SECTION 583 - SHOTCRETE

General
The most important aspect of shotcrete is surface preparation. Shotcrete application is very dependent on three main factors: materials, equipment, and skill of the applicator. Only pre-approved materials are allowed for use in shotcrete. The best results are obtained from an experienced applicator using good equipment. Shotcrete characteristics (compressive strength, bond, durability, etc.) are significantly affected by application. Therefore, it is very important to be familiar with correct shotcrete practice to monitor the work.

The most comprehensive, up-to-date information, with detailed instructions, descriptions and problem solving suggestions, is included in A.C.I. 506R-90 “Guide to Shotcrete”. Copies of this manual are available through the Regional Materials Engineer and the Materials Bureau in Albany.

583-1.02 Definitions
There are two approved methods of shotcrete application: Dry Mix and Wet Mix, with Dry Mix being predominant. If Wet Mix is proposed for use, please contact the Materials Bureau in Albany at (518) 457-5956 for air and slump information, (never added to our Specification Books), or for other shotcrete related matters.

583-2 Materials
The addition of small quantities of Approved List pozzolans may also be approved by the Materials Bureau on a project by project basis, either individually or as blended cement. Microsilica enhances adhesion, especially for overhead work, and results in less waste. Fly ash and microsilica reduce permeability and shrinkage by making shotcrete denser.

Prebagged Shotcrete Material
If this material is proposed for use, please call the Materials Bureau in Albany at (518) 457-5956 as soon as possible, and submit a formal request.

583-2.02 Qualification Test
Qualification test panels may be cut or broken such that the interior of the panel and its reinforcement is exposed. Usually, the best face to examine is a clean, fractured one. Things to look for inside the panel are:

A. Voids: A prime concern is voids behind reinforcement. This is very detrimental and requires a re-evaluation of the placement procedure and applicator technique. Increased care, closer proximity and/or the use of a blowpipe, should rectify this problem.

Scattered voids are also a problem when numerous, large, or interconnected. This can be caused by overly dry material, poor equipment or applicator error.

B. Dry Pockets and Sand Lenses (Streaking): These problems are predominantly encountered in the Dry Mix procedure. A layered and streaked appearance could mean problems with the moisture content of the material (See C.I.M. Section 583-3.02, Preparation of Material), or operation of the equipment. If the equipment is inadequate, material propelled to the nozzle may not be a smooth, continuous flow, and slugging may occur in the hose. Also, the nozzle chamber should combine the cement and sand mixture with a constant flow of water to produce a uniform spray. The nozzle operator should recognize a too dry or wet spray, and be able to adjust the amount of water added. Work should not proceed until acceptable visual results are obtained. Additional qualification test panels should be requested whenever changes in conditions, personnel, location, equipment, etc. affect the quality of placement.

Also, when unusual shooting circumstances arise, such as shooting at an angle, in tight corners, in narrow slots, etc., have a qualification test panel made to duplicate that shape. After the operator
shoots that panel in circumstances similar to the actual site, remove the sides of the panel to inspect how well the shotcrete filled the panel area. Allow other tries if warranted. Then decide if that work should be done with shotcrete, another material or another method.

583-3.01 Surface Preparation
A. Concrete Structures:
   See C.I.M. Section 582-3.02 Removal of Unsound Concrete.

Wire Fabric Installation (All Locations):
Provide shotcrete as much space and the least impedance to the repair surface as possible. In most cases, position the wire fabric parallel to the finished grade. Minimize lapping and maximize the space between layers. Also, do not utilize more than 1 overlap. Cut away additional layers or make sure the wires line up with each other.

583-3.02 Preparation of Materials
A. General:
   It is very important that sand moisture content be maintained in the 3 to 6% range. If not, the cement may not stick to the sand, and be blown away. A quick test to determine adequate moisture content is to squeeze a ball of damp sand in your hand. If it is too dry, it falls apart. If it retains its shape and leaves no free moisture on your hand, it is okay.

B. Dry Mix Process:
   Wetting agents break down the surface tension of water and thus work as a water reducer. Air entraining agents also act as wetting agents, but in the case of dry mix shotcrete, little or no air is entrained.

C. Wet Mix Process:
   Wetting agents break down the surface tension of water and thus work as a water reducer. Air entraining agents also act as wetting agents, and in the case of wet mix shotcrete, a normal amount of air is entrained in the mixing process, but half or more is lost during the application process.

