Chapter 6
Concrete Placement

6-1. General

Architectural concrete may be placed by many methods, including face-down for precast work, face-up for both precast and cast-in-place, and the vertical cast-in-place. Equipment for placement consists of a bucket, buggy, chute, belt, and pump. Each requires changes in procedures and precautions for uniform satisfactory results. All equipment should be clean prior to handling architectural concrete. All concrete requires consolidation to properly compact the mortar around any aggregate to be exposed and to prevent rock pockets and diminish surface bugholes. Placement procedures should be kept uniform for uniform results. The proposed method and equipment should be used on the field mockup sample.

6-2. Effect of Equipment Type

a. Bucket. Placement by bucket will tend to be slower than other methods due to the time required to lift and convey the concrete to the point of delivery and the limited amount of concrete for each delivery. If drop chutes are used, additional time will be required. Production of placed concrete is limited and cold joints can occur with high long forms. Generally, this method is becoming rare for architectural concrete except for those mixtures which cannot be handled by pumping.

b. Pumps. Pumping is becoming the most prevalent method of placing concrete. Its advantages for architectural concrete are the ease of placement in difficult-to-reach areas and the ability of placing concrete in the bottom of a form wide enough to receive the hose. The production rate of 38.2-53.5 m^3 (50-70 yd^3) per hour can efficiently supply concrete so that cold joints are not a problem as long as equipment or delivery schedule problems do not occur. Pumping of concrete may require changes in proportions of concrete mixtures. This should be limited to a 2- to 3-percent increase in sand and a similar decrease in percentage of coarse aggregate. Such changes should not be initiated after commencing the placement of concrete for exposed aggregate concrete, as uniformity of the surfaces will be affected. If the approved job-site mockup had a different concrete mixture, the approved change in concrete proportions should be followed by construction of a new job-site mockup prior to production use of the new concrete mixture.

c. Belt conveyors. Belting is rarely used for conveying architectural concrete. On elevated structures, such belting conveys the concrete to a hopper for reconsolidation. Due to restricted space for additional belts, buggies are used to convey the concrete to the vertical forming. For architectural concrete flatwork on grade, belt conveyors may be used economically.

d. Chute. For flatwork and low walls, the chuting of concrete from the ready-mix truck remains the most feasible. If the aggregate has been preplaced, care must be exercised to prevent displacement of the aggregate by the chuted concrete. A slow flow, a low drop, and deflection by a hand shovel is the best method to prevent this. Where Styrofoam or ABS forming is used workmen should be cautioned not to damage the forming by walking within the formed area.

6-3. Placement

a. Form protection. Splattering of mortar on the form must be prevented from occurring as this creates lenses of hardened mortar on the surfaces which are exposed and difficult or impossible to remove during sandblasting. During hot weather, this splatter tends to harden quickly and does not recombine with the concrete reaching that level at a later time. Prevention has included thin metal or polyethylene sheets against the form face which are pulled up as the concrete level rises.

b. Height of layers. Most specifications require layers to be held to heights less than 0.6 m (24 in.). However, greater layer heights up to 1.2 m (4 ft) may not be a problem when concrete is properly consolidated, except under the following conditions:

(1) Gap-graded aggregate mixtures are placed.

(2) Mixtures containing high percentages of coarse aggregate in combination with low slumps are placed. In both of these cases, the layers must be kept thin. If

excessive bugholes are problems, greater layer heights with adequate consolidation may diminish this problem. When superplasticizers are used to develop flowing concrete, layers of 2 m (6-1/2 ft) have been used successfully for architectural concrete. Any proposed placing procedure should be tried out on field mockup samples or a wall which is not architectural or will not be left exposed in the complete building.

c. Timing. Timing of the placement depends on scheduling of the concrete, temperature of the concrete, and the method of placement. If problems are occurring, some changes in procedure must be made. Any change should be tried in some unimportant area to determine any change in the architectural appearance. Uniform placement procedures are key to a uniform product.

6-4. Consolidation

The technology of consolidation can be found in the standards produced by ACI Committee 309 (ACI 1990a, 1992b, 1993, 1996). Additional requirements for architectural concrete are listed below.

a. Internal vibration. The main goals of internal vibration are to thoroughly consolidate the mortar around the reinforcing steel and aggregate and to force the face air bubbles upward toward the surface. Consolidation techniques are described in Engineer Manual 1110-2-2000. Time for vibration can be determined on the field mockup when the proposed mix is placed. For thick sections, consideration must be given to using high-amplitude and high-frequency vibrators in tandem. In no case should the vibrators be used any closer to the form face than 50 mm (2 in.) for as-cast finishes and 75 mm (3 in.) for exposed aggregate finishes. For harsh mixes, the vibration should cease when the mortar just covers the rock to prevent a dark lense upon exposure. The rock has a tendency to lock up after vibration and it may be difficult to penetrate from the next lift. Generally, internal vibration is not used for precast flatwork except around hardware to be encased in concrete.

b. External vibration. External vibration is used by most precast plants for consolidation of architectural flatwork. The equipment is usually air operated and attached to metal framing supporting the concrete formwork. Formwork must be reinforced for the external forces. This vibration has been found to be beneficial for removal of surface air voids. Care must be exercised with rib type ABS liners used on vertical forming, as the form pressures may be too high and collapse the ribs.

c. Revibration. A second delayed vibration after most of the bleeding has taken place, but before initial set has begun, will help to further densify the concrete and remove additional bugholes from the face of the concrete. Revibration of the top lift will prevent the darkening of the last lift and lessen the large amount of air bugholes normally found there. Sufficient concrete should be available for releveling of the top after revibration. Revibration can be beneficial as long as the vibrator still penetrates by its own weight.