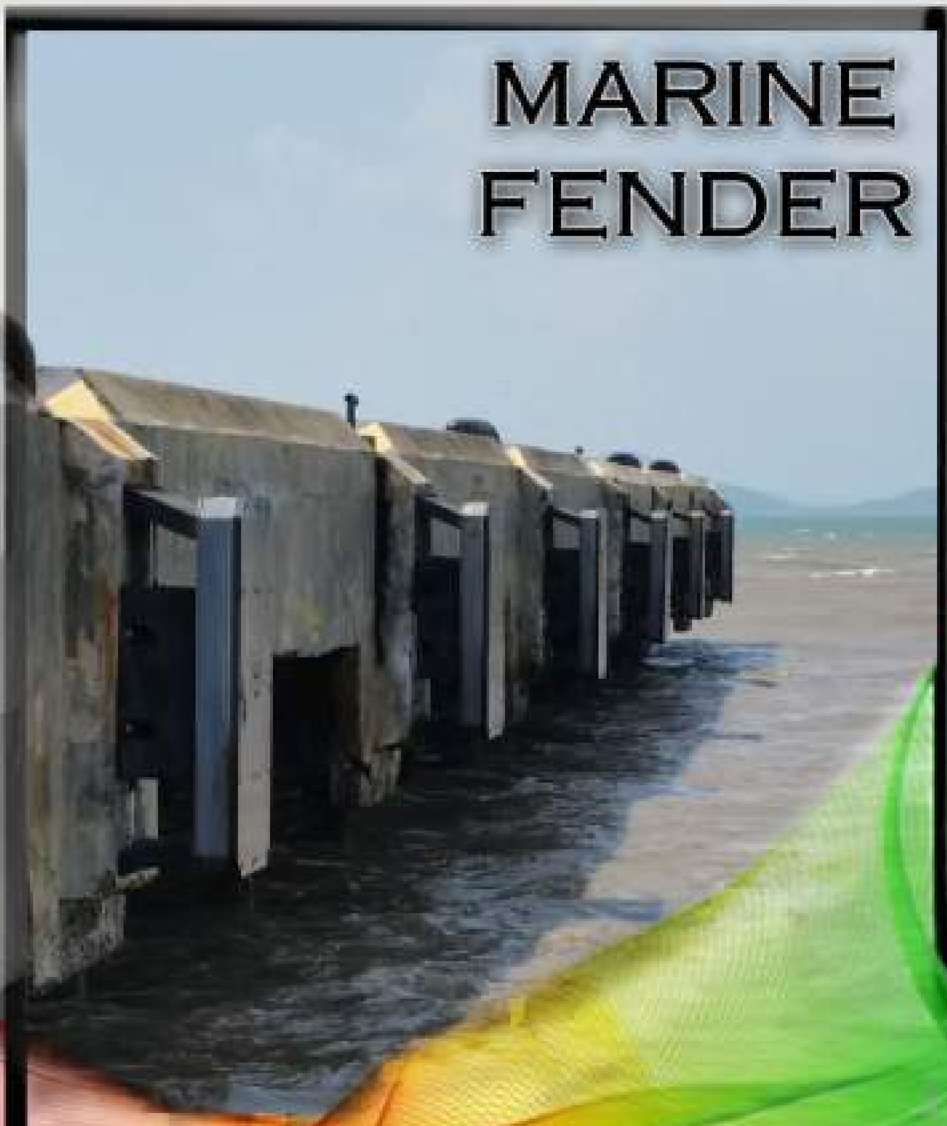
HICOR

MARINE FENDER



HICOR MANUFACTURING CORPORATION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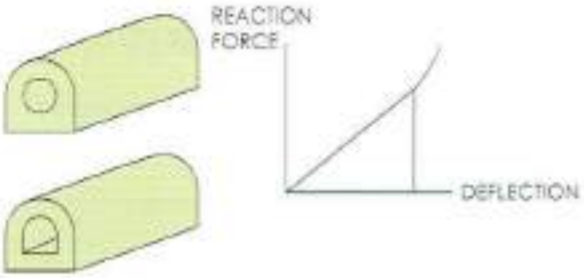
CONTENTS

1) HICOR Fender

The purpose of the fendering system is to serve as a bumper to protect the hull and berthing facility from damage when vessels berth alongside.
Another function is to operate as a shock absorber by absorbing the berthing energy of a vessel on the berthing operation and soften the berthing impact to the berth and hull.
Therefore, the two main functions of the fendering system are:

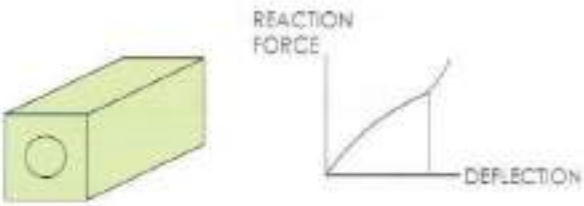
1) To perform as a bumper to protect the hull and berthing facility from damages.
2) To perform as a shock absorber on the berthing operation.

