Marine Rubber Fender

Mooring & Docking Equipment

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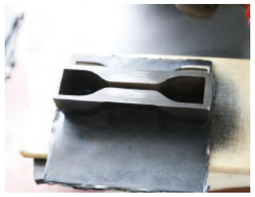
How GLEN ensure Fenders Quality?



GLEN's fenders are manufactured from high quality nature rubber and other styrene butadiene SBR based compounds.

*GLEN shall **test raw material** for each batch of fenders including: Tensile strength, elongation at break, compression set (70℃， 22h,25%), hardness (shore A), tear resistance Die B, ozone aging (40℃, 48h,20%50pphm), and hot air aging.

*GLEN's fenders shall be tested in accordance with the requirements of **PIANC's "Guidelines** for the Design of Fender Systems: 2002" and ASTM F2192-05 "Standard Test Method for Determining and Reporting the Berthing Energy and Reaction of Marine Fenders"

***Performance verification testing** is to be undertaken on the fenders units supplied. All fenders shall be fully pre-compressed at least once prior to installation.

*Fender **chains' safety factor is 2~3 times** of working load.

*Fender mounting fixings, structural steel and chains are well painted. Mounting fixings and chains are painted by **H.D.G** with min. thickness 0.075μm, and the panel is painted by TSA or TSZ to increase anti-corrosion.

*Each fender has a **tracking No.** for manufacturing & testing records.

*All GLEN's fenders have **one year warranty** calculated from the shipping date.

***3rd party inspection** party LR is GLEN's long-term cooperation partner. LR certification is to be supplied for each batch of fenders supplied.

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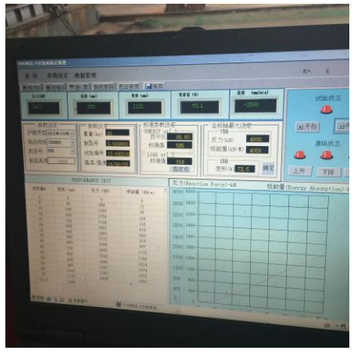
Rubber Property

GLEN's rubber fenders are manufactured from the highly quality nature rubber and other styrene butadiene SBR based compounds to satisfy various performance requirements. Other special rubber is also available upon customers' special requirements. The main performance index is shown as below:

Property		Testing Standard	Unit	Value
Tensile strength		GB/T 528,1;ASTM D 412 Die C; ISO 37; DIN53504; AS1180.2; BS 903.A2; JISK6251	MPa	≥16
Elongation at break		GB/T 528,1;ASTM D 412 Die C; ISO 37; DIN53504; AS1180.2; BS 903.A2; JISK6251	%	≥300
Compression set (70℃, 22h,25%)		GB/T7759,1;ASTM D395 ISO815; DIN53517; AS1683.15.2B; BS 903.A3; JISK6262	%	≤30
Hardness (shore A)		GB/T531,1;ASTM D2240 ISO815; DIN53505; AS1683.15.2B; BS 903.A26; JISK6253	Degree	≤84
Tear resistance Die B		GB/T529; Crescent Test Piece; ASTM624 ISO34.1; DIN53507; AS1683.12; BS 903.A 3; JISK6253	N/mm	≥70
Ozone resistance (40℃,48h,20%,50pphm)		GB/T13642;ASTM D1149 ISO34.1; DIN53509; AS1683.24; BS 903.A 43; JISK6259		No cracking
Hot air aging (70℃, 96h)	Variation ratio of tensile strength	GB/T13512;ASTM D412 Die C; ISO37; DIN53504; AS1180.2; BS 903 A 19; JISK6257	%	≤20
	Variation ratio of Elongation at break	GB/T13512;ASTM D412 Die C; ISO37; DIN53504; AS1180.2; BS 903 A 19; JISK6257	%	≤20
	Hardness (shore A)	GB/T531;ASTM D412 Die C; ISO815; DIN53505; AS1683.15.2B; BS 903 A 26; JISK6253	degree	Max +8



PIANC Type Approval

PIANC type approval can prove the products have a reliable quality and the reasonable design requirements.

1 .Following conditions need to be determined in order to choose a suitable fender system

1）Effective berthing energy of vessel
2）Reaction force allowed by the berthing structure
3）Maximum hull pressure the vessel can withstand
4）Position and area for the fender system to protect
5）Natural environment (including wind, current and wave, etc.)

