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Landmark Structures – Buda, TX Tank

CB&I - Greensboro N.C., Tank

Architectural Concrete Quality Assurance

THIS SUBMITTAL IS OFFERED AS IMPORTANT INFORMATION TO THE COMPOSITE TANK PURCHASER AND SPECIFIER. IT IS MEANT TO BRIEFLY DESCRIBE THE REQUIREMENT FOR, AND THE PROCEDURES FOLLOWED, IN ARCHITECTURAL CONCRETE CONTROL.

What is Architectural Concrete?

The composite tank is considered by the marketplace to be the equal or superior tank style as compared to all steel tanks. For this preference to be valid, the concrete support structure must meet both structural and architectural standards. The structural standard (concrete strength, dimensional tolerances, etc.) is easily defined and measured. The architectural standard, or aesthetics, has been well established in the industry but is harder to measure.

Architectural concrete is defined by uniform surface color, absence of surface defects, and an alignment of the concrete surfaces.

Four ft. form – Example Result

Eight ft. form - Typical Result

Achieving Architectural Concrete

Achieving the best architectural result lies in three factors – the concrete mix design, the experience and skill of the contractor and the forming systems. It is the last factor – the forming systems – that has the greatest impact and is also the easiest to affect and control.

The composite tank industry has evolved to two very different schools of thought in this area. The primary composite tank contractors, Landmark and CB&I, have been involved in the industry since its inception, continue to believe that architectural quality concrete is achievable at little to no additional cost and continue to use proven concreting practices that obtain the results that are the industry accepted standard.

Other contractors would suggest that the concrete support wall should be judged on its structural adequacy only, that architectural quality concrete is not important and have seemingly invested in concreting systems to support this view.

The difference in concrete quality that results from the four-foot (silo) forming system as compared to the architectural forming system is obvious.

Not as obvious is how the characteristics of each forming system drive these results.

This article describes the characteristics of the form systems and their impact on concrete finish and aesthetics. This information is derived from architectural concrete specifications and experience gained from over 10,000 wall placements.

To obtain uniform concrete color and finish, an architectural form system is designed to address grout leakage, placement rate, procedures and strict dimensional tolerance.

Grout Leakage

Placement Rate

Dimensional Tolerance

Grout Leakage

Improper joint detail allows moisture loss that produces undesirable localized shade variations, rough and broken corners, rock pockets and honeycomb. Moisture loss is a primary factor affecting uniform color.

Placement Rate

Extended pour times will result in partial set, multiple pour lines and unsightly shade variation. Proper techniques must place concrete directly between reinforcement with drop chutes to eliminate form splatter with the resulting surface variations. The concrete must be placed quickly and without interruption to the top of the form to eliminate pour lines and achieve consistent, uniform results.

Dimensional Tolerance

Finally, in addition to producing a pleasing overall effect, the form pattern, or rustications, attracts the eye to the quality of the concrete surface. Departures in plane resulting from bulging forms and misalignment are unnecessary and obvious.

Robust Form Design

Form Lapping

Vertical Full-Height Pour

Architectural Concreting Systems – 8 ft. Forms

Robust Form Design

The architectural concreting system utilizes technology common to heavy construction, but is adapted for the specifics of the tall, circular, as-cast architectural concrete of the composite tank support structure. The form segments are pre-fabricated to exactly match the support wall curvature. Rustication strips manufactured into the form face to impart an architectural pattern to the concrete surface. Grout cannot leak behind this rustication strip. Rustication strips placed at the joint between panels blend with the form pattern, resulting in a seamless finish.

Architectural forms must be designed to withstand the vertical pour rates and increased dimensional control. The forms are a rigid structural system and, once set in position and locked together with the thru-wall form ties, impossible to move. This insures exact dimensions are obtained, rustication alignment is exact, and allows full height concreting without deflection. Thru-wall form ties maintain the alignment of the form and ensure consistent wall thickness.

Form Lapping

The form system is designed to lap and attach to the previous concrete placement. This sets the form at the exact radius. The lapping of the form to the previous concrete eliminates grout leakage at this construction joint. A sealant is placed between the form and the concrete face to virtually eliminate moisture loss and the associated discolorations and honeycomb.

