

SECTION 35 59 13.16

EXTRUDED MARINE FENDERS  
**11/21**

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM INTERNATIONAL (ASTM)

ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A123/A123M	(2017) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A153/A153M	(2023) Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A563	(2021; E 2022a) Standard Specification for Carbon and Alloy Steel Nuts
ASTM B695	(2021) Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel
ASTM D395	(2016; E 2017) Standard Test Methods for Rubber Property - Compression Set
ASTM D412	(2016; R 2021) Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension
ASTM D471	(2016a) Standard Test Method for Rubber Property - Effect of Liquids
ASTM D573	(2004; R 2019) Standard Test Method for Rubber - Deterioration in an Air Oven
ASTM D575	(1991; R 2012) Rubber Properties in Compression
ASTM D1171	(2018) Standard Test Method for Rubber Deterioration - Surface Ozone Cracking Outdoors (Triangular Specimens)
ASTM D2240	(2015; R2021) Standard Test Method for

Rubber Property - Durometer Hardness

ASTM F844	(2019) Standard Specification for Washers, Steel, Plain (Flat), Unhardened for General Use
ASTM F2192	(2005; R 2022) Standard Test Method for Determining and Reporting the Berthing Energy and Reaction of Marine Feeders

INTERNATIONAL NAVIGATION ASSOCIATION (PIANC)

PIANC 2002	(2002) Guidelines for the Design of Fender Systems: 2002
------------	--

Japanese Standards Association (JSA)

JIS B 1048	(2007) Fasteners - Hot Dip Galvanized Coatings
JIS B 1180	(2014) Hexagon Head Bolts and Hexagon Screws
JIS B 1181	(2014) Hexagon Nuts and Hexagon Thin Nuts
JIS B 1256	(2008) Plain Washers
JIS G 3101	(2020) Rolled Steels for General Structure
JIS H 8641	(2021) Hot Dip Galvanized Coatings
JIS K 6251	(2017) Rubber, Vulcanized or Thermoplastic-Determination of Tensile Stress-Strain Properties
JIS K 6253-3	(2023) Rubber, Vulcanized or Thermoplastic - Determination of Hardness - Part 3: Durometer Method
JIS K 6257	(2017) Rubber, Vulcanized or Thermoplastic - Determination of Heat Ageing Properties
JIS K 6262	(2013) Rubber, Vulcanized or Thermoplastic - Determination of Compression Set at Ambient, Elevated or Low Temperatures

1.2 SYSTEM DESCRIPTION

1.2.1 Extruded Fenders

Extruded fenders are elements typically manufactured in a long length by an extrusion process. After manufacture, the elements are cut to length. These fender elements are typically used as fenders for small craft, rub strips on marine structures, and energy absorbing elements at the wale. Examples of extruded fender shapes are 'Side Mounted Hollow Bore', 'Cylindrical', 'D', 'Square', 'W' and 'Wing'.

### 1.2.2 Molded Fenders

Molded fenders are elements manufactured by the molded process. They typically have embedded metal plates cast into the molds. The fender elements are typically used as fenders for medium to large, flat sided vessels. The elements can be used as stand-alone fenders, combined with multiple fenders and a face panel, and energy absorbing elements at the wale. They include the shear fenders which absorb energy by deflecting parallel to the attachment plane. Examples of molded fender shapes are 'Leg Type', 'Arch Type', 'Cell Type', and 'Cone Type'.

### 1.3 SUBMITTALS

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

#### SD-03 Product Data

Galvanized Steel Hardware; G

Extruded Fender; G

#### SD-05 Design Data

Rubber Fenders; G

Energy-Deflection Curve; G

Load-Deflection Curve; G

#### SD-06 Test Reports

Minimum Tensile Strength

Shore Hardness (Durometer)

Maximum Compression Set

Minimum Elongation

Ozone Resistance; G

Water Absorption; G

Heat Resistance; G

Compression Deflection Resistance

Fender Compression Test

#### SD-07 Certificates

Galvanized Steel Hardware Certificates; G

#### SD-08 Manufacturer's Instructions

## Installation Instructions

### SD-10 Operation and Maintenance Data

#### Fender Manual

#### 1.4 DELIVERY, HANDLING AND STORAGE

Fenders must be undamaged when delivered. Handle and store fenders so as to prevent damage, such as bending or abrading end fittings, cutting of rubber, or damage to coating of hardware. Protect fenders from exposure to damaging liquids, oils, greases and extended exposure to sunlight.

##### 1.4.1 Rejection

Fenders that are delivered to the site in a damaged condition or that are not in conformance with this specification are subject to rejection. Replace any rejected materials with suitable materials, at no additional cost to the Government.

##### 1.4.2 Fender Marking

Unless unsuitable for specified fender or otherwise specified, identify all fenders in readable characters at least 25 mm high, either directly or on corrosion- and sunlight resistant permanently attached tags. The markings must include the following:

- a. Full or abbreviated manufacturer name,
- b. fender size model or part number designation,
- c. fender serial number, and
- d. other information as the purchase specification or contract requires.

##### 1.4.3 Fender Instructions and Manual

Provide installation instructions and a fender manual describing maintenance requirements for each fender type.

#### 1.5 QUALITY ASSURANCE

##### 1.5.1 Extruded Fenders, Molded Fenders

Fender elements must be manufactured of rubber, homogeneous and free from any defects, impurities, pores or cracks. Where internal plates are used, the rubber must be bonded to integral steel mounting plates. The plates must be fully encased in rubber to a minimum thickness of 2 mm.

