

Special Specification 4063

Steel Monopile with Floating Donut Fenders



1. DESCRIPTION

Fabricate and install, steel monopile with a floating donut style fender or individual components in accordance with the details shown in the plans.

2. EQUIPMENT

Provide equipment necessary to complete the work. Operate all water going vessels, barges, etc., in accordance with United States Coast Guard regulations. Provide pile driving equipment as applicable.

3. MATERIALS

Mark materials for shipment and storage in accordance with Military Standard, MIL-STD-129. Furnish materials conforming to the following:

- 3.1. **Paint**, provide the type of paint as shown in the plans.
- 3.2. **Steel Monopile and Cap (SMC)**. Use Grade A36 Structure Steel conforming to Article 442.2, "Materials."
- 3.3. **Free Floating, Foam Filled, Donut Marine Fender Upper and Lower Unit**. Provide a free floating, model specified in the plans or equivalent, foam filled, donut marine fender manufactured by "Trelleborg" or equivalent, as approved. The components of the donut should include the following:
- 3.3.1. **Internal Core**. Rigid cylindrical internal core constructed of a minimum ½ in. thick, ASTM A36 grade steel plate. Protect all exposed steel surface in accordance with Item 445, "Galvanizing".
- 3.3.2. **Resilient Foam Layer**. Provide a layer of resilient closed-cell foam continuous from the internal core surface to the outer skin of the fender.
- 3.3.3. **Inner Bearing Surface/Wearing Pads**. Provide virgin UHMW/PE internal wearing pads as called for in the specific model plans or equivalent.
- 3.3.4. **Foam Core**. Provide a resilient, closed cell, cross linked, polyethylene, energy absorbing, foam core of heat laminated construction. Chipped or granulated particulate foam is not acceptable. The foam core must meet the requirements outlined in Table 1.

Table 1.
Foam Core

Density	3.6 lb./ft. to 4.6 lb./ft.
Tensile Strength	100 psi minimum.
Elongation (Ultimate)	140% Minimum
Water Absorption	Less than 0.05 ib./ft.2 of cut surface

- 3.3.5. **Fender Skin**. Construct the outer skin of filament-reinforced polyether polyol/TDI-based polyurethane elastomer, of the thickness as specified in the plans. Use 2, 4-toluene diisocyanate, polytetramethylene ether glycol, and an aromatic amine based urethane elastomer, with the unreinforced properties outlined in Table 2. for the elastomer used in the fender skin.

Table 2.

Shore A. Hardness (ASTM D-2240)	75 to 95
Tensile Strength (ASTM D-2240)	2000-psi minimum
Elongation (Ultimate) (ASTM D-412)	300 % minimum
Tear Strength (ASTM D-642)	185-lb./in minimum
Flex Life (Ross) (ASTM D-1052)	10,000 cycle's minimum
Abrasion Resistance (NBS) (ASTM D-1630)	100 minimum

3.3.6. **Filament Wrap** Construct each filament-reinforcing wrap with continuous filaments applied in helical pattern, at a helix angle of 45 degrees to 60 degrees to the longitudinal axis of the fender. Two such filament helixes of equal but opposing helix angles will comprise each wrap.

3.3.7. **Filament Reinforcement.** Construct the other skin with reinforcing filaments consisting of nylon tire cord of 2,520 denier weight in accordance with the properties outlined in Table 3.

**Table 3.
Filament reinforcement Properties**

Breaking Strength	52 lb.
Elongation (Ultimate)	18%

3.3.8. **Reinforced Skin Properties.** The reinforced skin must exhibit the following properties when tested in accordance with the guidelines below:

3.3.8.1. **Tensile Strength.** Minimum breaking strength of 10,000-psi minimum, when a full-thickness specimen is tested in tension with the longitudinal direction of pull aligned with the filament direction (in one helix direction.)

3.3.8.2. **Elongation (ultimate).** Ultimate elongation 18% at the break in test for tensile strength.

3.3.8.3. **Tear Strength.** Tear strength of 13000 lb./in. when a full-thickness specimen of the skin is tested in tear with the specimen shaped like Die C in ASTM D-624, and with the direction of pull aligned with the filament direction (one helix direction.)

3.3.9. **Performance.** Provide Monopile with floating donut fender meeting the characteristics outlined in Table 4.

Table 4

Pile Diameter:	5 ft.
Fender Diameter:	15.8 ft.
Skin Thickness:	1.25 in. minimum
Energy Absorption (70% compression):	700 ft-kips
Reaction Force (70% compression)	1000 ft-kips

- Rated Energy Absorption: The energy absorption capacity of the fender at the rated deflection.
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- Rated Reaction Force: The reaction force of the fender at the rated deflection.
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- Rated Deflection: The distance that the resilient foam layer is designed to deflect, measured radially inward toward the axis of the fender, on one side of fender only.
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- *Actual values may vary + or – 15% from slatted values due to variations in material properties dimensional tolerances, temperatures.

4. CONSTRUCTION

- 4.1. **Steel Monopile and Cap (SMC).** Construct a steel monopile with an outside diameter as specified on the plans, with 1 in. wall thickness and of length shown on the plans. Drive the monopile in accordance with Item 404, "Driving Piling." Construct a steel cap of equal diameter as the outside diameter of the pipe, $\frac{3}{4}$ in. thick. Weld the steel cap to the top of the monopile. Perform full penetration welds in accordance with Item 448, "Structural Field Welding," and perform welding with Certified Welders.