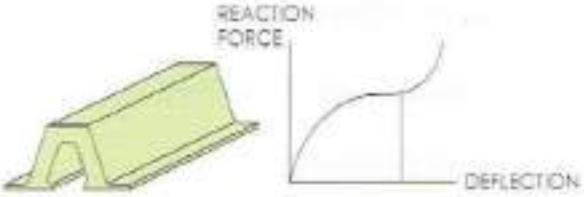
The adoption of a suitable fendering system will help to ensure smooth berthing operation.
Hence it is important to give priority to the selection of a fendering system that can actually reduce the whole berthing facility construction cost, instead of simply choosing low-cost fenders.



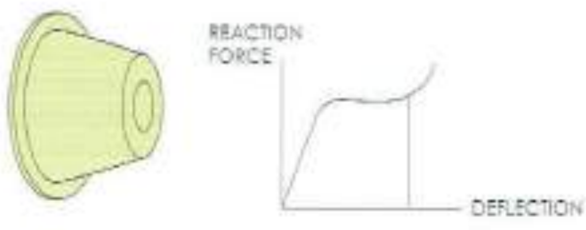
2) History

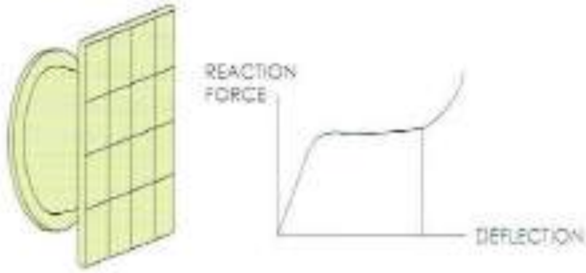
In the early days, vessels are made of wood and run by wind or human efforts. There was no necessity to use special fenders other than timber fenders for berthing vessels.
With the advanced technologies after the industrial revolution, vessels are propelled by steam engines or diesel engines, and hull are constructed out of steel in place of wood.
It becomes possible for larger size vessels to be onstructed with thinner and weaker hulls structures with improved knowledge in ship-building and cost minimization.
Due to the lack of suitable fendering system, large vessels were forced to moor at anchorages and cargoes were transferred by small boats or barges. Alternatively, the large vessels had to berth alongside with strong hull construction. With the development of mass transportation, it was important to develop fendering system to enable vessels to berth alongside of the quay.
Cylindrical type rubber fenders was developed in the 1940's, which allowed vessels to berth directly at the wharves. However the cylindrical fender is easily damaged because it is installed by chains and shackles, and has a high reaction force.
To overcome the above defects, V-shape fenders were developed after some research and development works done by the relevant authorities, together with fender manufacturing in Japan in the 1960's.





V-shape fenders are anchored directly onto the quay walls instead of securing chains as in the case of cylindrical fenders. It offers better durabilities and energy absorption capacity with lower reaction force as compared with cylindrical fenders.
After 1960's, the research and development works continued to develop more ideal fenders for each individual special requirement.
Today, with the correct application of the suitable fendering systems from various kinds of fenders, construction costs of berthing are nationalized.
You can select suitable fenders to meet your requirements, for berthing of small boats to super tanker, from cylindrical type fenders,V-shape fenders, improved V-shape fenders, circle fenders, improved circle type fenders, fenders with steel frontal panels, pneumatic or foam type floating fenders, tugboat fenders, roller fenders, and simple D or square shaped fenders.





3) FENDER TYPES AND CHARACTERISTICS

3-1) Characteristics of fenders

The characteristics in terms of performance of rubber fenders are expressed by:

A) Energy absorption: E (Tonf - M)
"Rated energy absorption" is the amount of energy absorbed by the fender when it is compressed to the rated deflection.
It is given by area under the reaction deflection curve.

B) Reaction force: R (Tonf)
"Rated reaction force" is the reaction force corresponds to rated deflection.

C) Rated deflection: (%)
"Rated deflection" is the most efficient on the relation between energy absorption value (E) and reaction load value ®, that is the deflection at which the ratio of E to R makes the maximum values (E/R).

D) Hull pressure: (Tonf/m^2)
"Hull (surface) pressure" is the force transferred to hull (per sq. meter) of a ship from the fender. Hull (surface) pressure = (reaction force)/(contact area).

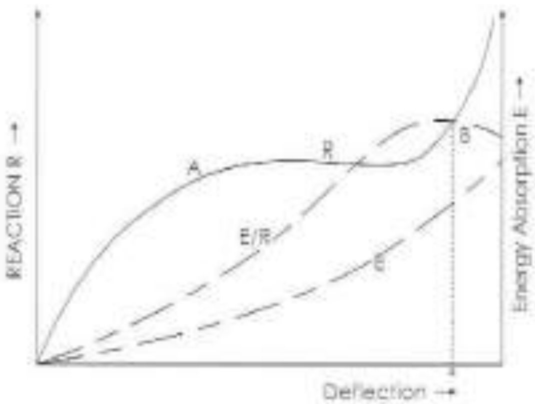


Fig.1-1 Performance Curve

HICOR

INTRODUCTION

3-2) Types of fenders

During compression for some fenders, the relationship between deflected in Fig. 1-1, while Fig.1-2 depicts the performance curve of the other fenders. (Deflection is expressed by a ratio to height of fender).

