

What is Air Content Loss in Pumping?

Increasingly, specifiers are testing concrete at the discharge end of concrete pumps and, in some cases, finding air contents much lower than that in samples tested at the end of the chute. It is normal to find 0.5 to 1.0 % less air at the pump discharge. However, under certain circumstances when long boom pumps have the boom in an orientation with a long, near vertical downward section of pipe, the air content at the discharge may be less than half of the concrete going into the pump hopper.

When the boom is upward or horizontal, except for a 3.7 m section of rubber hose, there generally is no significant loss of air. There is some controversy over how frequently air loss is a problem in pumped concrete. Certainly, it doesn't occur every time, or even most times. However, it does occur often enough to be considered seriously until better solutions are developed.



Example of pumping concrete

What Causes Air Loss?

There are several mechanisms involved, but air loss will occur if the weight of concrete in a vertical or near vertical downward pipe is sufficient to overcome frictional resistance and let a slug of concrete slide down the pipe. One part of the theory is that when the concrete slides down the pipe, it develops a vacuum

which greatly expands the air bubbles; and when they hit an elbow in the boom or a horizontal surface, the bubbles collapse.

Naturally, the transition from several hundred MPa of pressure in the line to a near vacuum condition may make matters worse. Most field experience suggests that air loss is greatest with rich, flowable mixes which slide down easier; however, air loss has also been experienced under different conditions as well.

How to Prevent Air Loss?

To minimize air loss, prevent concrete from sliding down the line under its own weight. Whenever possible, avoid vertical or steep downward boom sections. Be cautious with high-slump mixes, particularly those with high cement content or containing silica fume. Steady pumping may help somewhat but usually will not solve most air loss problems.

Techniques:

- a. Insert four 90-degree elbows just before the rubber hose (ensure pipe clamps meet all safety requirements). This helps but is not a perfect solution.
- b. Use a slide gate at the end of the rubber hose to restrict discharge and provide resistance.
- c. Use a 1.8 m diameter loop in the rubber hose with an extra section of hose; this is reported to be more effective than (a) or (b).
- d. Lay 3.5–6.0 m of hose horizontally on deck pours. This does not work for columns or walls and requires extra labor.
- e. Reduce the rubber hose size from 125 mm to 100 mm. A transition pipe may be needed to avoid blockages.

What Precautions Can be Made?

The following are precautions to avoid air loss while pumping.

Air Content Loss in Pumped Concrete

- a. Plan alternative pump locations before the pour and decide what actions will be taken if air loss occurs. Be prepared to test air content frequently.
- b. Sampling from the end of a pump line can be difficult. Always wear proper personal protective equipment and never sample the initial concrete through the pump line.
- c. Sample the first load on the job after pumping 4–5 m³. Temper it to the maximum permissible slump. Swing the boom over near the pump to get the maximum length of vertical downward pipe and drop the sample into a wheelbarrow. If air is lost, take precautions and sample at the point of placement.
- d. If air loss occurs, do not try to solve the problem by increasing the air content delivered to the pump beyond the upper specification limit. High air content concrete with low strength could, or almost certainly will, be placed in the structure if boom angles are reduced or slightly lower slump concrete is pumped.

Three Rules to Consider:

1. Expect some air loss when pumping but treat large drops as a warning sign especially with long or steep downward boom sections
2. Control the pumping setup to prevent concrete from sliding down the line which means avoiding steep downward runs and adding resistance with loops, elbows or smaller hose where needed
3. Never try to fix air loss by sending higher air concrete to the pump, since this risks placing concrete that is out of spec and too low in strength

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