##### 1.5.2 Elastomer Skin

The elastomer skin of the fender must be free from cracks, burrs, warpage, checks, chipped or blistered surfaces, and must have a smooth surface.

##### 1.5.3 Steel Fabrication

The steel used in fabrication must be free from kinks, sharp bends, and other conditions which would be detrimental to the finished product.

Manufacturing processes must not reduce the strength of the steel to a value less than intended by the design. Manufacturing processes must be done neatly and accurately. Make bends by controlled means to insure uniformity of size and shape.

## PART 2 PRODUCTS

### 2.1 EXTRUDED FENDERS

#### 2.1.1 Configuration

Provide dimensions, material specifications, and method of manufacture for each type of fender.

##### 2.1.1.1 Extruded Fender

Fenders must be extruded and continuous in the length indicated. The fenders must be black in color. No encased hardware or molded fenders are allowed. The fender and hardware must be designed and factory tested to the loads per linear meter of fender specified in paragraph PERFORMANCE. Fender anchor bolts and method of anchorage must be of the size and spacing required by the manufacturer's design and testing; however, the size and spacing of anchor bolts indicated must be construed to be the minimum required, unless exceeded by the requirements of the fender manufacturer's design.

##### 2.1.2 Elastomer

The elastomer must have the following properties:

<u>ELASTOMER PROPERTY REQUIREMENTS</u>	
Minimum Tensile Strength (JIS K 6251 or ASTM D412)	16 MPa
Shore Hardness (Durometer) (JIS K 6253-3 or ASTM D2240)	70 <u>plus</u> 5
Maximum Compression Set JIS K 6262 or ASTM D395 Method B	30 Percent
Minimum Elongation	350 Percent
Ozone Resistance (ASTM D1171 Exposure Method B; 70h Bent Loop at 38 degrees C; 50 ppm)	80 H <u>plus</u>
<u>ELASTOMER PROPERTY REQUIREMENTS</u>	
Water Absorption (ASTM D471 Method B; 70h at 100 degrees C; Volume Change plus 5 Percent	10.0 Percent

<u>ELASTOMER PROPERTY REQUIREMENTS</u>	
Heat Resistance (ASTM D573 or JIS K 6257; 70h at 100 degrees C; Ch Tensile, Elong. minus 25 Percent, Hardness plus 10	Shall exceed requirements
Compression Deflection Resistance ( ASTM D575 Method B; 3 S Dwell at 23 degrees C	Shall exceed requirements

### 2.1.3 Performance Requirements

Submit rated performance data (RPD) and published performance curves per ASTM F2192 or PIANC 2002 for the rubber fenders.

Each of the rubber fenders must have the following performance characteristics:

SIZE	ENERGY ABSORPTION	REACTION FORCE
	at rated deflection	at predicted energy attainment
300 mm x 300 mm x 150 mm	12.8 kN-m	159 kN

### 2.1.4 Test Reports

Perform tests on the specified fender within 5 years of submittal of the reports for approval. Test reports must be accompanied by notarized certificates from the manufacturer certifying that the tested material is of the same type, size, quality, manufacture and make as that proposed to be supplied. Perform the following tests:

- a. Minimum Tensile Strength
- b. Shore Hardness (Durometer)
- c. Maximum compression set
- d. Minimum Elongation
- e. Ozone Resistance
- f. Water Absorption
- g. Heat Resistance
- h. Compression Deflection Resistance
- i. Fender Compression Test

Compress fender along its longitudinal axis between two parallel flat plate surfaces to its rated deflection. Record load and the corresponding deflection at 6 mm increments and plot as a graph of load versus

deflection. The Load-Deflection curve must then be integrated to generate an Energy-Deflection curve for the fender.

#### 2.1.5 Break-In Deflection

Break-in deflection is required for buckling type fenders with reaction ratings of 100 tonnes or more, or if the energy-absorbing material has a reaction decrease of more than 10 percent between its original deflection and its fifth deflection. Break-in deflection must be to at least the manufacturer's rated deflection. The number of break-in cycles must be sufficient to assure each elements first on-dock reaction will not exceed its fully broken-in reaction by more than 10 percent.

#### 2.1.6 Fender Hardware

Provide manufacturer's product data for all fender hardware, including bolts, anchor bolts, inserts, nuts, washers, chains, turnbuckles, dimensions, material specifications, working loads and ultimate loads, as applicable. For anchor bolts and inserts, include methods and materials for installation.

##### 2.1.6.1 Galvanized Steel Hardware

All hardware must be hot-dip galvanized in accordance with ASTM A123/A123M, ASTM A153/A153M, ASTM B695, or JIS B 1048 or JIS H 8641 as applicable.

Submit galvanized steel hardware certificates of compliance certifying that materials meet the requirements specified herein. In addition, when the coating is shop applied, submit certificates of conformance or compliance certifying that surface preparation, coverage, and thickness meet the requirements specified.

##### 2.1.6.1.1 Plates and Bars

ASTM A36/A36M or JIS G 3101 SS400.

##### 2.1.6.1.2 Bolts, Nuts and Washers

Bolts, nuts and washers must be ASTM A307 or JIS B 1180. Nuts must be ASTM A563, grade A heavy hex, or JIS B 1181. Washers must be ASTM F844 of carbon steel, JIS B 1256 OR JIS G 3101 SS400.

### PART 3 EXECUTION

#### 3.1 EXTRUDED FENDERS

Tighten the bolts per the manufacturers requirements.

#### 3.2 CONNECTIONS

##### 3.2.1 Antiseize Compound

Coat threads of bolts prior to applying washers and nuts. Recoat bolt thread projection beyond nut after tightening.

-- End of Section --