Buckling (Constant Reaction) type fenders having the performance curve as shown in Fig.1-1 will have a reaction load that suddenly rises comparatively as a result of elastic compressive deformation in the initial stage of deflection. However, when the reaction load reaches point A, it tends to remain almost constant within a certain zone regardless of increase in deflection once elastic buckling deformation has taken place. If the deflection progresses further, hollow section of fender will be closed and elastic compressive deformation will be restored resulting in a sudden rise in reaction load.

Fenders having the performance curve as shown in Fig.1-2 are the constant elastic modulus type fenders, and hollow cylindrical fenders will fall into this category. Approximately in proportion to increase in deflection, the reaction load will gradually increase and then suddenly rise after it reaches point B where the hollow section is closed. In this case, similar to bucking type fender. The deflection corresponds to point B (see Fig.1-2 for the prescribed deflection).

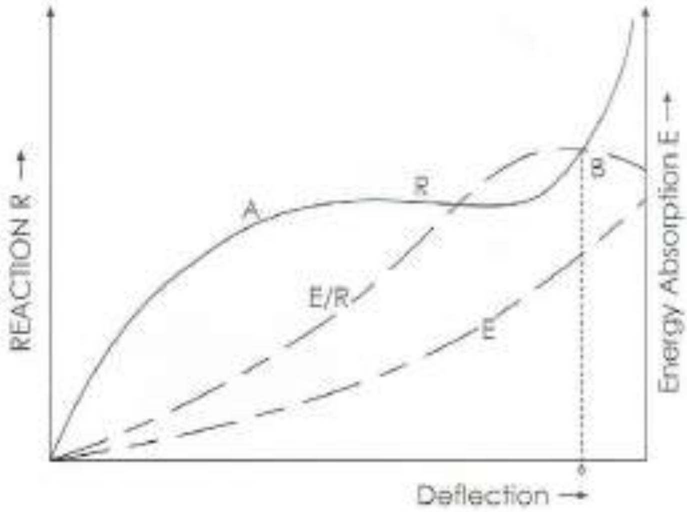


Fig.1-1 Performance Curve

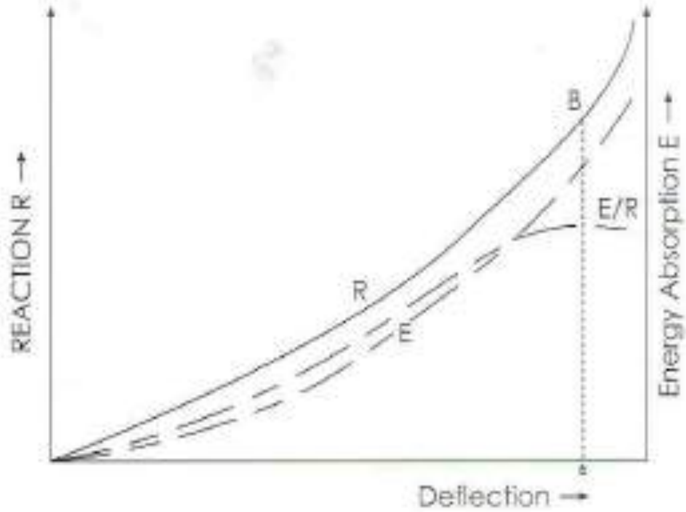


Fig.1-2 Performance Curve

DESIGN DATA COLLECTION

1) BASIC ITEMS FOR FENDER'S SELECTION

A) Berthing energy
B) Allowable reaction force from fender to the structure
C) Allowable hull (surface) pressure
D) Position and area to be protected by fendering system
E) Natural force (wind, current, wave)

2) REQUIRED INFORMATION
(*: important)

2-1) Vessels (refer to chapter 3.1): vessel

A) Type *
: General cargo, Oil tanker, Container carrier, Bulk carrier, Ferry boat, Passenger boat, Work boat, Tug boat, War ship.
B) Weight *
: D.W.T., D.P.T., or gross ton
C) Length
: Loa or Lpp
D) Breadth
E) Draft
G) Free board

2-2) Berthing facility (Berthing structure)

A) Type *
: Wharf, Jetty, Pier, Dolphin or Pontoon
B) Structure
: Pile type or gravity type
C) Elevation *
: Top deck (platform) level, High water and Low water level.

For existing quay structure, the following additional information are required:
D * Space for fender installation with its elevations from sea water level.
E) * Horizontal allowable force acting on the structure.

