in the excavation add a French drain under the pipe below the base rock. Sub-excavating and installing a free draining layer below the pipe allows the ground water to move under the pipe without eroding the bedding material.

Drawings to an exaggerated scale



Excavation into solid rock and reducing boulders

Pipes for stream simulation are designed to be bedded on a crushed rock base. If large rocks or bedrock is found in the excavation limits, it must be removed. Blasting or impact tools are typically required. Culverts for stream simulation and fish passage are designed with selected control points at the inlet and outlet changing the grade because of rock is not an acceptable solution. As a minimum the contractor should be advised to have a contingency plan for removal of rock if found in the excavation.

Contractually many agencies define all material as “unclassified’. Any boulder reduction or blasting is than up to the contractor without a pay increase or modification. If materials are undefined or classified into types such as “common” or “rock”, removing the rock is than a contract change unless a separate pay item is included for that work. “Ordered work” outside the”neat lines” of the project is considered a change. Review these concerns at the pre work conference to avoid confusion during the construction process.

Removal and Wasting of Unsatisfactory Excavation

Locate all waste sites prior to advertising the contract. Include contingencies at the waste areas for erosion protection to include silt fences, or hay bales, mulching, etc. If temporary waste sites are requested on the site they need to have the same review as permanent ones and should be clearly defined.

Weak or Soft Base under Culvert

The accepted solution for a weak or soft base is to sub excavate the site, place drainage fabric around the hole and then backfill with free draining angular rock. That solution has been modified slightly to take advantage of higher strength fabrics now on the market. Revised typical details are included for installing culverts on weak and very weak soils. The details incorporate a high strength fabric, two or three feet of free draining rock, and additional width of excavation.

The proposed fabric is a high strength, woven drain fabric. The fabric does the following. Along the bottom it prevents the rock from sinking into the soft material and provides tensile reinforcement. Along the sidewalls the fabric allows water to drain into the free draining rock below in addition to providing additional anchoring to the fabric along the bottom.. The fabric is overlapped a minimum of two feet and extends along the sidewalls to at least the level of the haunches.

The subbase rock is specified as a free draining angular riprap. The goal is to have a rock that will act both as a French drain and as a high strength base that will distribute the fill to the full width of the trench. The width of the trench is increased three feet, the same as the depth of the subbase rock. The desired phi angle for this rock is 45 degrees or better. See Leslie Crossing Project for details and photos.

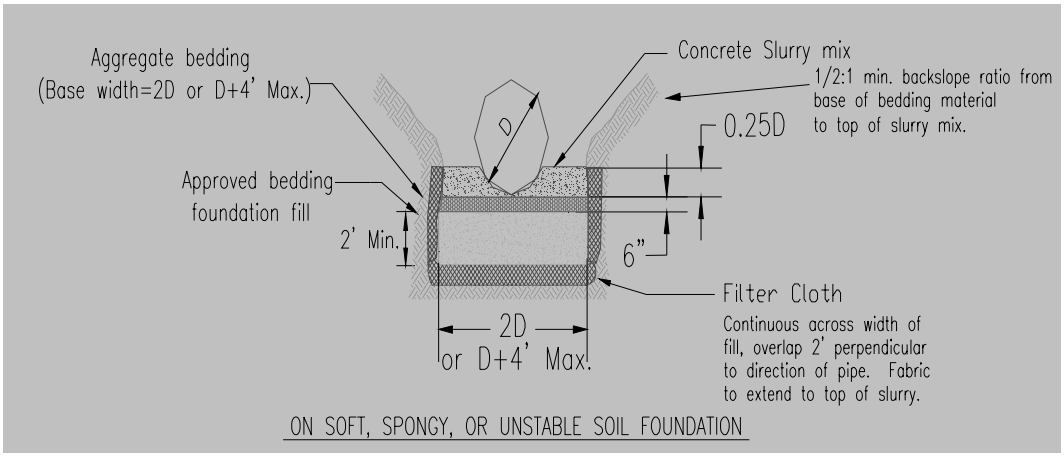
CONSIDERATIONS

1. The fabric specified is a heavy drainage fabric not readily available. The contractor or contracting agency must have the fabric on hand at the site prior to any work beginning. Consider having a roll of heavy drain fabric available as a government furnished item.

2. Identified the source of the base rock early in the contract. Pay for the rock separately as an optional item when “directed in writing.”

3. The foundations of major pipes are approved by the contracting agency prior to placing the pipe. Coordinate with contractors to insure engineers are available at crucial times.

4. The additional excavation below the pipe is a changed site condition unless a pay item and method of measurement is defined in the contract for that work. A convenient procedure is to define the sub-excavation limits in terms of "neat lines." Payment for the additional excavation will than be limited to work only inside those "neat lines" without affecting the other excavation at the site. A pay item for sub-excavation is than included in the contract when "ordered by the engineer" in writing.



De-watering of a construction site

De-watering of sites historically was left to the contractor with general guidelines on sedimentation limits. An emphasis on water quality now requires that construction sites have a plan for diverting water. This is often a minor issue on coastal streams where the flow is very small during the construction periods. A typical de-watering plan includes:

1. A settlement pond upstream of the inlet outside the construction area.

2. A pipe from that pond though the project or around it diverting the water from the site.

3. The outlet pipe will be in a pool or placed to not erode soil into the stream.

4. For large streams a pump is often installed in the pond. The pond may be lined and often is with a plastic liner. Construct the pond with clay or impermeable material to prevent leakage. A small amount of bentonite well mixed with the natural soil will often prevent leakage.

Local and state regulations often will specifically define how this pump

chance will be constructed, its location, and require a complete removal of all imported material at the end of the project. The designer needs to review those regulations.

The pond is normally constructed from materials in the channel. Removal can be accomplished by breaching the dike at the end of the project. This results in a short term increase in turbidity and movement of rocks into the culvert structure. Often the pipe baffles will trap those sediments such that the pipe achieves much of the desired substrates for stream simulation.