RUBB TECHNICAL REPORT #0101

Salt Storage Building Design Considerations

CONCRETE AS A CONSTRUCTION MATERIAL FOR BULK SALT RETAINING WALLS

When choosing concrete as a wall system to retain bulk salt a major concern is the porosity of the concrete. In a salt storage situation when water penetrates the concrete it carries with it chlorides from the salt. The concrete surface in direct contact with the bulk salt will tend to flake away over time. The real damage takes place inside the wall where the chlorides attack the reinforcing bar and cause it to corrode. As corrosion occurs, large sections of concrete will break away from the wall exposing the rebar even further and causing more damage. Once this cycle starts it is very difficult to stop or repair the damage. One method to prevent the chlorides from leaching into the wall is to provide a barrier layer so that the salt is not in direct contact with the concrete. Materials, such as wood, that don't corrode easily when in contact with salt can be fastened to the inside of the wall. These materials can then be repaired or replaced as damage occurs due to loading and unloading operations within the structure. Another method is to apply a coating material such as coal tar directly to the concrete. This coating must be waterproof to prevent the leaching process. When this method is used it is necessary to have a routine maintenance schedule to repair the damaged areas.

WOOD AS A CONSTRUCTION MATERIAL FOR BULK SALT RETAINING WALLS

Wood has been used successfully for years to provide effective retaining walls for bulk salt. Wood can usually be fastened to the inside of a salt structure provided that the structure is designed to take the extra lateral loads caused by the bulk salt. A properly designed wooden retaining wall should be made from materials that are easy to find and easy to repair. The wood should also be treated with a chemical preservation to extend its service life. One advantage to a wooden wall system when compared to concrete is that a wooden wall is light and easy to install and localized repairs can be performed easily and economically. A wood wall system can also be readily dismantled and transported to a different location if building requirements change.

DESIGN SUGGESTIONS FOR DIAGONAL BRACING

Typically cables or rods are used to stabilize and diagonally brace a buildings structural frame. In a salt storage building these cables or rods should be oversized so that they will still provide adequate strength after some corrosion has occurred. Another option is to use plastic coated or stainless steel cable. For maintenance purposes any system used in such a corrosive environment should be designed for ease of repair or replacement.

PROTECTION OF STRUCTURAL STEEL

Galvanizing is a very common method of protection for structural steel in membrane clad buildings.

Two commonly used methods of galvanizing are pre-galvanizing before fabrication and hot dip galvanizing after fabrication. Widely accepted specifications for pre-galvanizing are ASTM G-60 and ASTM G-90. For hot dip galvanizing after fabrication ASTM A-123 is the usual standard. Pre-galvanized tubes are typically produced in one of two methods. In one method galvanized sheet steel is slit, formed into a tubular shape and welded. Following the welding process the weld area is remetalized. In another method, tubing is formed from uncoated steel and galvanized on the outside in a continuous process that immerses the welded tube in a zinc bath and provides a painted coating on the inside of the tube.

Hot dip galvanizing to ASTM A-123 occurs after fabrication when completed assemblies are immersed in a molten zinc bath. In this method, both the inside and outside surfaces of the material are galvanized and the protective zinc coating is generally many times thicker than on

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pre-galvanized products. It is important to note that the thickness of the zinc coating is directly proportional to the service life of the finished product.

PRE-GALVANIZED TUBING AS A CONSTRUCTION MATERIAL FOR TUBULAR STEEL TRUSSES

One of the least expensive methods for producing tubular steel trusses is to use pre-galvanized tubing. The material used in this method is typically thin walled, high strength steel tubing with the interior surface painted for protection and exterior surface coated with a thin (0.6 oz/sf) zinc coating. According to the American Galvanizers Association a 0.6 oz/sf zinc coating could be expected to achieve a service life of less than five years in a moderately industrial environment.