2-3) Natural condition

A) Wind: Direction and speed
B) Current: Direction and speed
C) Wave: Height, period and direction

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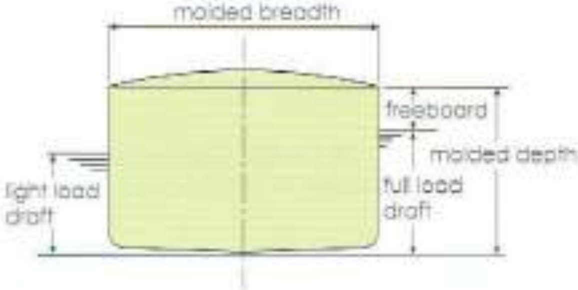
DESIGN OF FENDER SYSTEM

1) VESSEL

As a general rule, one should use the actual values of the ship to calculate the berthing energy. However, in some cases where the actual values are not known, one can refer to the attached "Appendix C TableC-1" on Page 16 showing the typical ship's measurements given by the PIANC 2002*.



Usually, ships are built according to the standard sets of dimensions and carrying capacity. The terminology used are defined as follows:

TERMINOLOGY		DEFINITIONS
Gross Tonnage	GT (ton)	Total volume of vessel and cargo. It is derived by dividing the total interior capacity of a vessel by 100 cubic feet.
Net Tonnage	NT (ton)	Total volume of cargo that can be carried by the vessel.
Displacement Tonnage	DFT (ton)	Total weight of the vessel and cargo when the ship is loaded to draft line.
Dead Weight Tonnage	DWT (ton)	Weight of cargo, fuel, passenger, crew and food on the vessel.
Light Weight	LW (ton)	Weight of ship.
Ballast Weight	BW (ton)	Weight of ship and water added to the hold or ballast compartment of a vessel to improve its stability after it has discharged its cargo.
Length of ship	Loa or Lpp (m)	The length from the top of the bow to the end of the stern of a ship.
Breadth of ship	B (m)	The distance across the parallel section of the sides of a ship.
Loaded Draft	d (m)	The distance from the water surface to the keel of the ship when the ship is loaded to the freeboard mark.
Light Draft	db (m)	The distance from the water surface to the keel of the ship when the ship is at light.
Depth of Ship	D (m)	The actual Depth of ship.

Note: PIANC* : PIANC Working Group MarCom WG33 Guidelines for the design of Fender Systems: 2002

2) BERTHING ENERGY

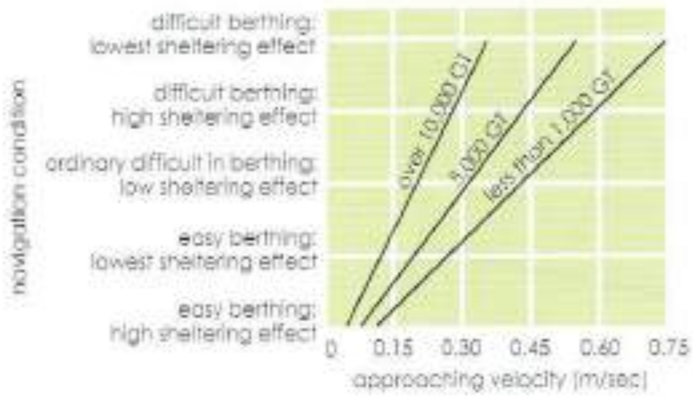
2-1) Berthing Energy

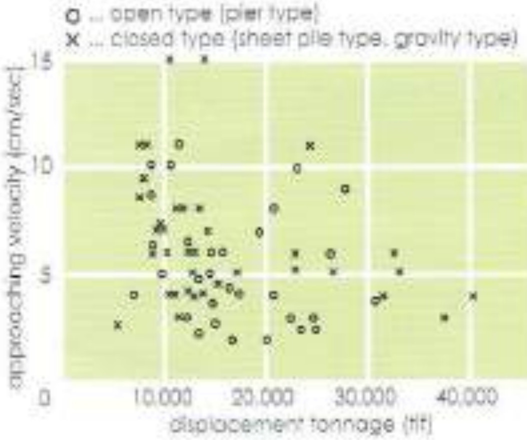
Effective berthing energy is calculated as follows:

$$E = \frac{M \cdot V^2}{2 \cdot g} \text{ Ce. Cm. Cs. Cc.}$$

where:

E : Effective berthing energy (ton-m)
M : Displacement tonnage (tons)
V : Berthing velocity (m/sec)
Ce : Eccentricity Coefficient
Cm : Hydrodynamic Mass coefficient
Cs : Softness coefficient (Generally accepted coefficient 1.0)
Cc : Berth configuration coefficient (Generally accepted coefficient 1.0)





g : Acceleration of Gravity (9.8m/sec²)

2-2) Berthing velocity (V)

Berthing velocity is one of the most important factors for designing a fendering system.
Berthing velocity of vessels is determined from values of measure or from experience at existing berthing facility.
Generally, we would like to suggest following figures as designated berthing velocity.

a) Good berthing conditions, sheltered.

b) Difficult berthing conditions, sheltered.

c) Easy berthing conditions, exposed.

d) Good berthing conditions, exposed.

e) Navigation conditions difficult, exposed.

