

Proper Selection of Equipment and Nozzle for ACI Shotcrete Nozzleman Certification

By Raymond C. Schallom III and Marc Jolin

Since the beginning of the ACI Shotcrete Nozzleman Certification program in 2001, a number of Examiners have encountered owners or nozzlemen requesting use of equipment and nozzle setups meant for low-volume/low-velocity applications such as fireproofing, plaster, stucco work, or even spin casting of sewer pipes (generally vertical layers of 1 in. [25 mm] or less). Unfortunately, none of these setups meet the true definition of shotcrete, which is “mortar or concrete pneumatically projected at high velocity onto a surface”; the **high velocity** component of this definition is critical and essential in providing superior bond characteristics and increased density, strength, durability, and toughness typical of high-quality structural concrete. All these qualities are highly desirable in the wide variety of shotcrete applications, including ground support, concrete repair, swimming pools, soil nail walls, structural walls, and lining applications. In North America, shotcrete is sometimes referred to as “pneumatically applied concrete,” whereas in Europe it is more commonly referred to as “sprayed concrete.”

In terms of equipment, the capacity of the air compressor controls the acceleration of shotcrete material to a high velocity as it exits the nozzle. The high velocity is essential to drive the fresh,

wet material around the reinforcement and into the receiving surface (a minimum of 185 to 365 ft³/min [5.25 to 10.5 m³/min] if using a blowpipe for wet-mix and 600 to 750 ft³/min [17 to 21 m³/min] for dry-mix). The high velocity provided by an adequate flow rate of compressed air is an essential element needed to provide the excellent material properties found in shotcrete. In contrast, plaster and stucco nozzles do not supply enough air volume or ft³/min (m³/min) (typically only using a 1/4 to 1/2 in. [6.5 to 13 mm] supply air hose up to the nozzle) to accelerate the material adequately enough to provide high compaction or force it around the reinforcement. These nozzles were designed to apply a fine mortar material only (not concrete materials with 3/8 in. [10 mm] aggregate or fiber-reinforced concrete mixtures) at 6 in. (150 mm) or less from the surface in a splatter pattern when adjusting the 0.25 in. [6.5 mm] air nozzle. Shotcrete reference document CP-60(09), “Craftsman Workbook for ACI Certification of Shotcrete Nozzleman,” clearly states that the nozzle with adequate material velocity should be between 2 and 4 ft (0.6 and 1.2 m) using a 3/4 in. (20 mm) delivery air hose for wet-mix shotcrete and 2 in. (50 mm) delivery air hose for dry-mix shotcrete.

The nozzle setups shown here *are not recognized* as shotcrete nozzles by ACI. They all have a 1/4 to 1/2 in. (6.5 to 13 mm) air lines into the nozzle.



These low-velocity spray nozzles were designed for the type of applications noted previously that need low ft³/min to splatter the material for thin applications that do not have reinforcement to shoot around. The spin casting head is designed to fling the grout-type material onto the pipe surface, again, with no reinforcement. None of these nozzles can handle a 3/8 in. (10 mm) coarse aggregate concrete mixture with or without fibers of any type

Technical Tip

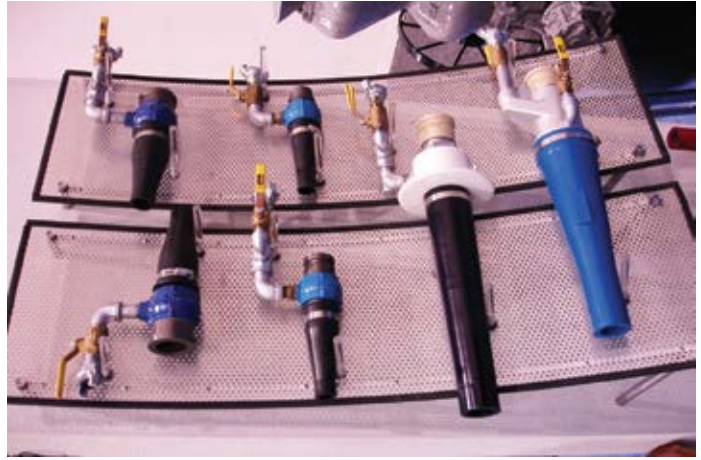
The nozzle setups shown here *are recognized* as shotcrete nozzles for wet- and dry-mix applications by ACI.

