# Enviro-Span on Concrete Footings

By Ron W. Hammerstedt, B.Sc.F., RPF.

Enviro Span may be installed on concrete footings in several different and equally effective ways as follows:

1. **Conventional grade beam foundation**

   Galvanized steel (CSP) arches currently use conventional (flat surfaced) grade beams as the foundation of choice for permanent installations. A grade beam is defined as "a reinforced concrete beam placed directly on the ground to provide the foundation for any superstructure (arch culvert in this case)". With such a grade beam, a uniform prepared bearing surface is required. For steel arches (with their limited elasticity), uniform elevation, grade and alignment must be maintained absolutely in order to prevent structural failure. This is much less critical, and even largely unnecessary for Enviro Span, with its high elasticity (see number 4 below). However, Enviro Span will function exceptionally well using a conventional grade beam installation as required.

   For Enviro Span, a grade beam may be precast or poured on site depending upon accessibility and/or preference. As with a steel arch culvert installation, a flat surfaced grade beam simply requires anchor bolts placed at measured intervals in the concrete to allow for bolting the Enviro Span modules to the foundation. No other parts are required. Bolt spacing is provided in the attached diagram and it is recommended to use 12.5mm diameter (½ inch) by 100mm long (4 inch) anchor bolts.

   To install Enviro Span on the grade beam, simply drill a bolt hole in the bottom dead center of each corner rib base (see diagram) to accept a 12.5mm (½ inch) diameter bolt. Then fit the Enviro Span module over the anchor bolts on the grade beam and bolt them down. Enviro Span drills easily and quickly with a standard steel drill bit.

   This will provide you with a very conventional installation that looks much like one that would be used for a standard CSP arch and may be buried and armoured in relation to the stream bed and scour line as determined by the engineer on site.

2. **Pre-Cast, Half Cylinder Top, grade beam foundation**

   Since Enviro Span is designed to be installed without the need for fasteners, one may take advantage of this feature by utilizing a precast, half cylinder topped, grade beam. By using a grade beam with the half cylinder top shape, you can install Enviro Span by simply placing the

modules on top of the grade beams and using only the Enviro Span connectors for a very quick assembly (just minutes to assemble a full crossing). See attached diagram.

The advantage of using this system is that in the event of a severe flood and complete washout of the critical fill prism, Enviro Span (unbolted), will simply wash out undamaged and may be gathered up and re-used to re-build the crossing.

As with the conventional grade beam, all other aspects of the installation remain the same (i.e. fill specs and compacting, depth of burial, armouring, etc...).

**3. Concrete Filled Steel Pipe grade beam foundation**

A third option would be to use a 12" diameter steel pipe filled with concrete and laid on a uniform prepared bearing surface as with a conventional grade beam. See attached diagram. Concrete filled pipe is a well-known and widely used structural component.

The advantage of this system is that one can utilize all of the advantages of Enviro Span's quick and effective installation design while still having a reinforced concrete grade beam. There are no bolts or other fasteners required and the modules can be placed quickly upon the foundation, by hand, in a matter of minutes.

As with the conventional grade beam, all other aspects of the installation remain the same (i.e. fill specs and compacting, depth of burial, armouring, etc...)

**4. A Further Note Regarding Installation of Enviro Span**

The above options will provide for an installation that mimics the installation of a conventional CSP arch and performs as well or better when under use. However, the necessity of using such methods with Enviro Span would only be to meet specific, regulatory requirements. Due to both the material elasticity and the design of the connecting system of Enviro Span, it has a powerful ability to "adapt" to changes in the grade and alignment of a foundation. Because of this, Enviro Span may be installed in a permanent setting by utilizing more elastic, "compliant" footing materials (e.g. steel pipe or heavy or double walled plastic pipe). In temporary installations, log footings are very appropriate and Enviro Span is designed to take advantage of the availability and low cost of such materials. Log footings, in combination with Enviro Span, will adapt to changes over time caused by shifting fills that are inevitable in some soil types or slopes.

For these reasons, it is recommended that the use of more elastic footings be considered for long term installations when using Enviro Span as it would utilize the full potential of the composite arch to provide a more durable and long lived crossing than conventional systems. Using conventional grade beams, Enviro Span can outlive other crossing types simply because

of the long lifespan of the material. However, with the additional ability to adapt to change in the fill over time, a flexible Enviro Span installation has the potential to outlive conventional crossings by many more years

**Note**: The ability of flexible pipes to adapt to non-uniform compaction, non-uniform fill materials, or shifting of fill, is a well-known phenomenon and is the result of a composite soil-pipe interaction. Rigid materials do not have the capacity to form this interaction.

**The following references present this phenomenon:**


1. Jim Noll, P.E., Professional Development Series. Flexible Pipes for Culvert and Drainage Applications: Understanding Design and Performance Differences. 2006.

2. Armco Drainage & Metal Products, Inc., Out of an Idea, an Industry, 1960.

3. ASTM Standard D2412: Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading; and AASHTO M294: Standard Specification for Corrugated Polyethylene Pipe, 300- mm to 1,500-mm Diameter.

4. ASTM Standard D638: Tensile Properties of Plastics; ASTM Standard D 695: Compressive Properties of Rigid Plastics; and ASTM Standard D 790: Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.

5. Gabriel, Lester H., Ph.D., P.E., The Complete Corrugated Polyethylene Pipe Design Manual and Installation Guide, University of California, 1998.