* These figures should be used with caution as they are considered to be high.

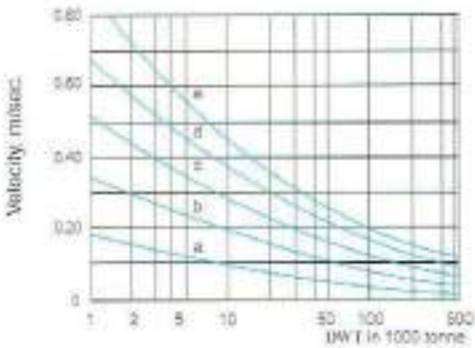


Figure 4.2.1. Design berthing velocity (mean value) as function of navigation conditions and size of vessel (Brolsma et al. 1997)

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2-3) Hydrodynamic Mass coefficient: Cm

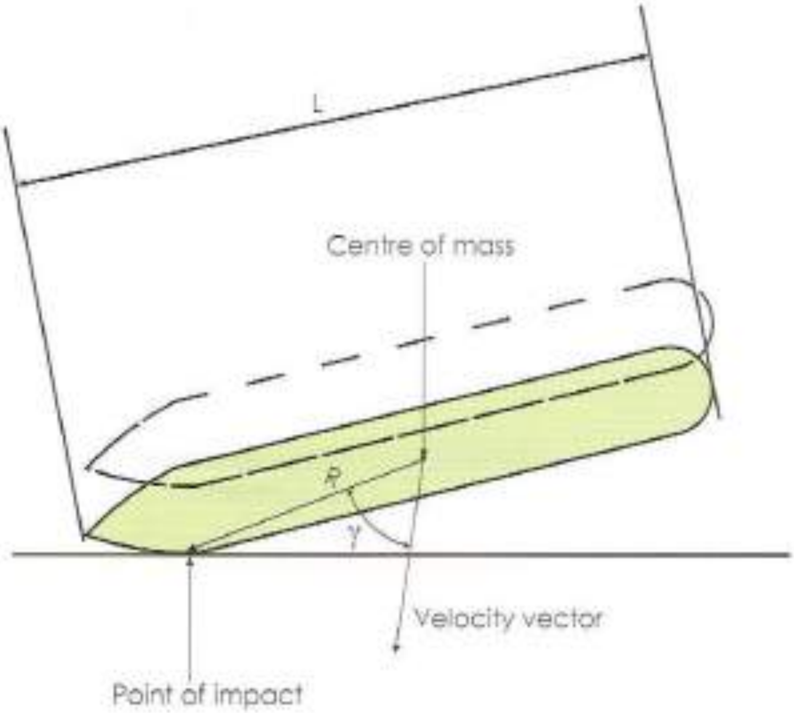
The hydrodynamic mass coefficient allows the movement of water around the ship to be taken in account when calculating the total energy of the vessel by increasing the mass of the system. The hydrodynamic mass coefficient (Cm) may be calculated by the following equation.

$CM = 1 + (2d / B)$

2-4) Eccentricity coefficient: Ce

A ship mostly berths at a certain angle. Therefore, vessel turns simultaneously at the time offirst contact.
Some of the kinetic energy of the ship is converted to turning energy,
and the remaining energy is transferred to the berth.
The eccentricity factor (Ce) represents the proportion of the remaining energy to the kinetic energy of the vessel at berthing.

$Ce = (K^2 + R^2 \times \cos^2 \gamma) / (K^2 + R^2)$



- K = radius of gyration of the vessel (depending on block coefficient, see below) (in m)
- R = distance of point of contact to the centre of the mass (measured parallel to the wharf) (in m)
- γ = angle between velocity vector and the line between the point of contact and the centre of mass.

$$K = (0.19\,C_b + 0.11)*Lpp \text{ and } C_b = \frac{M}{L*B*D*\rho}$$

Where:

Cb = block coefficient (usually between 0.5 - 0.9, see below)
M = mass of the vessel (displacement in tonnes);
L = length of vessel (in m);
B = breadth of vessel (in m);
D = draft of vessel (in m);
ρ = density of water (about 1.025 ton/m³ for sea water)

Lacking other data, the following may be adopted for the block coefficient

For container vessels	0.6 - 0.8
For general cargo vessels and bulk carriers	0.72 - 0.85
For tankers	0.85
For ferries	0.55 -0.65
For Ro/Ro-vessels	0.7 - 0.8

2-5) Softness Coefficient (Cs)

Part of the kinetic energy of the berthing vessel will be absorbed by elastic deformation of the vessel hull.

