Interface Issues with New Equipment and Existing Concrete Tankage

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Summary: This paper discusses two significant challenges for contractors and equipment suppliers who deal with projects involving retrofitting existing concrete process tanks with new equipment. The challenges discussed involve: the determination of existing tank configurations and dimensions, and the ability of the existing concrete to support anchorage to meet current design codes - something that is particularly troublesome in areas with higher probability of seismic activity.

Verification of Tank Dimensions

Treatment plants for the most part use concrete tanks for unit processes. The interface between the concrete and the equipment is critical as there may be very little adjustment of the equipment possible to account for variations in the concrete. For example, a floating digester cover constructed to a specific diameter must move vertically in a concrete tank. The walls of the tank must be circular to a diameter consistent with the floating cover throughout the vertical distance of travel. New clarifier mechanisms must be dimensioned to fit with existing tank elevations and the degree to which the tanks are true to the given dimensions indicated in bid documents.

Currently most equipment supply work for treatment plants involves replacement of equipment in existing concrete tanks where both equipment suppliers and the installing contractor must work to a fixed project completion date. However, prior to bid, the only choice the equipment supplier has is to base the price and schedule for the equipment on the limited dimensional information for the existing tanks that is available with the project bid documents. This presents an interface issue that frequently impacts the project schedule and cost of the new equipment. The installing contractor is not responsible for the existing tanks that may have dimensions or configurations that vary from general information indicated in the bid documents. The uncertainty of existing tank dimensions does not allow the equipment supplier to account for additional costs and schedule impact if there are configuration and dimensional variations within or among several tanks, if any, exist. This is like requesting bids for foundation work without first making subsurface information including log and soil sample test data available to the bidders.

Certainly all parties involved in the project have an interest in making sure the equipment is sized for the existing tankage prior to fabrication, because, once fabricated, there is very limited adjustment to the overall dimensions of the equipment. Project specifications may state that the contractor must provide equipment suppliers with verified tank dimensions prior to the submittal. However, since the contractor is not known at the time of bid, the verification process cannot take place until after the prices and schedules have been committed to, and without consideration for potential costly revisions to the equipment if problems are found with dimensional variations in the existing concrete.

The process of obtaining verified tank dimensions after a contract is awarded is a common source of delay in the schedule for both equipment suppliers and the installing contractor. The

usual problem is restricted access to the tanks that must be surveyed. Restricted access creates a situation where the equipment supplier and the contractor are committed to a schedule but neither can proceed because the critical dimensions of the existing tanks cannot be verified in a timely manner. It is possible that the equipment supplier could proceed to fabricate equipment based on the general dimensions stated in project specifications, however there is a question of responsibility when, if later, it is found that there are flat areas of tank walls, or floor slopes and other elevations are not what they should be, all resulting in equipment that does not fit with the existing structure.

The problem is further complicated when new mechanisms are specified for multiple tanks that are described in bid documents with identical general dimensions (diameter, length, width, depth, floor slope etc.). The equipment supplier may offer a total price based on the assumption that each tank is truly identical. The real cost and schedule impact to the supplier and installing contractor is not realized until there is verification of the actual tank dimensions. The risk to all involved is that there are differences in the dimensions among the existing tanks that result in dimensionally unique sets of equipment for tanks that are only of only similar size. As equipment suppliers, we have encountered this problem numerous times much to the costly disappointment to all involved in the project.

Recommendation -
We recommend that when new equipment is to be installed into existing concrete tanks, verification of the tank dimensions should be completed prior to bid and included in bid documents so that costs and schedules can be more accurately established by both suppliers and installers.

Anchorage for New Equipment

The use of existing anchors for replacement equipment going into existing concrete tanks involves consideration of who is responsible for the design of the anchorage. Existing concrete tanks are generally quite old, perhaps several decades old, and were designed in an era when seismic design was in its infancy and anchorage calculations were performed with engineering judgment and no codified guidance. In 2002 the American Concrete Institute (ACI) produced in its ACI 318, Building Code Requirements for Structural Concrete, an appendix, Appendix D, which prescribed proper procedures for designing concrete anchors. The concrete anchor industry was initially slow to take this new appendix seriously, but after concrete panels fastened to the Boston tunnel by epoxy anchors failed, resulting in a death, all of the concrete fastener providers took a much more proactive approach. The vendors now spend extensive time and money performing research and development and keeping their anchor specifications and software up to date with the current design Codes.

Anchors for new equipment attached to existing concrete will involve the design of threaded rods to be installed in predrilled holes filled with a proprietary epoxy. Responsibility for the design of the new anchorage becomes troublesome for the equipment supplier for the following reasons:

- Concrete anchor vendors assume their product will be installed in compliance with their Evaluation Service Report (ESR), with which their software complies. While they don't guarantee the installation of their product, their disclaimer does reserve the right to pursue litigation against anybody who installs their product not in compliance with their guidance.
- The ESR is issued by a subsidiary of the International Code Council (ICC).

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- The ICC publishes the International Building Codes (IBC).
- Outside of Chicago, some version of the IBC (2003, 2006, 2009, 2012 or 2015) is endorsed by all municipalities as law.
- The IBC references and modifies, normally conservatively, some version of the above named ACI 318 (02, 05, 08, 11 or 14) as part of its Code.
- Almost without exception, anchorage installed previously will no longer comply with modern Codes.

The more recent changes in the design codes and standards require larger edge distance spacing and thicker concrete due to more stringent tension, shear and combined loading requirements. This is especially true in moderate and high seismic regions where forces can be large and the codes require ductile failure of the steel before concrete failure, even if both materials demonstrate adequate strength to resist the seismic loading. In other words, upgrading an anchor rod from 1 inch to 1 ¼ inch or increasing the number of anchors reduces the design capacity and can cause the anchors to fail to meet design code requirements. Another counterintuitive example of the difficulty is a deeper anchor embedment decreases an anchor's capacity once it exceeds a certain depth because of some of the equations the Code prescribes.

This leads us to a question of who is responsible for compliance with current design codes if existing anchors are to be re-used. Equipment suppliers cannot be responsible for determining the condition, adequacy, capacity or suitability of existing concrete for use with either new anchors or the existing anchors. We expect that bringing an existing concrete tank into compliance with the governing code would involve added reinforcement, and necessary concrete modifications that is beyond the scope of an equipment supplier.

Recommendation -

We recommend that, prior to bid; appropriate concrete experts evaluate existing concrete tankage for placement of anchors for support or attachment of retrofit equipment so that the anchors will be in compliance with current design codes. If modifications to the existing concrete are necessary, then the design of the anchorage should be incorporated in the modifications and be based on loads determined by the suppliers of the proposed new equipment to be installed. An added step may be to have the concrete experts devise field test methods to test the original existing anchor bolts to see if they can resist the determined loads. If the anchor bolts successfully pass the tests, then the Consulting Engineer or Engineer of Record for the project can instruct the equipment suppliers to design their equipment to utilize the original anchor bolts.

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