

Achieving super-smooth cast-in-place walls

A Texas contractor used an innovative method to achieve fair-faced concrete walls for its new headquarters. Pumping a superplasticiser mix from the bottom has produced beautiful results in architectural concrete.

Phil Morley, for AUI Contractors, Fort Worth, Texas, USA

In early 2003, AUI Contractors of Fort Worth, Texas was bursting at the seams. Business was booming, with no end in sight, so the owners made the decision to construct a new corporate headquarters. They purchased land in a highly visible location on an interstate highway in north Fort Worth. It was a great opportunity to let the new corporate facility be a showcase for the quality of work the company produces.

"We wanted the building to display, wherever possible, the work that AUI performs with its own crews," says Doug Alumbaugh, AUI's president. "That is why there is so much exposed structural concrete and various flat-work concrete finishes. Our vision was that the building be compartmentalised for good workflow, yet feel open to support our team-work culture."

Early in the design process, the owners decided that the building should make a bold statement through the use of unfinished, super-smooth concrete walls. Tilt-up panels were rejected because they simply didn't offer the level of finish AUI sought for its new home. Potentially, cast-in-place walls offered the solution it was seeking, but the cast-in-place process has numerous challenges of its own.

Challenges of the concrete pour

The largest walls in the project are more than 23ft (7m) tall and 74ft (22.5m) long. Pouring concrete into formwork from that height commonly leads to a certain amount of separation of the concrete from the aggregate, leaving weak spots in the wall.

Additionally, air is trapped in pockets in the concrete. This problem can be mitigated to some extent through the use of internal concrete vibrators, but over-vibration can lead to segregation of the aggregate and excessive bleeding. The aggregate segregation is a problem because vibration causes the heavier components (coarse aggregate) to drop, while allowing the lighter elements (fine aggregate and sand) to rise, creating a layered effect that is visible on exposed concrete surfaces.

Six test panels were poured to experiment with formwork surfaces, mix design and tie spacing, but none of the finished products



Figure 1 top: Unloading preassembled formwork.

Figure 2 above: Erecting one side of wall formwork with routed joints.

met the high standards of ultra-smooth finish and tie-hole edge detail that AUI was seeking. It became clear that the construction team would have to take a different approach if they were going to achieve the super-flat, super-smooth exposed concrete finish desired by the owners.

The team decided to host a meeting that included the owner/contractor (AUI Contractors), the architect/structural engineer (Gideon Toal Architects), the concrete formwork system supplier (PERI Formwork Systems), the concrete supplier (Beall Concrete Enterprises), the concrete additive supplier (Admix Supplier), and the concrete pumping company (Central Concrete

Pumping). Various suggestions were put forth and considered. Ultimately, the team concluded that the best outcome would be produced by using self-compacting concrete, pumping the concrete from the bottom while avoiding any vibratory action. This approach, AUI believed, would virtually eliminate problems with aggregate segregation and air entrapment, which studies have shown can amount to as much as 20% of total volume before consolidation.

The next step was to design the formwork to withstand the pressures of 23ft (7m) of still-fluid concrete without deflecting or blowing out. Each foot (300mm) of wall height can add as much as an additional 150 pounds

Photos: AUI Contractors, Inc.



Figures 3–6 clockwise from top left: Erecting second side of wall formwork; Port for pumping concrete from bottom; Pumping concrete into wall formwork from bottom; Splitting concrete flow to two ports.

per square foot (7.2kN/m²) of pressure on the formwork at the bottom. A 23ft (7m) wall can potentially produce a remarkable 3450 pounds per square foot (165kN/m²) of pressure at the base. Special attention was paid to every joint and opening to avoid leakage.

Fifteen-layer WISA plywood panels made by UPM of Finland were selected for the facing because of their ultra-smooth finish and excellent strength. WISA is an engineered plywood product made by bonding multiple layers of white birch under extreme pressure and then coating the assembly with a super-smooth film of phenolic resin.

Each 1/2" × 4' × 8' (13mm × 1.2m × 2.4m) WISA panel was attached to a 3/4" (19mm) BB plywood subpanel by back-screwing through the subpanel to maintain the smooth face of the WISA panel. All four edges of each WISA panel were carefully routed with a 1/4" (6mm) concave bit so that the panels, when assembled, would produce in the finished wall a

convex half-moon appearance at each form joint. A number of these panels were made up into form assemblies using PERI Formwork Systems' Vario G24 formwork system. Vario G24 consists of vertical wood lattice girders backed up by double-channel steel walers. The plywood panels were secured to the wood girders, then hoisted into position on the spread footing and braced.

Vertical and horizontal reinforcing steel was attached to the reinforcement already stubbed out in the spread footings. The reinforcing steel frame was erected the length and height of the wall, with additional reinforcement at the corners and all openings. To hold the form panels precisely 6" (150mm), or in a few cases 8" (200mm), apart before and during the pour, the DK system of two reusable sealing cones and an embedded spacer tube was used. These custom-made PVC sleeves and cones for the tie rods were placed at 2' (610mm) on centre

horizontally and vertically. Then the opposing wall form system was hoisted into place and braced. 5/8" (16mm) diameter hi-tensile steel threaded rods were inserted through the sleeves and steel wing-nuts with capture plates were screwed down tight against the steel walers.

Once the formwork was properly erected and braced, the self-compacting concrete was carefully pumped into the formwork from the bottom, while workers kept a close eye out for leakage or deflection. After the walls had cured for a minimum of three days, the formwork and ties were removed, cleaned, and reused, and the walls were immediately braced until all of the structural work was completed. Later, the tie holes were patched, but a perfectly formed indentation remains exposed every 2' (610mm) on centre in the walls, framed by a rectangular grid of half-moon concrete ridges where the formwork panels came together.

The finished project serves as a great workspace for the company's employees and as a showplace for the firm's work. The ultra-smooth, stark, concrete panels offer an inviting counterpoint to the many attractive finishes found throughout the interior. Each of the three conference rooms and many of the other public spaces showcase different materials: granite and laminate countertops; carpet, wood, slate and stained concrete floors; concrete, painted drywall, and red oak panelled walls; even a rubberised floor in the fitness room.

When clients are given a tour, they can see exactly how their own project might look using similar materials. "With AUI's in-house capabilities of self-performing concrete projects and our significant experience in this field, we wanted our corporate headquarters to showcase our ability to exceed a client's expectations," says Tony Rader, AUI's director of sales and marketing. "The response from the architectural and engineering community in using this architectural-quality concrete installation method, once they have seen the end product, has been extremely well received." ■



Figure 7: Completed exterior – AUI Contractors' corporate HQ.



Figure 8: Completed interior – AUI Contractors' corporate HQ.