Cs is generally taken as 1.0

Cs for VLCC is used as 0.9

2-6) Berth Configuration Coefficient (Cc)

The berth configuration coefficient ("Cushion Factor") indicates the difference between an open structure (e.g. piled jetty) and closed structure (e.g. quay wall)

For open berth and corners of quay wall Cc is generally taken as 1.0

For (solid) quay wall under parallel approach Cc is generally taken as 0.9

2-7) Abnormal Impact

Fenders have to be capable of catering for a reasonable abnormal impact. The following table gives general guidance on the selection of the factor for abnormal impact to be applied to the design energy.

The factor of abnormal impact should not be less than 1.1

Type Of Berth Impact	Vessel	Factor for Abnormal Impact Applied to Berthing Energy (Cab)
Tanker and Bulk Cargo	Largest Smallest	1.25 1.75
Container	Largest Smallest	1.5 2.0
General Cargo Ro-Ro and Ferries		1.75 2.0 or higher
Tugs, Work Boats, etc.		2.0

3) ALLOWABLE REACTION FORCE

The allowable reaction force from the impact of the ship is governed by the designed lateral resistance of the berthing structure. If the lateral resistance is exceeded, the structure would be damaged. (This reaction force would also act on the hull of the berthing ship. If the pressure exceeds the hull resistance, the hull would be damaged.)
Therefore the fendering system must be designed such that

REACTION FORCE IN FENDERS < LATERAL RESISTANCE OF STRUCTURE

It is important to note that the reaction force from the impact of a ship is not a constant value. It varies with deformation and is represented by the performance curves of the protecting fender. In design, different types and combination of fenders may be tired out, so as to arrive at a rated reaction force below the allowable resistance of the berthing structure. Generally, the lateral resistance of dolphins and open piled piers are lower than that of the more massive quay wall structures.

4) ALLOWABLE HULL (SURFACE) PRESSURE

4-1) Allowable hull (surface) pressure

The data is not available. In the design of fenders for dangerous cargo vessel such as oil tanker, Allowable hull pressure ranges from 20 tons/m².
There, however, are many cases of tankers berthing on to the fender with surface pressure exceeding 100 tons/m² without any damage of the hull

Type Of Vessel	**Hull Pressure kN/m²**
Container vessels 1st and 2nd generation	< 400
3rd Generation (Panamax)	< 300
4th Generation	<250
5th & 6th Generation	<200
General Cargo Vessels	
=/< 20.000 DWT	400 - 700
> 20.000 DWT 40	<400
Oil Tanker	
=/< 60.000 DWT	< 300
> 60.000 DWT	< 350
VLCC	150 - 200
Gas Carries (LNG / LPG)	< 200
Bulk Carries	< 200
SWATH	These vessels are usually belted
RO - RO Vessel	
Passenger Vessel	

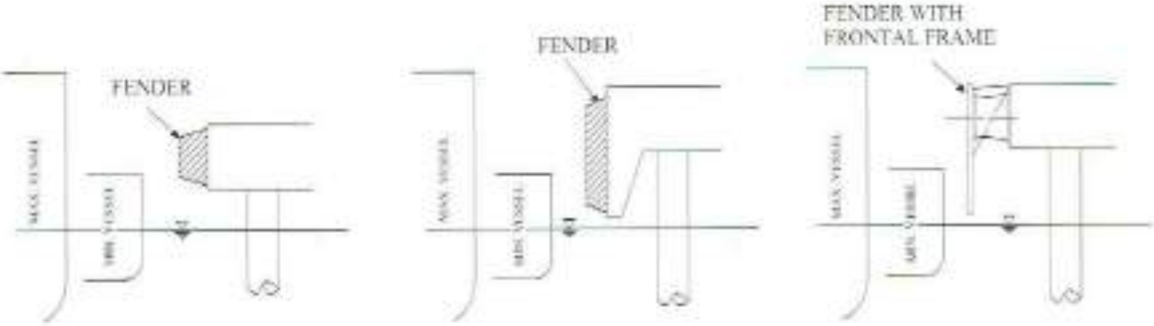
4-2) Actual values of typical fender

The following are the surface pressure of typical fender:
V-Shape : 50 - 140 (ton/m²)
Improved V-shape : 40 - 120
Floating type fender : 10 - 25
Fender with frontal panel : values can be adjusted by changing the size of the frontal panel

5) POSITION AND AREAS TO BE PROTECTED

5-1) Vertical Direction

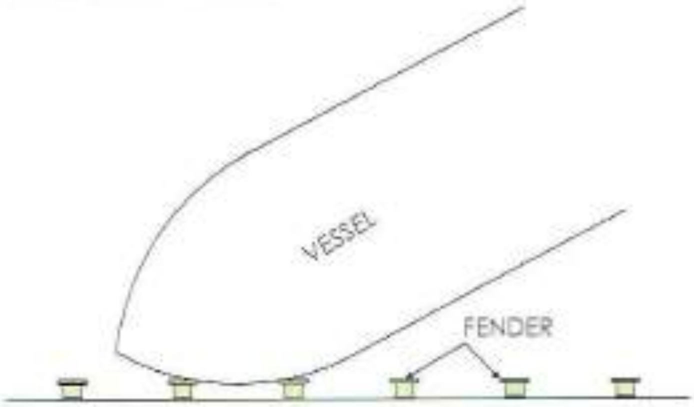
The types of the fenders and its position at the quay must be determined to protect and absorb the berthing energy of all types and size of vessels at all possible tidal range.



