Chapter 10
Design of Lock Wall Accessories

10-1. General

This chapter provides details on the design of lock wall accessories. These items should be designed to comply with the safety requirements contained in EM 385-1-1.

10-2. Floating Mooring Bitts

a. General. The need for larger and stronger floating mooring bitts has been caused by the development of synthetic lines for checking and tying up the larger tows. The 2-in. synthetic lines now in use have a breaking strength up to 107,000 lb compared to the 31,000-lb breaking strength of new 2-in. manila lines which were the criteria used for the original development of the floating mooring bitts. All affected components of the floating mooring bitt should be designed for 160,000-lb load at normal working stresses. This force is derived from the parting strength of a doubled line reduced by a factor of 0.75 to account for unusual loading. Plate 39 provides further information on floating mooring bitts.

b. Recesses. At the lock face, a small recess opening should be provided to protect the bitt from damage by barges or from the twisting effect of line pull. A recess opening from 1.5 to 2.5 ft is recommended.

c. Embedded guides. The embedded guides should be composed of corrosion-resistant steel plate or corrosion-resistant clad steel plate. This material should be fabricated so that a large, rectangular cross-section track is provided instead of the rolled channel sections with tapered flanges that are in use in some projects. This flat shape gives the wheels wider faces on which to roll. This measure would also help alleviate flaking and pitting of steel faces that has been experienced with use of the rolled channel section guides. The guides should be adequately braced to resist displacement and distortion during placement of concrete and should be anchored into the concrete mass to transfer the large wheel loads to the concrete itself. The top of the guides should be terminated in a yoke arrangement to assure that the floating mooring bitt cannot accidentally be propelled out of its recess by buoyancy after the sudden release from the hold of ice or debris. This arrangement can also provide a means of hoisting and storing the bitt out of the water when it is not in use. Locks with the top of walls near upper operating pool should have the guides extended above the wall to accommodate the floating mooring bitt. Guides extending above the top of the lock wall should also be encased in concrete.

d. Wheels and axles. The wheels should be as large in diameter as practical with a minimum of 12 in. to resist high stresses from overloading and impact. Wheels should be made of cast or forged steel with a corrosion-resistant steel rim either shrunk on or built up with weld overlay. Axles should be made of corrosion-resistant steel and should be as large in diameter as is practical to resist bending. Stops (or feet) should be provided at the bottom of the floating mooring bitt to prevent the bottom wheel from striking the floor of the recess and bending the axles. Stops should incorporate rubber bumpers to cushion the impact.

e. Wheel bushings and lubrication lines. Aluminum bronze is recommended for wheel bushings because it will perform better under heavy axle loads than most materials readily available. Graphite impregnated bushings are not recommended since it is not possible to obtain adequate bearing areas. Grease fittings should be provided for the lubrication of the wheel bushings and axles. Submerged wheels will require grease lines extending to the top of the tank. All grease lines should be located in the interior of the tank to prevent damage to the grease lines from debris and ice. To prevent leakage, welded-in couplings should be provided where lines pierce the tank.

f. Tank. The tank should be a minimum of one- fourth-inch-thick corrosion-resistant steel compatible with the corrosion-resistant steel guides. If the tank is being replaced on existing locks, the tank should be of the same material as the guides to prevent galvanic action between the two. If a carbon steel tank is used, either a fiberglass coating or cathodic protection or both should be provided. The shell should have circular transverse diaphragm rings on approximately 3-ft centers and reinforcing plates at stress points. A diameter of 3.5 ft should be considered for use on new designs. Where possible, tanks should be designed with a sufficiently high flotation level to allow a minimum adjustment of 18 in. in floating depth by an inert ballast material to compensate for future changes in weights and tow conditions.

g. Ladders. With the use of diaphragms, ladders are not essential inside the tanks and should not be provided.

h. Fiberglass coating. Instead of using paint, the outside of carbon steel tanks could be covered with fiberglass impregnated in a bituminous material. In prototype usage, this material has been proven to reduce maintenance costs and corrosion. If used, the fiberglass

coating should be periodically examined for cracks or leaks.

i. Cathodic protection. If carbon steel tanks are not coated with fiberglass, some type of cathodic protection should be provided. In past projects, sacrificial magnesium block or ribbon anodes, attached with welding studs at selected locations, have been used successfully.

j. Debris shield. If a wide recess opening is used, a shield should be mounted on the tank at the waterline to protect against floating debris.