Surface preparation and coating of the steel monopile and cap will be as shown on the plans.

- 4.2. **Floating Donut.** Install floating, foam-filled, donut marine fender over the monopile.

- 4.2.1. Dimensions will be as specified to obtain the required performance and to avoid jamming or excessive cocking on the pile during berthing operations. The fender will have a cylindrical body (axis vertical), free to rotate around the supporting pile, and be able to move up and down in various water levels. A one-piece structure with an upper energy-absorbing section, covered with a net of load-spreading composite marine timbers connected together with galvanized steel chains, and a flotation section designed to maintain the center of the energy-absorption at ferry rub-rail level.

- 4.3. **Reinforced Composite Plastic Timbers.** Reinforced Composite plastic timbers to be replaced in accordance with the plans shall be::

- From recycled plastic,
- Be abrasion resistant,
- Be of low friction material, with anti-oxidants and ultraviolet inhibitors,
- Be reinforced with fiberglass rebar,
- Have structural properties sufficient to distribute the load from contact by the ferry,
- Be of ultra-high molecular weight (UHMW) polyethylene resistant to abrasion, oil, seawater, and weather,
- Be of sufficient material to evenly distribute the reaction load over the pile,
- Fasteners shall be stainless steel conforming to ASTM F593, alloy type 316L.

- 4.4. **Polyethylene Timber Facing.** Polyethylene facing to be replaced in accordance with the plans shall:

- Be ultra-high molecular weight (UHMW),
- Be 100 percent cross-linked for abrasion resistance,
- Be ultraviolet (UV) stabilized with 0.6 percent to 2.5 percent carbon black,
- Be of 100 percent virgin UHMW polyethylene material,
- Fasteners shall be stainless steel conforming to ASTM F593, alloy type 316L.

- 4.4.1. Butt-welded UHMW polyethylene will be accepted provided the following requirements are met.

- The manufacturer has at least 5 years of experience in welding UHMW polyethylene in thickness greater than 1 inch,
- The manufacturer has produced butt-welded material for critical technical applications.
- Is able to produce documentation to substantiate butt-welded applications.
- The welded joint shall have at least 90 percent of the tensile strength of the base material,
- Welded seams shall be flush with smooth contour.

- 4.5. Reinforced Composite Plastic Timber Chain Set.

- Reinforced Composite Plastic Timber Chain Set shall be of the type, size, model and quantities specified by the manufacture of the Floating Donut Unit repaired or replaced in accordance with the plans.
- All chain set attachments including shackles, timber keepers and rubber chafing hose will be incidental to the chain set provided.

4.6. Floating Unit Lower

A Lower Floatation Unit will be constructed as described under "Materials" or be the model specified in the plans. Connecting bolts and nuts and friction bearings will be considered subsidiary to the purchase and installation of the unit

4.7. Floating Unit Upper

A Upper Floatation Unit will be constructed as described under "Measurement" or be the model specified in the plans. Reinforced Composite Plastic Timbers, Chain set, connecting bolts and nuts and Friction Bearings will be considered subsidiary to the purchase and installation of the unit.

4.8. Complete Floating Unit without SMC

A complete Floating unit will consist of an upper and lower unit as described in F and G above.

4.9. Swap a Complete in Service Floating Donut Unit Without SMC with a Complete Ashore Floating Donut Unit Without SMC . Swapping will consist of:

- Swapping out a complete in service Donut Unit without SMC with a Complete Donut Unit without SMC located ashore and in Department stock. This unit will be pre staged by the Department waterside and accessible to a barge crane.

4.10. Swap a Complete in Service Floating Donut Unit Without SMC with a Complete in Service Donut Unit Without SMC. This will consist of:

- Swapping out a complete in service Floating Donut Unit without SMC with another complete in service Floating Donut Unit without SMC in a different location.

5. MEASUREMENT

These Items will be measured by the each for fabrication and installation of the Steel Monopile with Cap (SMC) or Complete Floating Donut Unit without SMC or Floating Donut Unit Upper or Floating Donut Unit Lower or Reinforced Composite Plastic Timber, or Reinforced Plastic Timber Supporting Chain Set or Inner Bearing Surface/Wearing Pads or Polyethylene Timber Facing or Swap a Complete in Service Floating Donut Unit Without SMC with a Complete Ashore Floating Donut Unit Without SMC and Swap a Complete in Service Floating Donut Unit Without SMC with a Complete in Service Donut Unit Without SMC.

6. PAYMENT

The work performed and materials furnished in accordance with this Item and measured as provided under "Measurement" will be paid for at the unit price bid for Steel Monopile with Cap (SMC) or Complete Floating Donut Unit without SMC or Floating Donut Unit Upper or Floating Donut Unit Lower or Reinforced Composite Plastic Timber, or Reinforced Plastic Timber Supporting Chain Set or Polyethylene Timber Facing or Inner Bearing Surface/Wearing Pads or Swap a Complete in Service Floating Donut Unit Without SMC with a Complete Ashore Floating Donut Unit Without SMC and Swap a Complete in Service Floating Donut Unit Without SMC with a Complete in Service Donut Unit Without SMC

This price is full compensation for all machining, furnishing and incidentals and for all labor, equipment, materials.