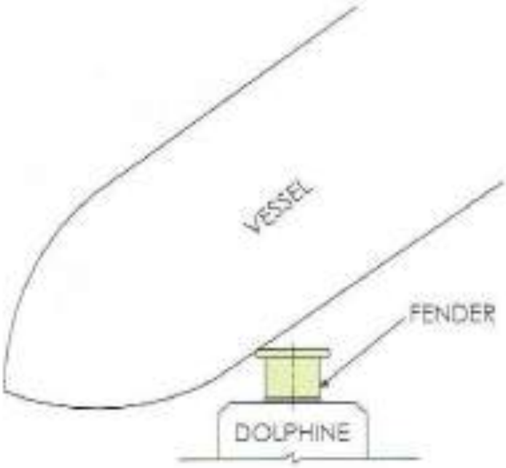
5-2) Horizontal Direction

The interval of the fenders must be determined so as to avoid direct contact with the quay wall under the designed berthing angle and designed deflection of the tenders.

1) Continuous Wharf
(* Refer to ITEM 7) " FITTING INTERVAL OF FENDER"



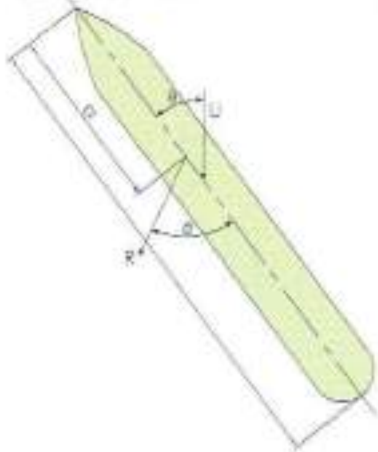
2) Dolphins Wharf



6) NATURAL FORCE

6-1) Wind Force

The wind force acting on the ship in moorage shall be determined using an appropriate method of Calculation. In general, the wind pressure is calculated by the following formula (refer to FIG. 3-10)



$$R1 = \frac{1}{2}\rho \cdot C \cdot U^2 (A_f \cdot \cos^2\theta + A_s \cdot \sin^2\theta)$$

where ;

- R1 : Resultant force of wind pressure (kg)
- ρ : Air density (= 0.123kgs²/m⁴)
- U : Wind speed (m/s)
- A_f : Area of projection of the front of ship above water surface (m^2)
- A_s : Area of projection of the side of ship above water surface (m^2)
- θ : Angle of the wind direction to the center line of the hull (deg)
- C : Coefficient of wind pressure

General Cargo:
$C = 1.325 - 0.05\cos2\theta - 0.35\cos4\theta - 0.175\cos6\theta$

Passenger Ship:
$C = 1.142 - 0.142\cos2\theta - 0.367\cos4\theta - 0.133\cos6\theta$

Oil Tanker
$C = 1.20 - 0.083\cos2\theta - 0.25\cos4\theta - 0.177\cos6\theta$

6-2) Current Force

The resultant force due to the current in the direction of the ship side is calculated by the following formula:

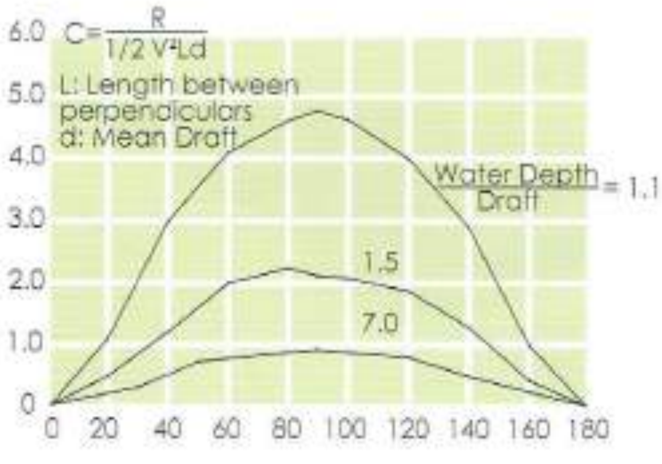
$$R2 = 0.5 \cdot \rho \cdot C \cdot V^2 \cdot As^2$$

Where ;

- R2 : Resultant force due to the current (kgf)
- ρ : Seawater density (= 1.025ton/m3)
- C : Coefficient of fluid pressure
- V : Current speed (m/s)
- As^2 : Area of ship side below the draft line (m^2)

6-3) Wave Force

The wave forces acting on the mooring ship can be calculated by appropriate methods such as the source method, the boundary element method, the finite element method, and the strip method which is most widely used for ships.



