Chapter 3
Forms

3-1. Selection

a. Materials and economics. Selection of forms for architectural concrete is not only determined by the texture desired but by the number of expected reuses, form installation, form removal, and use of form ties. Architectural forming can be constructed entirely of wood, have thin plastic liners with wood backing, of fiberglass reinforced plastic, metal, or molds of plaster or concrete. Precast concrete forms may be combinations of materials in order to cast required panels of intricate design.

b. Cost comparison. The following form materials are listed for cost comparison, starting with the lowest in cost first:

(l) Wood.

(a) Rough board.

(b) Plywood.

(c) Medium-density coated plywood.

(d) High-density coated plywood.

(2) Plastic liner.

(a) Styrofoam.

(b) ABS (Rigid extruded plastic).

(c) Elastomeric (rubbery flexible plastic).

(d) Thin flexible vinyl liner.

(3) Fiberglass-reinforced plastic.

(4) Metal forms.

(5) Concrete molds or forms.

(6) Plaster molds.

c. Expected life. Assuming proper care, the increasing cost of forming has the companion advantage of greater number of reuses. Grade B-B plywood can be used comfortably four times, while the high-density plastic-coated plywood will last for twenty reuses. The plastic liners start with Styrofoam for one use to the Elastomeric capable of fifty or more reuses. The cost of the liner is in addition to the wood backing. Generally, the size of the structure and its configuration will determine the number of reuses. Steel and concrete molds or forms have unlimited reuse. Plaster molds are used for special intricate figures and have limited reuse.

d. Patterns and textures. The architect's selection of the pattern or texture may determine the type of form material. A rough board finish would, generally, require rough board forming as the simulation produced by some plastic form liner needs further treatment to remove the sheen. A sandblasted texture would require that high-density forming be used when reuse is planned. This would rule out Grade B-B plywood but allow choice of steel, or vinyl plastic sheet lining. Medium-density forming for sandblasted textures is satisfactory for one use only. The cost of forming can be increased by the design spacing of form ties. Most as-cast finishes can be achieved with various types of form materials. Selection becomes an economic factor as long as the final product meets the job requirements. An example of an as-cast finish can be found in Figure 3-1 and a textured finish obtained by sandblasting away the mortar, in Figure 3-2.

3-2. Construction

a. Tolerances. Tolerances are specified in “Mass oncrete” (U.S. Army Corps of Engineers 1992) for mass concrete structures and hydraulic structures and outlined in ACI 117 (ACI 1990b) for other structures. Deflection of the plywood between supports should be limited, per recommendations of ACI 303R (ACI 1974), to 0.0025 of the span in order to prevent “pillowing” on plane surfaces.

b. Form liners. Irregularities can occur from improper fastening of form liners. (ABS) acrylonitrile-butadiene-styrene liners should be attached with 4.76-mm (3/16-in.) staples on approximately 75-mm (3-in.) centers. Elastomeric liners should be entirely glued to the form backing, as they are susceptible to sag

Figure 3-1. Example of an as-cast texture

Figure 3-2. Textured finish by sandblasting

when fastened only with nails or staples. The fiberglass liners should be fastened with 19-mm (3/4-in.)-long screws on 1-ft centers. Since plastic form liners expand with temperature, they should be attached under warm conditions to prevent bulging during rising temperatures. Application of cold water prior to concrete placement may eliminate bulging of plastic liners which have not permanently set.

c. Joints. In order to obtain acceptable architectural concrete, specifications must require that form joints be sealed against mortar leakage by use of non-absorbent tapes, sealants, or form coverings. Failure to require this will result in dark lines or sand streaks at most form joints as a plain butt joint is not sufficiently mortar-tight during vibration of the concrete. Tape may be used on the surface when additional treatment such as sandblasting is deep enough to remove the slight depression left by the tape. When high-density forming is used, additional glue should be used under and over the tape to prevent slippage and wrinkling. Butt joint compressible tapes should be securely fastened to prevent blowout or movement into the concrete during vibration. Sealants can be a silicone or a nonabsorbent plastic filler, which will dry firm but still be resilient. This protection must be renewed with each reuse. When further treatment is scheduled, such as sandblasting, application of glue over the sealed form joint provides additional insurance against leakage on subsequent placements. Thin resilient tape should be placed behind all ABS and fiberglass liner joints to prevent leakage. Elastomeric liners have sloping edges which seal the liner against leakage. Thin (1.3- to 1.5-mm (0.050- to 0.060-in.)) vinyl plastic form liners have been experimentally used in Saudi Arabia and California. The 0.9-m (3-ft)-wide liner comes in 17- to 20-m (50- to 60-ft) rolls and must be fully glued to the wood backing. Figure 3-3 illustrates choices in elastomeric form liners and Figure 3-4 shows an American use of the thin sheet plastic form liner. Its use eliminates the need for form panel joint sealing as the mucilage type glue used for the liner squeezes out and effectively seals the liner joints. The final result is a faint fine line which disappears with sandblasting.

d. Bolts and ties. Spacing of tie holes may be a design feature. Size of the tie is dependent on the spacing and the expected form pressures due to concrete placement procedures. To prevent blemishes on the architectural surfaces, measures are needed to prevent leakage. Elastomeric and the thin vinyl liners are self-sealing around the tie cones. All other types of forming systems require additional caulking or resilient tape to be used around the cones or bolts.