Dry shotcrete nozzles



The dry-mix process nozzles are designed to handle the high material velocity and produce adequate spray patterns

Wet shotcrete nozzles

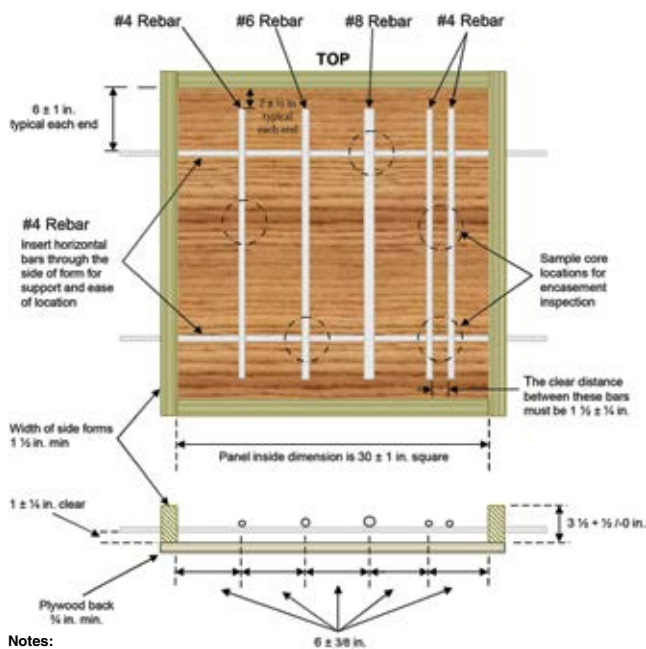


All wet shotcrete nozzles have a minimum of a 3/4 in. (20 mm) air line running into them for maximum material velocity

There are some who will try to convince this reading audience that low-volume, low-velocity mortar spraying is considered shotcrete spraying. Countless trial-and-error attempts have been tried throughout the years, ending up with the same result: failure. The low-volume sprayed mixtures would build up on the face of the bar and not wrap behind it, leaving voids behind the reinforcement. Spraying overhead was a bigger disaster because the material did not pack into

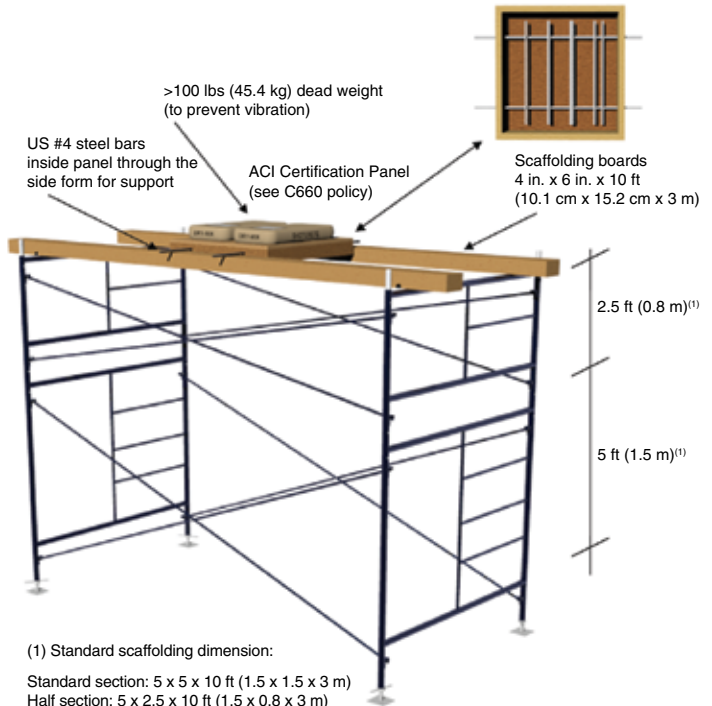
the surface or around the bar, producing weaker bond and leaving voids, resulting in fallouts to the ground. ASA is an excellent source for archived articles that have useful information on obtaining the correct nozzles, equipment, and compressors for specific types of shotcrete projects. Many of these articles are listed for reference reading at the end of this article.

Properly shooting the standard ACI Shotcrete Nozzlemaster Certification Test Panel for vertical



- Notes:**
1. Core diameter 4 in. (nominal)
 2. Core locations may be adjusted slightly at the discretion of the examiner, so long as they remain along the axis of the reinforcing bars, and at least three bar intersections are covered

Typical ACI Shotcrete Nozzlemaster Certification Test Panel



- (1) Standard scaffolding dimension:
 Standard section: 5 x 5 x 10 ft (1.5 x 1.5 x 3 m)
 Half section: 5 x 2.5 x 10 ft (1.5 x 0.8 x 3 m)

Typical ACI overhead Test Panel setup

and overhead orientation is difficult if you do not have the correct shotcrete nozzle, correct ft³/min (m³/min), and proper delivery equipment. Many nozzle men have learned this the hard way on job sites or during ACI Shotcrete Nozzleman Certification sessions. Shooting a coarser mixture helps keep the reinforcing bars clean when shooting through the reinforcing steel.

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