Dimensional Control

The architectural forming systems are fully adjustable. Once the bottom of the form is secured to the previous concrete lift, the top of the form is adjusted to the exact vertical alignment by measuring the edge of each panel to a centrally located vertical laser beam. This means of adjustment maintains exact alignment and dimensional tolerance. The support wall is effortlessly placed to heights exceeding 200 feet within a tolerance of +/- 3/8”.

Segmented Wall Pour Procedure

Mock-Up Panels

Segmented Wall Pour Procedure

Architectural concrete forming systems are designed to support the full liquid head of wet concrete. Architectural concrete requires continuous placement and fast pour rates to prevent the differential set, concentrations of mortar paste and bleedwater issues that result in pour lines and surface color variations.

To achieve this, the wall pour is broken into segments to match the number of concrete trucks using temporary vertical bulkheads. There is no requirement to pour multiple lifts in a circular manner. Since the concrete comes from a single truck, shade variations within the segment are eliminated. Pour time is now the absolute minimum, slump is reduced providing uniform surface density. The segmented wall pour also eliminates problems that arise with concrete delivery interruptions. Should the concrete supply be stopped, the bulkhead can be left in place until the following day.

Mock-Up Panels

Mock-up panels are used to observe the actual combined effects of the mix design, the placement procedure and the form system and to provide a reference standard to judge surface quality, appearance and uniformity of color.

Summary of Architectural Concreting Systems

Architectural concreting systems ensure consistent concrete color and eliminate pour lines. The form system and segmented wall pour procedure offers additional control in case of pump failure or interrupted supply.

The form system and the associated placement procedures provide a support wall that is plumb with true and aligned form surfaces, smooth construction joints, uniform color and surface density without shading and pour lines.

Architectural concrete is obtained only with form systems described. The four-ft. forming system has none of these characteristics and has consistently provided results that indicate the obvious quality difference. With the description above, the reason behind the differences found with alternate systems can now be better understood.

Four-Foot Form Systems

Four Ft. Form Systems

The four ft. concreting system utilizes three rings of lightweight, flexible, four-foot tall forms. There is no structural rigidity to resist imbalanced, heavy loads of concrete during placement. There is no method to adjust the form to correct plumb. The absence of form ties allows the form to move. Successive form placements are connected to the panel below, not to the prior concrete casting. This then starts the next form in the wrong position resulting in misalignment and bulges. Without lapping and attaching the form to the previous pour, grout leakage, shade variation and surface defects are impossible to prevent. Grout leakage at rustication panels results in broken corners on form removal. Concrete is conveyed with three cubic feet at a time, compared to 35 feet with standard forming system. Concrete is placed in 16” lifts, in a circular manner, with resulting multiple pour lines and shade differences.

Many contractors are accustomed to casting concrete primarily on the basis of lowest cost and structural adequacy. This is not the focus of contractors involved in composite tank construction.

The as-cast architectural concrete finish of the composite support wall is difficult to accomplish in a uniform manner and once cast, impossible to change. The architectural concrete of the support pedestal demands the advanced characteristics of architectural forming systems in order to obtain an acceptable finish.

The silo forming system is not designed with these features, cannot meet established industry expectations, and does not provide acceptable architectural concrete.

LANDMARK
Elevating Expectations

RESOURCES

Landmark Structures
1665 Harmon Road
Fort Worth, Texas 76177
817.439.8888 Phone
817.439.9001 Fax
www.teamlandmark.com

American Concrete Institute
38800 Country Club Drive
Farmington Hills, Michigan 48331
248.848.3700 Phone
248.848.3701 Fax
www.concrete.org

Portland Cement Association
5420 Old Orchard Road
Skokie, Illinois 60077
847.966.6200 Phone
847.966.8389 Fax

500 New Jersey Avenue NW
7th Floor
Washington, D.C. 20001
202.408.9494 Phone
202.408.0877 Fax
www.cement.org

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