

Concrete in Practice

What, why & how?



CIP 21 - Loss of Air Content in Pumped Concrete

WHAT is Air Loss in Pumping?

Increasingly, specifiers are requiring concrete to be tested for air content at the discharge end of concrete pumps at the point of placement in the concrete structure. In some cases it is observed that air contents are much lower than that in samples tested at discharge from the truck chute. It is normal to find a loss of about 0.5 to 1.0 percent air as concrete is conveyed through a pump. However, with long boom pumps have the boom in an orientation with a long, near vertical downward section of pipe, the air content at discharge may be less than half of that of the concrete going into the pump hopper. When the boom is upward or horizontal, or if there is a 12-ft (3.6-m) section of rubber hose placed horizontally at the discharge end, there generally is no significant loss of air. Certainly, air loss through a pump doesn't occur every time. However, it does occur often enough to be considered seriously until better solutions are developed.

WHY is Air Lost?

There are several mechanisms involved, but air loss will occur if the weight of concrete in a vertical downward section of pipe is sufficient to overcome frictional resistance to allow a slug of concrete to slide down the pipe. As the slug of concrete slides down the pipe, it develops a vacuum on the upper end that greatly expands the size of the air bubbles; and when the concrete hits an elbow in the boom or a horizontal surface, the bubbles collapse. The effect of this impact can be demonstrated by dropping concrete 15 or 20 ft (4.5 to 6 m). The loss of air can be further exacerbated due to the transition from a high pressure in the pump to a near vacuum condition in the pump line.

Most field experience suggests that air loss is greatest with high cement content, flowable concrete mixtures which slide down easier; however, air loss has also been experienced in mixtures with a moderate cement factor at about 500 lb/yd³ (300 kg/m³) and moderate

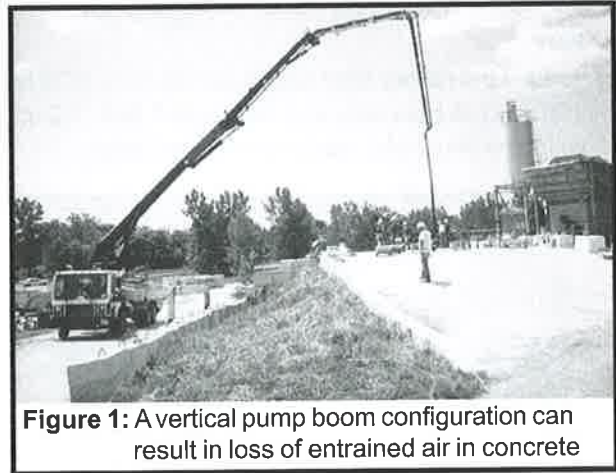


Figure 1: A vertical pump boom configuration can result in loss of entrained air in concrete

slump. Loss of air content in pumped concrete will not reduce freeze thaw durability of concrete as long as the air void system is not compromised.

The air loss due to pumping can be determined by measuring the air content of samples discharged from the ready mixed concrete truck and at discharge from the pump. Testing concrete as discharged from the pump alongside the pump will require the most critical boom configuration that will cause the highest loss of air content. If concrete at a higher air content, to compensate for this loss, is placed at a less critical, more horizontal boom configuration, the concrete placed in the structure will be at a high air content and lower strength.

HOW to Prevent Air Loss?

To minimize the loss of air of concrete through a pump procedures should attempt to keep concrete from sliding down the line under its own weight. Ensure that there is a continuous stream of concrete within the pump and inside the pumpline. Where possible, avoid vertical or steep downward boom sections. Be cautious with high slump, and particularly with high cementitious content mixtures. Steady, moderately rapid pumping may help somewhat to minimize air loss, but will not solve most problems.