

## **Two Challenges When Providing New Equipment in Existing Concrete Tanks**

There are at least two significant challenges for contractors and equipment suppliers who deal with projects involving retrofitting existing concrete process tanks with new equipment. The first involves the determination of existing tank configurations and dimensions, and the second involves the ability of the existing concrete to support anchorage designed to meet current design codes - something that is particularly troublesome in areas with moderate or high probability of seismic activity.

### **Challenge 1: Verification of Tank Dimensions**

Treatment plants for the most part use concrete tanks for their processes. The interface between the concrete and the new equipment is critical as there may be very little possible adjustment of the equipment to accommodate variations in the concrete. For example, a floating digester cover constructed to a specific diameter must move vertically in a concrete tank. The shape (circular, egg-shaped, out of plumb, etc.) of the walls of the tank must be known so that the new digester cover can be designed to fit that shape so it can function and move properly throughout its travel. Likewise, new clarifier mechanisms must be dimensioned to fit with existing tank dimensions both in diameter and in elevation.

### **The Dilemma**

Currently most new 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 uncertainty of existing tank dimensions does not allow the equipment supplier to account for additional costs and schedule impact if actual tank dimensions are different from information given in the bid documents and 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.

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 5/1/20215/1/2021the critical dimensions of the existing tanks cannot be verified in a timely manner.

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 frequently 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. This leads to costly disappointment to all involved in the project.

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. Any required retrofitting to ensure the new equipment conforms to the existing tank will require additional time, effort, material cost, and can yield delays and less than originally desired outcomes.

### **Recommendation for Consideration**

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 similar to subsurface surveys so that costs, schedules, and designs can be more accurately established by both bidding suppliers and installers.

### **Challenge 2: Anchorage for New Equipment**

Determining proper anchorage for the replacement equipment going into existing concrete tanks is the

second challenge. 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) added an appendix, Appendix D, which prescribed proper procedures for designing concrete anchors to its ACI 318, Building Code Requirements for Structural Concrete. 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.

### **The Dilemma**

Almost without exception, anchorage installed previously will no longer comply with modern Codes. This leads to a question. If existing anchors are in good condition and might be re-used, should they be required to comply with current design codes when they have performed satisfactorily over the life of the existing equipment that is being replaced?

New 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. Recent changes in the design codes and standards require larger edge distances, anchor 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.

Due to this ductile failure requirement, upgrading an anchor rod, for example, from 1 inch to 1 ¼ inch or increasing the number of anchors 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 calculated capacity once it exceeds a certain depth because of some of the equations the Code prescribes.

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 current governing code would involve added reinforcement, and necessary concrete modifications that is beyond the scope of an equipment supplier and probably was not anticipated or provided for at the start of the project.

**Recommendation for Consideration**

The recommendation is that, prior to bid; appropriate concrete experts evaluate the existing tank concrete and anchorage. The concrete experts can evaluate the original existing anchor bolts and their condition to see if they can appropriately resist loads determined by the suppliers of the proposed new equipment to be installed. If the anchor bolts are judged adequate, 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.

If the original anchorage is deemed not acceptable then new anchors will have to be provided. If upon evaluation, the existing concrete and anchors are deemed not to be adequate then new anchorage can be designed by the concrete experts integral to modifications to the existing concrete with the required reinforcement so that the new anchors and concrete can act as a unit to meet current codes based on the determined loads.

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