

## **CONSIDERATION FOR FLOTATION WHEN CONTROLLED LOW STRENGTH MATERIAL (CLSM) IS USED AS A BEDDING MATERIAL FOR VCP**

CLSM is being successfully used as a bedding material for vitrified clay pipe. It simplifies the installation of pipe, reduces labor and inspection costs, allows for early backfill, is easy to place, and provides a 2.8 Load Factor.

No field installations using CLSM have resulted in flotation of clay pipe. However, buoyancy calculations done using the Archimedes' Principle (that a body wholly or partly immersed in a fluid is buoyed up with a force equal to the weight of the fluid displaced by the body) indicate that the pipe should have floated. Studies conducted by the National Clay Pipe Institute with its member companies<sup>1</sup> on 8", 18", and 36" pipe have shown that the reason clay pipe doesn't float is that CLSM acts as a Bingham fluid<sup>2</sup>. A Bingham fluid, also known as a Bingham plastic<sup>3</sup>, is a viscoplastic material that resists movement at low values of shear stress in the fluid. Buoyancy forces generate shear stress in the CLSM. If the stress applied by the buoyant force does not exceed the shear yield stress of the CLSM, the pipe will not float.

For these reasons, it is important when using CLSM to use a high density material like vitrified clay pipe. Evidence from the field has shown that lighter density pipe materials will float during installation and must be weighted down. It is also important that the CLSM needs to be prepared and placed correctly<sup>4</sup>.

The buoyancy tests performed by NCPI are illustrated in figures 1 - 3. In Figure 1, the pipeline is shown blocked and marked so that the degree of flotation could be measured. In Figure 2, the CLSM is poured. The pipeline is not constrained in any way. In Figure 3, the curing of the CLSM is checked with a penetrometer. As can be seen in the photo, flotation did not occur prior to the CLSM setting.

Engineers may find the following references useful when considering vitrified clay pipe for their projects.

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1 Sikora, E.; Lys, R. "NCPI Flotation Field Test", 1994, National Clay Pipe Institute, Lake Geneva, WI.

2 Tsai, C.-L.; Du, Y.; Tsai, Y.-S. "Experimental Study of the Rheological Behaviors of Fresh Concrete, Mortar, and Clay Grout" J. Marine Sci. Tech. 2003, 11(3), 121-129.

3 Bingham, E.C. "An Investigation of the Laws of Plastic Flow" U.S. Bureau of Standards Bulletin, 1916, 13, 309-353.

4 "Guidelines for Controlled Low Strength (CLSM) Mix Design, Placement and Testing for Use as a Bedding Material for Vitrified Clay Pipe", 2011, National Clay Pipe Institute, Elkhorn, WI.

# NCPI FLOTATION FIELD TEST



Figure 1



Figure 2



Figure 3