k. Styrofoam-filled tank. Filling the tank with styrofoam, either partially or completely, is not recommended. This measure would prevent inspection of the inside of the tank, prevent the tank from being sunk should this be necessary, and may cause the tank to rust beneath the foam because of moisture entrapment.

l. Self-sinking device. To prevent the bitt from being suddenly propelled upward after sudden release from freezing or being jammed by debris, an automatic sinking device should be provided to permit the tank to fill with water. The water can be forced out later by using compressed air. The compressed air inlet connection must be extended above lower pool when the floating mooring bitt is resting on the bottom of its recess.

m. Mooring posts. Posts for floating mooring bitts should be fabricated from 8-in.-OD, 1-in.-thick wall steel tubing, ASTM A618, Grade 1, with properties suitable for welding and with a yield point of 50 ksi.

n. Single-deck floating mooring bitts. The loaded - unloaded draft differential of modern barges can be as much as 7 to 8 ft. In the case of empty jumbo barges, the kevel may be as much as 10 ft above water; as a result, mooring with a single-deck floating mooring bitt could be difficult and dangerous. Consequently, single-deck bitts are not recommended.

10-3. Line Hooks and Check Posts

Although not directly related to floating mooring bitts, a vertical row of heavy line hooks for checking tows (to discourage checking on floating mooring bitts) should be provided at each bitt and at 150-ft intervals in the wall faces outside the lock chamber. Check posts should be provided at the top of the wall at each of these locations. The hooks and posts should be fabricated from 8-5/8-in.-OD, 1-in.thick wall steel tubing ASTM A519, Grade 4130, condition SR, and filled with grout. Cast-iron or cast-steel should not be used because it is harder to get quality castings. The hook, post, and anchorage should be designed for reactions resulting from a 160-kip line pull. The arrangement should include curved steel frame and adequate anchorage reinforcement. Plate 40 includes more information on line hooks and check posts.

10-4. Tow Haulage Unit and Movable Kevel

The recommended line capacity of a tow haulage unit with a pair of hoists should be about 5,000 to 7,000 lb with a maximum speed of 50 to 60 ft/min. Electric drive must have a variable speed control, as the barges will accelerate very slowly. However, hydraulic controls are not suitable for these hoists. For a single-hoist layout, a maximum line pull of 10,000 lb is recommended, so as not to break the normal hawsers used on barges. A speed of 80 to 100 ft/min may be used. Speed and line pull control on recent units is through an eddy-current coupling controlled by a stepless auto transformer unit. For layout description of tow haulage units and movable kevels, see paragraph 5-11.

10-5. Wall Armor and Corner Protection

The rubbing and scraping action of barge tows in contact with the lock walls will wear down and frequently damage unprotected concrete surfaces. To prevent this concrete damage, a facility should be equipped with horizontal runs of T-section wall armor as well as horizontal and vertical corner protection. Horizontal wall armor and horizontal corner protection should not cross monolith joints. Preformed plates or castings are used at the top of lock walls and at exposed corners of recesses for miter gates, lift gates, bulkheads, ladders, line hooks, and mooring bitts. Currently, the standard wall armor section is rolled infrequently (only for a certain tonnage by a single manufacturer). If the minimum order of T-sections cannot be met even by combining demands, a T-section may be fabricated from plates. If any doubt exists as to availability of the T-section during preparation of the contract drawings, the fabricated section should be detailed on the drawings as an alternate. Horizontal timber, steel box, or rubber sections have also proven suitable for protection from tow abrasion. Plate 43 also illustrates typical details.

10-6. Guardrails

a. Stationary. A stationary rail or permanent fixed guardrail should be provided for the top of lock walls and for service gate and bridge walkways. These rails are required for safety around any openings in the top of the

lock wall that are not equipped with covers. If the public is allowed on the lock walls, then appropriate wire mesh panels or other details must be provided for additional safety. Rails next to lock faces should be set back a sufficient distance so that overhanging barge rakes do not destroy them. Some locks have been designed using concrete parapets instead of railing at the lock face. Local conditions, including climate, will usually govern whether concrete parapets or rails are used. The location of the rail or parapet should account for the space required for a present or future tow haulage unit. Ample room (rail clearance) should be provided to allow easy access to check posts. Under no condition should the rail be positioned over the check posts where it would interfere with lines using the posts.

b. Laydown. Laydown (collapsible) railing should be used on the top of lock walls where the lock walls are subject to being overtopped by floodwaters. Plate 54 provides design details.