3-3. Release Agents

There are numerous proprietary form release agents on the market and trial use for approval is required on the field mockup to determine its effect on the architectural concrete surface. Any trial should be made with the forming proposed for use, as that may also affect the result. Best results are obtained when a form release agent is applied with a spread spray that produces a uniform thin film. Any runs should be wiped thin with cloth saturated in the form release agent. The form should be clean and dry for application. Any partially full drum of release agent which has been standing for any length of time should be checked for any deleterious effect on the surface due to concentration of its constituents.

3-4. Reuse

If allowed by the building design, the architectural forming materials result in a higher initial cost than Grade B-B plywood forming and reuse of the forming is expected, for maximum economy. To prevent contrasting color or texture caused by reuse of the forming, the forms must be handled with care during removal, storage, and reinstallation. Any defects must be repaired so that the defect is not transferred to the surface of the next placement or the defect removed and replaced with new forming. Formwork panels are to be stored flat. High-density, plastic-coated formwork and plastic-lined forming will check and deteriorate if stored in the sunlight. Metal forming cannot be leaned against the structure as this causes warping. All formwork surfaces to be reused require cleaning and wiping with a cloth saturated in release agent. All plastic liners, except the elastomeric, require the use of a release agent for every use to prevent wear of the liner from affecting the uniformity of the surfaces between different placements. The elastomeric liner provides its own type of releasing agent, but does require careful cleaning by brushing and handling during removal and installation.

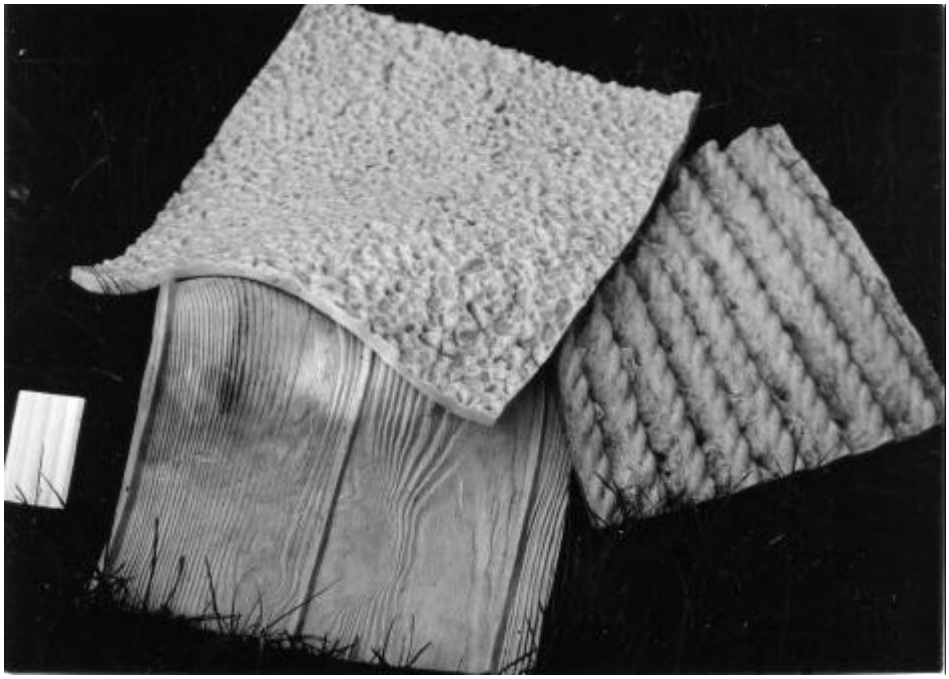

Figure 3-3. Samples of textures available with elastrometric lining

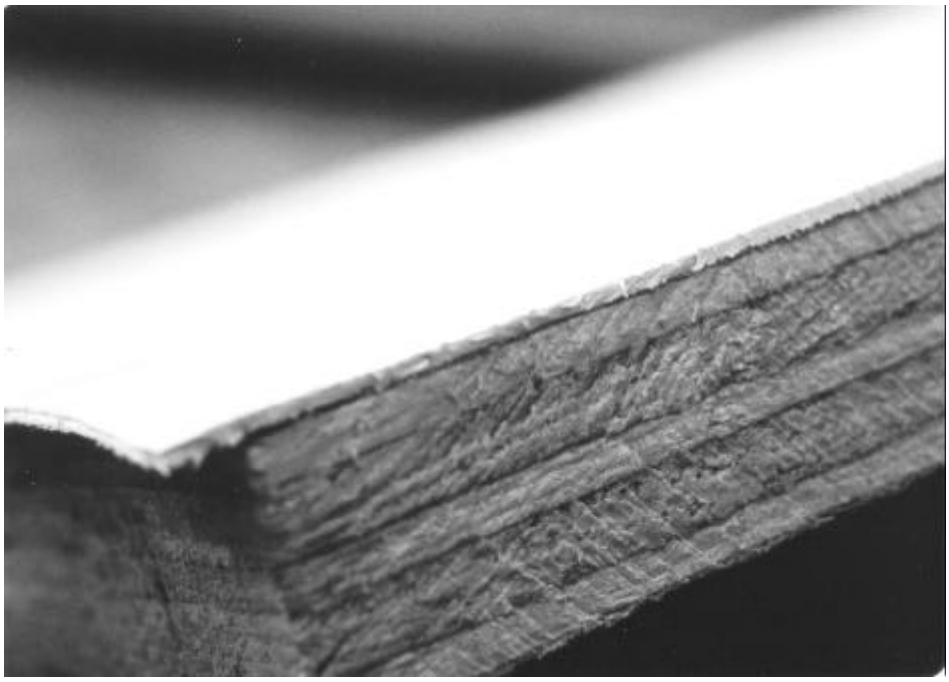

Figure 3-4. New development of vinyl lining for forming