Understanding that repairing a product every five years would be detrimental, tubing manufacturers usually apply a thin organic coating to the tube to help extend the service life. However these coatings are readily damaged during fabrication, shipment and installation. During fabrication the tubing is typically cut to desired lengths and welded together to form trusses. A zinc rich paint is used to cover the area that was burned off through the welding process. One of the problems in this type of fabrication is making the repaired surface stand up as well as the original surface. This is very difficult due to the fact that the original material is produced under conditions which are very difficult to duplicate in a fabrication facility. Another major downfall to this method is that not only is the outside protective layer damaged but the coating inside the tubing, typically paint, is also burned off in the welding process. The heat of the welding process burns away the organic coating, the zinc layer on the steel and typically damages the interior surface as well. Generally this weld area is then painted with a zinc rich paint. However, the inside damaged area cannot be repaired and has little or no protection starting from the date of fabrication. The corrosion that occurs on the inside of the tube at these unprotected areas will remain undetected until the rust is visible on the outside of the tube. At this time the structural characteristics at the welded joints will be severely compromised. Maintenance or repair at that point is very difficult and cost prohibitive.

HOT DIP GALVANIZING AFTER FABRICATION (ASTM A-123)

By comparison to the truss fabrication described above, with hot dip galvanizing to ASTM A-123, the entire truss is fully immersed in a tank of molten zinc. This process forms a thick zinc layer (ASTM A-123 specifies at least 2.3 oz/sf) on the exterior and interior components of the truss surfaces. According to the American Galvanizers Association 2.3 oz/sf of zinc can be expected to achieve a service life of over 25 years in a moderately industrial environment. This method of producing a zinc coated truss insures protection inside and out for many years with a service life that is more predictable.

DUPLEX SYSTEMS

Protection of steel from corrosion typically involves either the use of hot dip galvanizing or some type of paint system. However, more and more corrosion specialists are combining both methods of corrosion protection in what is commonly referred to as a duplex system. The term duplex system refers to painting or powder coating steel that has been hot dip galvanized after fabrication. When paint and galvanized steel are used together, the corrosion protection system is superior to either protection system used alone.

When hot dip galvanized steel is painted, the duplex system provides a more sophisticated manner of corrosion protection. The galvanized coating protects the base steel, supplying cathodic and barrier protection. Paint, in turn, provides barrier protection to the galvanized coating. The paint slows down the rate at which the zinc is consumed, greatly extending the life of the galvanized steel. In return, once the paint has been weathered down or damaged, the zinc

is still available to provide cathodic and barrier protection. When painted steel corrodes, rust grows under the paint and eventually causes the paint to peel. However, if the steel is galvanized, the corrosion is minimal and the paint will not peel, thereby greatly increasing the life of the structure and minimizing paint peeling. One of the primary reasons for paint failure is discontinuity in the coating. A hot dip galvanized coating will eliminate early rusting at pin holes. In turn, the life of the product is greatly increased.

This synergistic effect is particularly important in areas such as corners, where paint film tends to be thinner. By contrast, hot dip galvanized coatings are often thicker at corners and edges due to the metallurgical bond of the zinc to the base steel. In buildings using pre-galvanized tube, connection plates are typically shop painted and not galvanized so there are no zinc alloy layers or metallurgical bond to provide protection.

A duplex system affords greater protection than either coating can provide alone. In fact, many test have shown that a duplex system will last from 1.5 to 2.5 times the normal combined lifetime of both the zinc and the paint systems. Periodic maintenance and painting can extend this synergistic lifetime even longer.

For example, if a zinc coating is expected to last ten years and a paint coating is expected to last five years, a properly applied duplex system of paint over zinc could be expected to last over 35 years.

COMMENTARY

When choosing a building design long term considerations should be made. Some of these considerations are:

Can the building designed be used for another purpose?

For example, many salt storage buildings have low side wall heights and curved roof designs which limit their effective use for other purposes such as equipment maintenance facilities or storage buildings.

Will the manufacturer still be in business when we need service, repair or replacement?

Many fabric covered building companies have come, and many have gone. It is wise to choose a company that has a long track record and has been successfully building upon the same design and materials for many years.

What kind of warranty should I get with this product?

Warranties on material goods should be read carefully. Many times a warranty is worded in such a way that it has little value. A thorough understanding of the terminology used is necessary to properly evaluate any warranty. For example, if a manufacturer warranties rolled goods used for cladding material this means that the warranty would cover the cost of the fabric only. This would typically not cover the cost of removing the old fabric, disposing of the old fabric, manufacturing or installing the new fabric. These “non fabric” costs may be many times the cost of the base fabric itself.

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