10-7. Parapet Walls

On some locks, concrete parapet walls have been used at the lock face instead of guardrailing. The walls are usually tapered away from the lock face to minimize damage by barge contact. The parapets must be reinforced to resist a barge contact load. Some factors involved in deciding whether to use railing or concrete parapets include climate, especially snowfall; lock wall overtopping; and presence of, or anticipated presence of, a tow haulage unit railroad rail.

10-8. Grating

Recesses in the top of lock walls should be provided with covers, usually of grating fabricated with steel or other appropriate material, to permit safe movement of lock personnel, equipment, and visitors. In some instances, the grating may be covered with steel plate for safety purposes. When a mobile crane is provided, the grating must be designed for the resulting wheel loads. However, large openings, such as miter gate machinery recesses or valve pits, may be left open and protected by guardrails on top of a raised concrete curb.

10-9. Trash Racks

Structural steel trash racks are required at the culvert intake manifold ports at the lock face. These trash racks are necessary to keep large debris out of the intakes and culverts. This prevents large items from blocking water flow, obstructing proper culvert valve operation, or damaging the valves. The trash racks should be firmly anchored in place so that the frequent flow of water through the racks does not cause them to be dislodged and lost. However, the detail of the anchorage should be such that the trash rack can be easily removed and replaced (especially in locations where zebra mussels are a problem).

10-10. Second Placement Concrete

Certain locations in a lock require precise alignment and elevation settings for the following embedded items: the steel sealing surfaces for the culvert valves and culvert bulkheads; the vertical wall quoin and the horizontal sealing surfaces for the miter gates; the bearing and sealing surfaces for the closure structures; operating machinery foundations; and other items. These second pour items require careful sizing and detailing so that enough space is available for adjusting the steel items to line and grade. This space will also allow for placing and vibrating concrete.

10-11. Gauges

Gauges are installed in recesses in the face of the lock walls at suitable locations to indicate the depth of water over both the upper and lower sills. The gauges usually are placed so that the top of the adjacent sill is the zero of the gauge; thus the depth of water over the sill is read directly off the gauge in feet and tenths. Numbers on the gauges should extend a few feet below low water and above high water. Gauges are located a short distance upstream and downstream from each service gate recess and on the wall opposite the normal operating wall, so the numbers are visible to lock operating personnel. Recording devices are also provided on locks to register on the control panels. These devices should be located inside the operations building and inside the control stations to display both the upper and lower pool elevations and lock chamber water elevations at all times for the convenience of the lock operating personnel. Selysen transmitters located at appropriate places have been used for this gauging purpose on more recent lock designs. Pressure sensors that furnish data for visual display or a Cathode Ray Tube (CRT) screen in the control stations and operations building are now in use for the above purposes on many locks.

10-12. Distance Markers

Numbered signs indicating the distance to the lock sill should be painted at the top of the lock approach walls and lock chamber walls. These signs should comply with

the sign manual EP 310-1-6A and 6B. Figures should be 12 in. high for good visibility from the pilot house of the incoming vessel and are normally spaced at 100-ft intervals. Markers on the lower approach wall show the distance to the downstream end of the lower gate recess; those on the upper approach wall show the distance to the upstream end of the upper gate recess. Markers in the lock chamber show the distance to the downstream face of the upper miter sill, which is also identified by a vertical yellow stripe on the face of both lock walls. The distance markers may be painted directly on the concrete, or they may be painted on aluminum or plastic plates which are mounted in shallow recesses in the face of the lock wall or supported on the guardrailing. Figures are generally white on a green background, and facilities may use a reflective type paint for easier reading at night.

10-13. Instrumentation (Structural)

A variety of instrumentation may be required for gathering structural related data. These data may include the following: uplift pressures, concrete monolith tilt, steel sheet pile cell interlock tension or cell movement, tie-back tendon or rod tension stress, crack width, pore pressure, interior concrete temperature, leakage, and pressures in culverts. EM 1110-2-4300 provides guidance for most of the required structural instrumentation.

10-14. Air Bubbler System

Service gate sills for miter gates and sector gates should be provided with air pipes located a few feet above the bottom of the gate recess and the gate sill and discharging near the gate pintle and miter point. A bubbler system is useful in moving floating items out of the quoin and miter areas during gate operation. This system helps to prevent gate damage caused by floating items caught between gate and wall contact blocks and miter contact blocks. Bubblers are automatically operated. For other type lock gates, air bubbler systems should also be provided.