583-3.03-C. Quality Control
Shotcrete application is an art. A simple suggestion for providing a quick way to monitor shotcrete quality and eliminate problems before proceeding further is as follows:

When test panels are made, or whenever it is felt necessary, have the shotcrete applicator make an additional “sample” (smaller and unformed) on any suitable surface, including firm ground. Break this sample open as soon as practical and inspect it for deficiencies (as defined in C.I.M. Section 583-2.02 Qualification Test above). If problems exist, have the Contractor correct them, and check by having more samples made. When the deficiencies are corrected, have a quality control test panel made for laboratory evaluation.

1. Test Panels:
   All shotcrete quality control test panels sent to the Materials Bureau should arrive at the Laboratory within 14 days from date sampled. Each individual panel needs to be accompanied by one BR 240a form, filled out with the appropriate information as shown in Exhibit 583-A.

2. Test Results:
   At the Laboratory, 50 mm diameter cores will be drilled from the panels, tested for compression, and strengths reported to the Engineer. Additional information on the condition of the shotcrete, such as sand pockets, voids, and laminations, will also be reported with the strength results.

If the Contractor desires, and the Engineer approves, six 50 mm diameter cores may be taken from
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each panel at the job site, under the direct supervision of the Engineer, and packaged for transmittal. The Engineer will fill out a BR 240 form for each set of cores (see test panels above), include it with the cores, and seal each package for transmittal to Albany for testing.

3. Coring:
If interconnected voids are found, the structural element represented by that core is rejected. Interconnected voids are defined the same as for the Qualification Panel; individual, isolated voids less than 25 mm in any direction, as determined by the Engineer.

If coring through in-place reinforcement would jeopardize the design integrity of any structural element, dummy rebars of the same size may be placed in the structure for coring purposes before shotcreting, and their locations carefully marked. One or more of these dummy areas may then be cored, as determined by the Engineer. Make sure that the shotcrete operator uses the same shotcreting shooting procedures everywhere.

Screed Finish - requires that the shotcrete be built up slightly over the guides and allowed to stiffen to the point where screeding will not pull or crack the surface.

Broom Finish. Use a stiff bristle broom and keep it clean.

Flash Coat Finish. Details of this finish are in the A.C.I. Guide To Shotcrete.

583-3.03-E. Curing
Curing compound (or any other type of coating, sealer, etc.) should not be used between lifts or layers because they act as bond breakers. If inadvertently used, it must be totally removed before commencing to shotcrete.

Although shotcrete is a fairly dense, low slump concrete, it is still very susceptible to drying shrinkage due to its small particle size and extensive, exposed surface area. The best cure is a wet cure. Apply all cures quickly.

Reference
A.C.I. 506R-90, Guide to Shotcrete
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<thead>
<tr>
<th>BR 240a Box Number and Title</th>
<th>Appropriate Contents</th>
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<tbody>
<tr>
<td>1) Material - ..................</td>
<td>Shotcrete (Specify Dry or Wet Process)</td>
</tr>
<tr>
<td>2) Item No. - ..................</td>
<td>583</td>
</tr>
<tr>
<td>3) Date Sampled No. - .........</td>
<td>Date Panel Was Shot</td>
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<td>4) Contract No. - ..............</td>
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<tr>
<td>5) Supplier and Location - ..........</td>
<td>Cement Supplier and Location</td>
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<td>6) Quantity in Lot - .............</td>
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<td>7) Lot No. - ..................</td>
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<tr>
<td>8) Manufacturer and Location - ..........</td>
<td>Applicator’s Company Name and Location</td>
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<td>9) Batch No. - .................</td>
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<td>10) Date of Manufacture - .......</td>
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<td>11) Sampled At - ..............</td>
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<tr>
<td>12) Type - ...................</td>
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<td>13) Sampled From - ............</td>
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<td>14) Sampled By - ..............</td>
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<td>15) Contractor and Project Location - ....</td>
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<tr>
<td>16) Additional Info - ..........</td>
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</tbody>
</table>

Aggregate“)

| Sand/Cementitious Material Ratio |
| Additives (Microsilica, Air Entrain., etc.) |
| Shooting Position (Vertical, Overhead or Horizontal) |

Exhibit 583-A