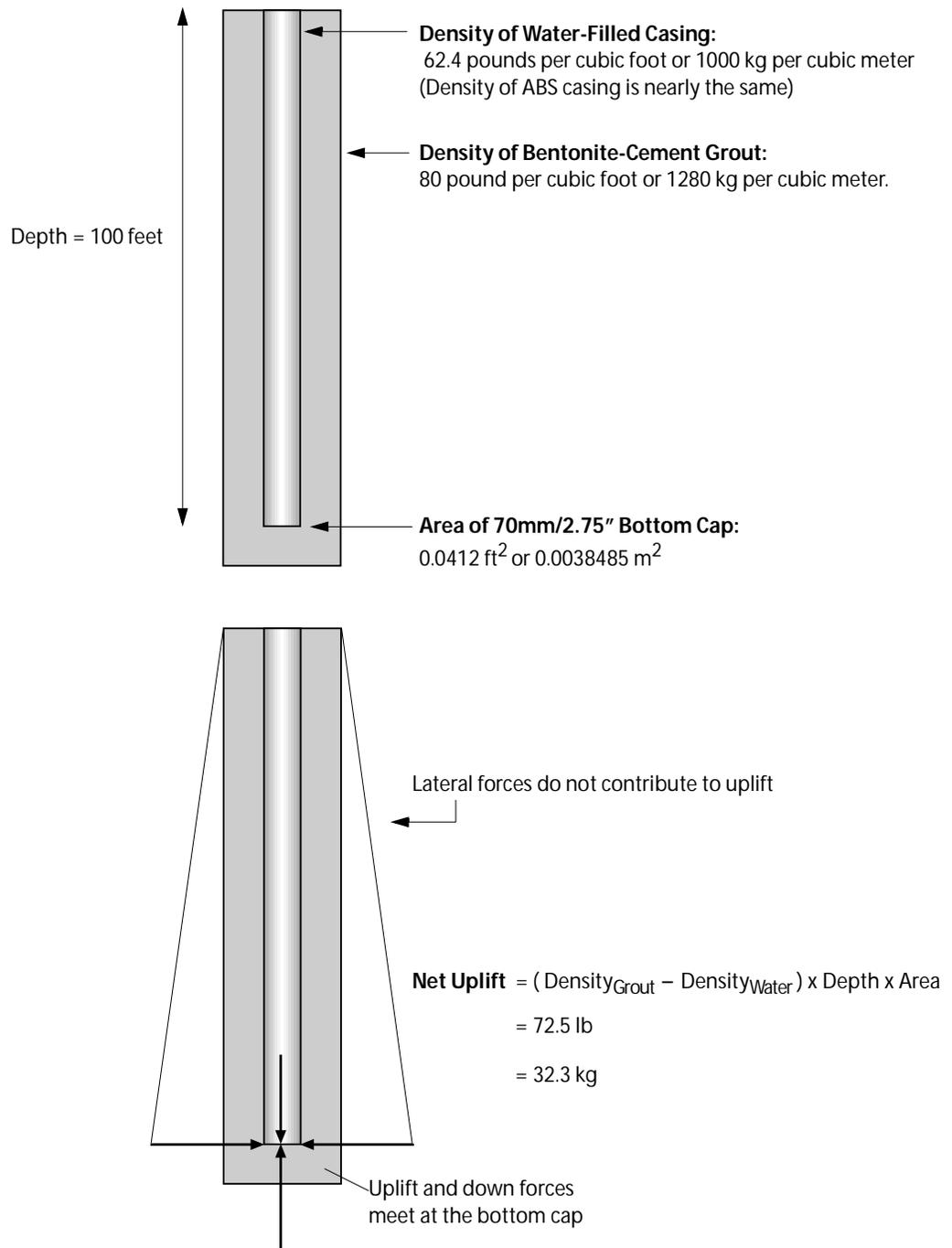


Countering Casing Buoyancy

Why Casing Floats in Grout

Grout backfill has a higher density than water-filled casing. During installation, when the grout is still a fluid, it exerts an uplift force on the bottom cap of the casing. This uplift force is greater than the down force exerted by water-filled casing. The illustration below shows how the net uplift force is calculated.



The Worst Way to Counter Buoyancy

Unfortunately, the easiest way to keep the casing in place - holding the casing down from the top - is also the worst way. The uplift force acts on the bottom of the casing, so if the casing is held in place from the top, the casing goes into compression.

When the casing goes into compression, it tends to snake from side to side in the borehole. This problem is particularly severe in large diameter boreholes and in deep installations, where the uplift force is largest and where portions of the borehole may be enlarged. Snaked casing increases the potential for:

Kinked or Separated Casing: The combination of compressive force and eccentric loading (due to snaking in enlarged diameter boreholes) can produce strong bending moments in the casing. In some cases, this bending moment has caused snap-together joints to fail where the glue-and-rivet joints do not.

Depth Errors: In snaked casing, slight changes or errors in the positioning of the probe will produce reading errors – the larger the curvature, the larger the error. For example, if the change of inclination between adjacent reading increments is two degrees, and the probe is positioned 25 mm from the correct depth, the resulting error in displacement would be 1 mm.

Better Ways to Counter Buoyancy

- Suspend a steel pipe or drill rods inside the casing. The bottom of the pipe should be just above the bottom cap or resting on the bottom cap.
- Pre-install an anchor at the bottom of the casing
- Pre-attach a weight to the bottom of the casing
- Grout the borehole in two stages.

Steel Pipe

Suspend a steel pipe inside the casing about an inch from the bottom cap. This ensures that the pipe remains straight and avoids resting the full weight of the pipe on the bottom cap. As the casing rises to meet the pipe, the down force of the pipe is activated to keep the casing in place.

The pipe can also be placed inside the casing to rest on the bottom. This allows the drill rig to be moved to another location, but requires that the bottom cap be reinforced. Also, there will be some curvature in the pipe.

If you use a grout pipe, be sure to flush any grout from it. This method can also be used with grout valves, particularly the gasket-type valve. The quick-connect valve may be opened accidentally unless a straddling adapter is fabricated.

The main disadvantage of this method is that the drill rig must remain on site or return to the site to retrieve the pipe (at least 12 hours after grouting).

Pre-Install an Anchor	Simple prong anchors or packer types have been used. Slope Indicator has produced several prototypes of such anchors. Different soils may require different types of anchor.
Pre-Attach Weight	This method requires a weight, a safety line to prevent casing from sinking, a borehole drilled deeper to accommodate the weight, and calculation of the uplift force. It is best used in shallow boreholes.
Stage Grouting	<p>The uplift force of grout varies with the height of the grout column. If the column is short, the uplift force is low and the casing can be held in place by its own weight or with very little down-force applied from the top. When the grout sets, the bottom cap is isolated from the column of grout and there is no surface for the uplift force to act on.</p> <p>No more than two or three meters to 3 m need to be grouted in the first stage. If the normal bentonite/cement grout is used it needs to set for at least 12 hours before second-stage grouting. Avoid use of a quick-set grout, since the heat of hydration could melt and deform the plastic.</p> <p>The two stages can be placed via an outside tremie pipe. Alternatively the first stage can be placed before lowering the casing, provided that all is done efficiently so that there is no chance of the grout setting prematurely.</p> <p>If grout valve method is used, first stage grouting can be done through the valve, and then the valve is abandoned. An outside tremie pipe for the second stage is lowered with the casing, with its bottom at the level planned for the top of the first stage. After first stage grouting, the excess is flushed out via the tremie pipe, and then this is raised until the first stage has set.</p>