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Design and details of elevated steel tank

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-----SUBJECT-----

DESIGN AND DETAILS OF ELEVATED STEEL TANK.

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—THESIS SUBJECT—

DESIGN AND DETAILS OF ELEVATED STEEL WATER TOWER.

—BY—

William A. Baueris "09"

An effort has been made in this work to furnish complete plans and specifications for a steel structure which could replace the concrete reservoir on natural elevation north of Rolla, attention being given to capacity and relative elevations.

A comparison of these two structures regarding relative advantages and disadvantages is herein given, with the intention of providing some foundation as a source of choice between these two classes of structures.

The first cost of the steel water tower would be greater than that of the reservoir on natural elevation, unless the extra cost of installing pipe line to said reservoir would compensate for the difference in cost of structures themselves.

The life of the two structures is practically indefinite when properly cared for. The concrete structure has the advantage of requiring less attention from year to year, as the steel structure should receive at least one coat of paint every five years.

The steel structure has an advantage, in that, it may be located at any desired place, usually near pumping station, thus enabling a constant knowledge of amount of stored water.

Loss of head due to friction in pipes is noticeable in pipe lines of long distance and should be avoided when possible, in this respect the tank located at the center of district to be supplied has the advantage.

The steel tank is supplied with two outlet pipes, one of which serves as a supply to mains, opening four feet above bottom of tank, and the other serving as a "flusher," this being level with the bottom of the tank. The flushing pipe can be opened and sediment drawn off without causing clouding of water higher up in tank or causing delay in general water supply. On the other hand, the flat bottom tank has to be emptied when cleaned, this causing delay in water supply.

In special cases where sanitary water service is separate from fire protection, the steel structure is best adapted as an auxilary tank can be suspended from the bottom of the main tank. The smaller tank supplying sanitary needs, while large tank serves as a protection against fire.

SPECIFICATIONS.

Workmanship:-

All workmanship must be first-class. All abutting surfaces of compression members must be planed or turned to even bearings, so uniform contact may be obtained over whole bearing surface.

All rivet or pin holes must be clean cut, without torn or ragged edges. Diameter of punch shall not exceed by more than one sixteenth (1/16) of an inch the diameter of the rivet to be used.

Rivet holes must be accurately spaced. The use of drift pins will be allowed only for bringing the several parts together, and they must not be driven with such force as to disturb the metal about the holes.

The rivets must completely fill the holes, have full heads concentric with the rivet, of a height not less than 6/10 the diameter of the rivet, and shall be in full contact with the surface or be countersunk when so required. Rivets should be machine driven wherever practicable.

Field rivets shall be regarded as having two-thirds (2/3) the value of shop rivets.

Built members must, when finished, be true and

Workmanship: (Continued)

free from twists, and open joints between component pieces. Fillers must be used wherever necessary to fill vacant spaces.

All pins must be smooth and truly circular. Diameter of pin shall be diameter of hole minus 1/32 of an inch.

The tank is to be absolutely water tight by caulking only. No foreign substance is to be put into joints between the plates. Caulking shall not injure abutting plate and shall be done on inside of tank where practicable. Caulking shall be tested by filling tank before the inside has been painted. Any leaks noted must be recaulked.

No steel shall be heated except corners of tank plates for scarfing.

Quality of Material:-

All metal in the structure, except rods, which require welding will be steel. All steel comprising the tank plates and principle parts of tower post shall be made by the Open Hearth Process.

All tests and inspection of material shall be made at the place of manufacture prior to shipment.

Specimens for testing shall be standard, and cut from the finished material.

Quality of Material. (Continued)

Rivet steel shall show an ultimate strength of from 48000 to 58000 pounds per square inch. Elastic limit, not less than 1/2 the ultimate strength. Bending test, 180 degrees flat upon itself without fracture on the outside of the bent portion.

Structural steel, the same as above, except ultimate strength, from 55000 to 65000 pounds per square inch.

In steel, made by acid process, the phosphorous limit shall be .08 per cent; made by the basic process .04 per cent.

Rods are to be made of best wrought iron. The surface and broken fragment must be free from slivers, blisters, cinder spots or other injurious defects. They must be well welded together, without seams or torn edges.

Details of Construction.

Anchor bolts shall be provided, to prevent overturning of tank (empty) due to unstable equilibrium produced by wind pressure.

Bearing plates on bottom of main posts shall be of sufficient thickness to distribute load evenly over foundation cap.

All joints in main post to be made above, and

Details of Construction: (Continued)

as near as practical to a horizontal strut. Splices are to be made with plates on all sides of the column with sufficient rivets to thoroughly hold the parts together. Batten plates at the ends of compression members shall not have a less length than the distance between rivets lines connecting them to channels, and the pitch of rivets in them shall not exceed four diameters of the rivet used.

The distance between connections of lacing bars to the flange of a channel shall not exceed two times the depth of the member, nor shall they be inclined to the axis of the same less than 45 degrees. Thickness of lacing bars to be not less than 1/50 the distance of center of rivets connecting the same to channels. The width of lacing bars shall not be less than 2 1/2 times the diameter of the rivet used.

In work that does not have to be caulked the pitch of rivets shall never exceed 6 inches or 16 times the thickness of thinnest outside plate, nor be less than 3 diameters of the rivet.

In work requiring caulking the maximum pitch shall never exceed 10 times the thickness of the thinnest plate connected, and shall not be less than 3 diameters of the rivet.

Gauge lines shall not be less than 1 3/4 times the diameter of rivet from edge of plate.

Details of Construction. (Continued)

All rods shall be provided with some adjustment for length. Where they are threaded, the ends shall be upset to provide for decreased area.

The inlet pipe must be so connected as to allow for changes of height of tower.

Loading:-

The structure shall be proportioned for the following loads:

The weight of the structure.

The weight of the water in the tank.

A wind pressure of not less than 40 pounds per square foot on tank, and a uniform wind load of 200 pounds per each vertical foot of tower. Wind assumed in any direction and members proportioned for maximum stress.

Unit Stresses for Proportioning Members:-

Members not exceeding 90 radii of gyration between supports, 16,000 pounds per square inch.

For length exceeding the above limit use the following formula:

$$P = 21{,}000 - 60\frac{L}{R}$$

No main post to exceed 125 radii of gyration in length.

Tension 10,000 pounds per square inch in tank.

Unit Stresses for Proportioning Members. (Continued)

Tension 12000 pounds per square inch in bracing.

Shear, 7500 pounds per square inch.

Bearing, 15000 pounds per square inch on rivets.

Bearing, 400 pounds per square inch on concrete caps.

Painting:-

All work shall be covered before leaving shop with one coat of graphite paint thoroughly mixed with pure boiled linseed oil, except the contiguous surfaces of tank plates. All other parts inaccessible after assembling must be well painted before assembling.

Structure shall have one field coat of same paint after erection.