2 .Required information

1）Vessel type: general cargo vessel, oil tank, container ship, bulk cargo carrier, ferry, cruise and workboat, etc.
2）Weight: gross tonnage, dead weight tonnage, displacement, etc.
3）Length of vessel 4）Width of vessel 5）Depth of vessel 6）Laden draft 7）Free board

3 .Berthing structure

1）Type: wharf, jetty, pier, etc. 2）Construction: pile type, gravity type
3）Elevation: top deck (plat form) level, high water level and low water level For existing quay structure, following additional information is also needed:
4）Space for fender installation at the relative elevation above sea level
5）Allowable horizontal impact force acting on the structure

4 .Natural conditions

1) Wind: direction and speed 2) Current: direction and speed 3) Wave: height, period and direction

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Front Panel Design

1. How to design the front panel?

The main function of front panel is to distribute the reaction forces from fenders units into the ship's hull, so the design should be suit each individual berth. The loads and stress loads exert to front panel will depend on many factors- the type of ship, berthing mode, characteristic of the rubber fender and tidal range etc. The design of front panel should meet the following requirements:

1. Resistance to bending moments and shear forces
2. Resistance to impact on part
3. There is no deflection on front panel and face pad during the compression
4. Suitable corrosion protection for intended environment

2. What's the structure type of front panel?

The front panel structure includes open style and closed style. The open style consists of steel pad, H steel and across steel. Closed style consists of steel pad, back steel and H steel.

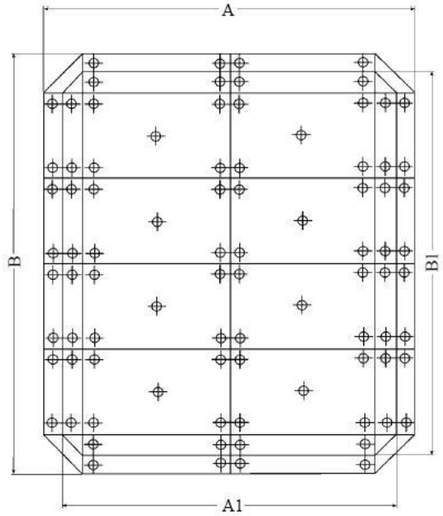
3.How to decide the dimension of the front panel?

The following requirement should be considered in the design

$$P=\frac{\leqslant R}{A_1 B_1} \leqslant Py$$

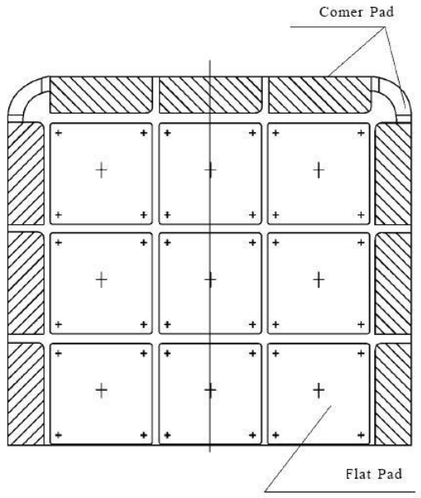
Where P = Hull Pressure

P= The sum of maximum reaction force of all fender (KN)
A1 = Valid width of front panel (m)
B1= Valid length of front panel (m)
Py= Hull allowable surface pressure (KN/m²)



Face Pad Design

1. The face pad is assembled with a flat pad and a corner pad as shown in the figure.



1.Specification

Type	Dimension (L x W mm) (thickness is 30mm or 40mm)					
Flat Pad	500 x 500	600 x 600	600 x 450	600 x 300	450 x 450	300 x 300
Corner Pad	500 x 220	600 x 220	300 x 220	450 x 220	380 x 220	

2.Material

Ultra high molecular weight polyethylene or Nylon resin are chosen as the material for face pads whose performances are shown in the following table.

Physical Performance

Physical performance/ Material	Density	Elongation at Break %≥	Tensile Strength MPa≥	Abrisio n Rate	Friction Factor	Yield Strength MPa≥	Compression Strength MPa≥	Resistance of shocks Kg/cm	Youngs Mudulus Kg/cm²
Nylon Resin	1.15	20	68.6	0.3	0.2	98	88.2	200	26000
PE Resin	0.9-1.00	20	24.5	0.5	0.2	19.6	19.6	75	5600-10500

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Chain Design

1. There are 3 types of chains in the fender system: tension chain, weight chain, and shear chain. The tension chain is to protect the fender from the damage while under local compression. The weight chain is to support the weight of front panel and the face panel. The shear chain is to protect the fender from damage while in shear deflection.

