

CONCRETE ENCASEMENT OF PIPE

Concrete encasement for pipe has often been considered independent of the type of product (i.e., flexible or rigid being installed).

A basic question relative to such proposed encasement is: what is the purpose of such encasement; and is such encasement necessary or applicable for all products?

In order to address the issue in detail, let's first establish the reason or benefit to be achieved:

- 1. If the encasement of the pipe is to prevent a depression in the roadway as live load is applied to the pipe, we must address the structural response of the pipe that received such loading and if the response of the pipe includes a corresponding dimensional change.**

For low fill heights, the distribution of the live load is concentrated over a narrow width.

In considering the effect of such concentrated loads, the designer must determine the width of the load relative to the diameter of the pipe. Depending on the type of pipe, narrow load application can, in addition to requiring increased structural integrity, result in substantially increased deformation.

Flexible Pipe

Flexible pipe products are known to deflect under load. The basic design concept being as the pipe deflects passive lateral soil pressure develops causing equilibrium of the soil structure system.

Many such systems rely on the adjacent soil for 90 to 99% of their structural capacity with the inherent strength of the basic pipe providing very little structural strength.

According to the Spangler design procedure, if the inherent strength of the pipe provides 10% to 15% of the load supporting capacity, the pipe would deflect into an elliptical shape with the vertical change being approximately 110% of the horizontal diameter change. Please be advised the Spangler equation assesses the horizontal change, not vertical change in diameter. For pipe contributing less than 10% to 15% in load strength, the deflection is no longer elliptical, with the vertical deflection increasing as pipe stiffness decreases.

With flexible pipe, we therefore have two basic components of performance that can be improved by concrete encasement.

- A) The required passive lateral forces are generated with a reduction in the vertical deformation.
- B) A concrete arch is formed to uniformly transfer load over the entire width of the pipe eliminating narrow load concentration and reducing deflection. This arch also reduces the load to the flexible pipe by providing an independent support mechanism.

In essence, the concrete encasement of a flexible pipe is simply a means to allow the flexible pipe to perform as a rigid pipe product without excessive deflection.

Rigid Pipe

The design of rigid pipe systems is entirely different than flexible systems in that passive soil pressures and deflection of the pipe are not depended on or included in the design. Change in diameter as a result of the applied load and corresponding strains in the concrete and steel are extremely small, approximately 0.001 times the pipe diameter for concentrated loads, such as those imposed in a 3 edge bearing test, and considerably less in the field performance due to improved load distribution.

Consequently, the concrete encasement of a rigid pipe has no significance from a roadway settlement standpoint.

2. If concrete encasement is to provide structural support.

Flexible Pipe

As mentioned above relative to deflection, the performance of flexible pipe systems is 90 to 99% dependent on the soil characteristics and field compaction. The greatest single variable factor, being soil compaction, can be eliminated by concrete encasement, thus providing increased assurance the designed performance will be achieved.

The encasement of flexible pipe in concrete is therefore a procedure that may be used to provide the required soil-structure system, without necessarily increasing the inherent strength of the basic product.

An alternative to concrete encasement in certain applications may be substantial increase in the pipe stiffness.

Rigid Pipe

Rigid pipe installations are not as sensitive to performance as flexible pipe, having tremendous inherent strength in the pipe itself. Concrete pipe, for example, is in a sense its own encasement above the springline, its performance being affected relatively little by soil compaction in this area. Rigid pipe, being available in strengths covering a wide range, does not have to depend on concrete encasement for its performance. The compaction levels for rigid pipe are readily achieved in the field, normally in the 85 - 90% standard Proctor range and the design of the pipe is based on such values. Pipe strengths are selected to fit the field conditions, and typically only consider active soil forces. Recent research has demonstrated that concrete encasement of a rigid pipe does not necessarily enhance the installation. For concrete pipe and other rigid pipe, the key is, simply, good contact between the soil and the pipe in the lower haunch area.