*About the author: Ron W. Hammerstedt, B.Sc.F., RPF. has been a Registered Professional Forester for the past 30 years. His career has been characterized by an unconventional and very successful approach to natural resource stewardship that has led to award winning innovations and operational improvements in large scale forest management systems.*

# Enviro Span Modular Culvert System

## Permanent installation using concrete footings

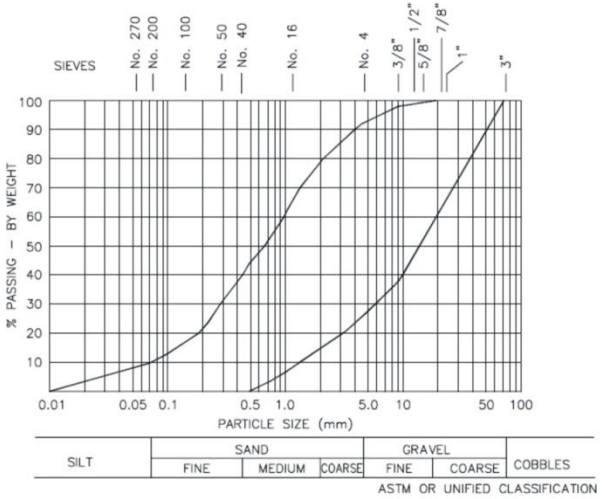
### *Notes on the use of Concrete Footings with Enviro Span:*

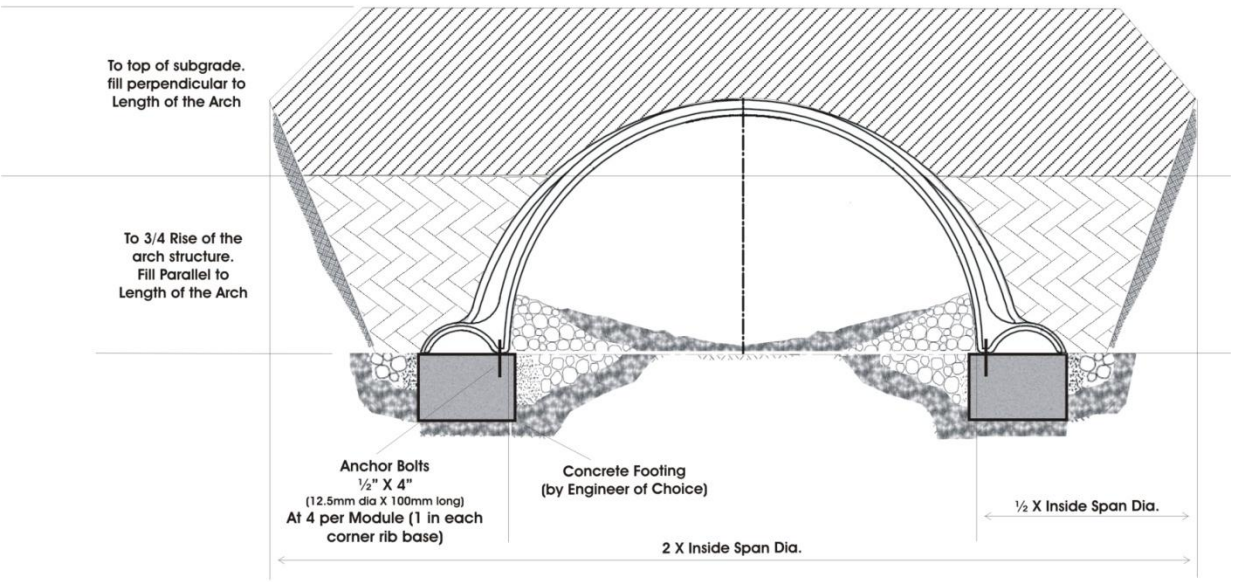
This drawing represents an Enviro Span modular arch installation that mimics a typical CSP Arch installation on a concrete footing. In this configuration, Enviro Span will perform to a standard that is equal to or greater than a comparably sized CSP Arch on a concrete footing. While this is an entirely suitable application for Enviro Span, it should be noted that Enviro Span is designed to be a visco-elastic structure mounted on compliant footings that allow it to form integrated soil arch structures.

Essentially, the use of rigid footings with Enviro Span simply does not take advantage of the full range of strength and durability properties that are available to the user.

**From an environmental perspective:**
If Enviro Span is installed with a compliant footing, it may be placed to straddle the stream from normal bankful line to bankful line without excavating the stream bank as with a concrete footing. This allows for **virtually zero stream disturbance** and requires **no stream diversion**. Further, the opportunity for scouring is greatly reduced with this configuration.

**From a structural perspective:**
In consort with a compliant footing, Enviro Span has the capacity to behave as though it uses smart material technology. It will adjust to movements in the soil prism (frost heaving, settling, earthquakes, etc.) by transferring loads back upon the stiffer soil elements, rather than accepting increased loads onto itself. This results in the formation of a composite soil arch structure that is stronger than the sum of the parts. This means that Enviro Span, on compliant footings, has very high survivability and durability in the face of catastrophic movements in the soil prism.




**Backfill:**

**Material for the critical soil prism surrounding the structure should be granular and angular, and should conform to the gradation curves in the diagram to the left.**

**Backfill should be spread by dumping truck loads no closer than 6" from the start of the dump while moving away from the structure with the load. Do not dump directly onto the structure.**

**For compaction, fill should be introduced in layers not exceeding 8" in depth.**

**Compact fill layers using standard vibrating or tamping equipment oriented in the directions indicated in the above drawing.**


Patent: US 8,596,910 B2
Patents Pending:
CA 2679462
Int. PCT/CA2008/00382




ENVIRO SPAN Modular Culvert Systems
Trinity Composites LLC

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