1. The following items should be noted in chain design:

1.1 the chain dimension should be as exact as possible, not too loose or too tight

1.2 the chain can not be twisted as this reduces the load capacity

1.3 open link is preferred

1.4 the initial angel of the chains is important. Normally weight chains are set at a static angle of 15~25 degree

1.5 all the chains must be with safety factors which should be 2-3 times of the work load

1.6 shackle selection: the dimension of the shackle is usually the same as the dimension of the chain , but if the shackle is required to bear the same load with the chain, thicker shackle is preferred

1.7 selection and calculation of chain

$h_1 = L\sin Ø_1$

$h_2 = h_1 - D$

$Ø = \text{asin.}\ [h_1 - D / L]$

$LW = \mu.\sum R + W / 9.81.n.\cos Ø_2$

$Lb = F_s . LW$

$H2 = H1 - D$

$Ø_2 = \text{a sin}\ [(H1 - D) / L]$

$T = (\mu * R + W) / 9.8 * n * \cos Ø_2$

R: combined reaction of all rubber fenders (KN)

μ: friction coefficient of face pad material (0.2)

W: the total weight of frontal panel, face pad and fender

$Ø_1$: static angle of chain (degree)

$Ø_2$: dynamic angle of chain (degree)

H1: height of fender before deflection (m)

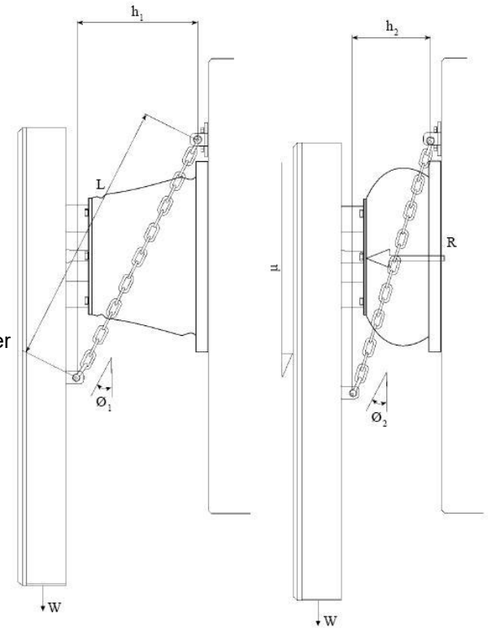
H2: height of fender after deflection (m)

L: length of chain (mm)

T: safe working load of chain (T)

D: fender compression (mm)

N: number of chains acting together



Regular Inspection

Fender systems used for large vessel berthing are usually assembled with frontal panels to reduce the hull pressure, they are more complicated in structure than the traditional fenders for general purpose. The fender system will lose its protective function in case the structure was damaged. Therefore regular inspection is compulsory to be carried out for long-term operation safety.

After the fender system is installed and put into service, inspection shall be carried out each time after berthing of the first three ships and then monthly inspections are to be conducted.

Inspection scope:

1 .Check the foot bolts for fender buffer installation and the bolts for fastening frontal panel. Fasten them enough in case of any loose and then fix the fastening bolt and washer by spot welding.

2. Check the fender buffer for any break or cut. Please contact our company immediately for any serious damage.
3. Check the frontal panel for any dent, crack or corrosion. If does, please contact our company. Annual anti-corrosion treatment is to be carried out to the frontal panel to avoid rusting.
4. Check the front panel for any inclination. The material accumulation in the inner part of front panel may cause frontal inclination, so the accumulations shall be cleaned as much as possible
5. Check the front panel for any scratching or compression damages, replace the damaged pads in time.
6. Check the concrete structure area where the fender system installed for any crack appearance. If crack exists, contact relevant department immediately for treatment.
7. Check the elastic rubber parts for suspending the front panel to ensure them under proper condition, replace any unpractical one.

Super Cell Fenders

Super cell fenders have a long history and the current structure is the result of many years improvement and continious refinement. The cell fenders are interchangeable with many older cell fenders as they have kept the same installation dimension. The cell fenders come in a great range of standard sizes and can meet multi-berthing conditions.

Features

- High performance, reasonable structure
- Can support large panes
- Strong, well-proven design
- Large range of performance

Applications

-Bulk terminals
-Oil and LNG facilities
-Container berths
-RoRo and cruise terminals
-Offshore platform
- Multi-user berths

Super Cone Fenders

Super cone fenders are the latest generation of fenders with high performance and efficiency. The conical body makes it very stable even at large compression angle.

Features

-big deflection, high performance
-stable shape resists shear
-can support large panel
-better performance on angel compression
--wide range sizes, can meet multi-design requirements
-easy installation

Applications

-general cargo berths
-oil and LNG facilities
-container terminals
-Ro-RO and cruise terminals
-bulk terminals

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Arch Fenders

Arch fenders are new generation of V type fenders which are simple and rugged so can be used in most severe conditions. Arch fender can be fitted with either UHMW-PE face pads or connected to steel panels.

Features

-low reaction force, high energy absorption
-simple and reasonable design, long service life
--excellent shear performance
--can be fitted with frontal panel
-large range of standard sizes

Applications

-general cargo berth
-RoRo berths
--workboat harbors
--barge and tug berths

Leg Fenders

Leg fenders have very high performance. They are versatile and can be combined in unlimited combinations of lengths and directions can meet various berthing conditions.

Features
-versatile modular system
-highly efficient shape
-strong in lengthwise shear
-large range of performance
-easy installation
-low maintenance

Applications:
-container terminals
-tanker berths
-RoRo and cruise ships
-bulk and general cargo berths

Cylindrical Fenders

Cylindrical fenders features simple design but versatile as well as being easy to install. This type of fenders is ideal for berths serving large also small vessels special for the upper protection of gravity quay wall.

Features
-Low reaction, reasonable energy absorption, low hull pressure
-Easy to install and maintain
-Versatile installation

Applications:
-Bulk cargo berths
-General cargo quays
-Ro-Ro and ferry terminals
-Fishing and workboat berths
-Pontoons and floating structures

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Tug Fenders

Tug fenders are installed on tug boats and work longer at extreme conditions.

Tug fenders include cylindrical fenders, M type fenders, W type fenders, key hole fenders and extruded fenders.

Wheel Fenders

Wheel fenders are widely used on exposed corners to help ships mannoeuvre into berths and narrow channels such as locks and dry-dock entrances.

Features
-Low rolling resistance
-Low maintenance cost
-Be used as single or multiple rows

Applications
-Dry-dock entrances and walls
-Lock approaches
-Exposed corners

Pneumatic Fenders

Pneumatic fenders are ideal for ship-to-wharf and ship-to-ship transfers. Larger fenders are commonly fitted with a chain-tyre-net for additional protection

Features

-Easy and fast to deploy
-Very low reaction, high energy absorption
-Suitable for small and large tidal ranges
-Easy to install

Applications

-Oil and gas tankers
-Fast ferries and aluminium vessels
-Temporary and permanent installations
-Rapid or emergency berthing

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Installation on site

Special type

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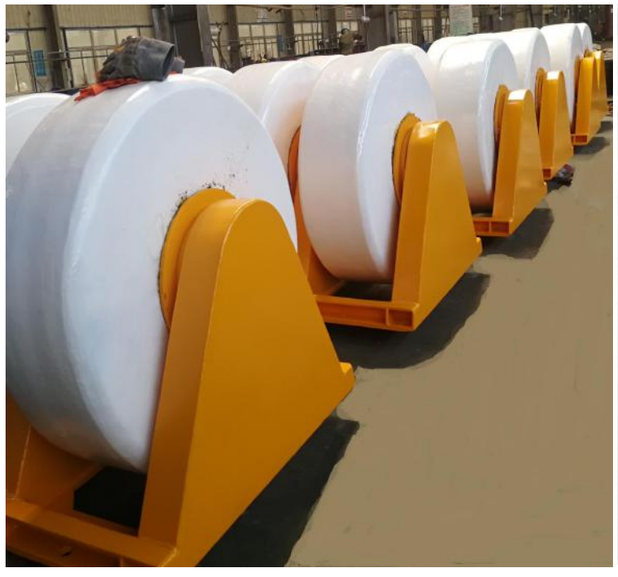

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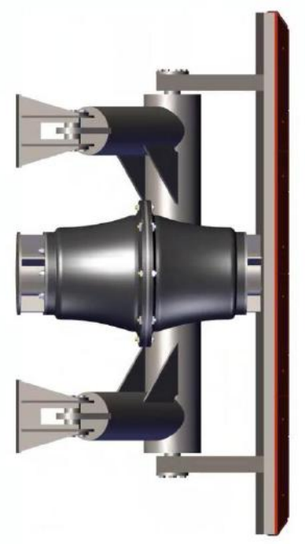

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