7) FENDER SPACING

A ship berths at a certain angle and contacts with the berth at certain point of bow or stern of the ship.
The fitting fender spacing should be determined at a point where ships do not crash during berthing.
At a suitable spacing, the following table is introduced in Technical Note No.30, Japan.

Water Depth	Fender Spacing
-4 ~ -6m	4 ~ 7m
-6 ~ -8m	7 ~ 10m
-8 ~ -10m	10 ~ 15m

The following equation can be used for determining the maximum fender spacing.

$$L = 2\sqrt{r^2 - (r-h)^2}$$

where ;
L : maximum fender spacing (m)
r : bent radius of bow side of ship (m)
h : Height of fenders when effective berthing energy absorbed (m)

If the information of a bent radius of board side is not available, then following equations offer a guideline to the bent radius.

General Cargo ------------------------
500 DWT ~ 30,000 DWT

Bow 5° : $\log r = -0.853 + 0.640 \log (DWT)$
10° : $\log r = -1.055 + 0.650 \log (DWT)$

30,000 DWT ~
$R = \frac{Lpp^2}{16B} + \frac{B}{4}$

Tanker, Ore Carrier ------------------------
DWT 5,000 DWT ~ 30,000 DWT

Bow 5° : $\log r = -0.541 + 0.560 \log (DWT)$
10° : $\log r = -0.113 + 0.440 \log (DWT)$
* (DWT): Dead weight Tonnage of Vessel

30,000 DWT ~
$R = \frac{Lpp^2}{16B} + \frac{B}{4}$

8) DESIGN EXAMPLES

(1) Example 1

i) Design Vessel

Vessel Type	General Cargo	
DWT (tons)	15,000	1,000
Loa (m)	156	67
Lpp (m)	147	62
B (m)	23	10.8
D (m)	13.1	5.8
d (m)	10.4	3.9
V (m/sec)	0.15	0.25
Berthing Point	1/4 point	1/4 point
Eccentricity Coefficient	0.5	0.5

ii) Facility

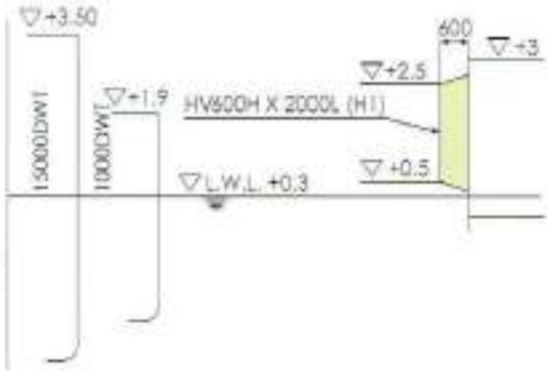
Wharf Length : 180 meter
continuous face
H.W.L. : + 2.0m
L.W.L : + 0.3m
Top elevation of deck : + 3.0m

iii) Berthing energy

DWT (ton)	Ws (ton)	Cb	Cm	Ce	V (m/sec)	B/E (tonf-m)
15,000	21,600	0.599	1.834	0.5	0.15	22.7
1,000	1,690	0.631	1.808	0.5	0.25	4.9

iv) Selection of fender

HV type fender model :HV600H x 2000L (HI)
Performance Fender Height : 0.600 meter
Rated Deflection : 52.5%
Reaction Force : 99.5 Tonf
Energy Absorption : 25.1 Tonf-m > 22.7 Tonf-m
Surface Pressure : 73.7 Tonf/m²



Relation of fenders & vessels at L.W.L
In the case of 1,000 DWT's berthing at L.W.L., the contact length of vessel to fender is 1.4 meter
(= 1.9 - 0.5).
The energy absorption of 1.4 meter length of fender is:
17.6 Tonf-m/1.4 m > 4.9 Tonf-m.

v) Fender Spacing

Please refer to data below for maximum spacing.

Vessel	:		15,000 DWT	1,000 DWT
Bent Radius	:	r (m)	45	8
Fender Height	:	H (m)	0.6	0.6
Fender Deflection	:	d (m)	0.315 (52.5%)	0.138 (23%)
Deflected Fender Height	:	h (m)	0.285	0.462
Max Spacing	:	L (m)	10.1	5.3

We would recommend 5.0 meters of fender spacing as to accommodate the minimum vessel for 1,000 DWT

(2) Example 2

i) Vessel

Kind	Ore Carrier	General Cargo
DWT (tons)	40,000	2,000
Loa (m)	194	83
Lpp (m)	182	77
B (m)	28.4	13.1
D (m)	15.8	7.2
d (m)	11.4	4.9
V (m/sec)	0.12	0.20
Berthing Point	1/4 point	1/4 point
Eccentricity Coefficient	0.5	0.5

ii) Facility

Wharf Length : 250 meter continuous face
H.W.L. : + 3.5 m
L.W.L : + 0.3 m
Top elevation of deck : + 4.5 m
Bottom elevation of deck : + 2.5 m

iii) Berthing energy

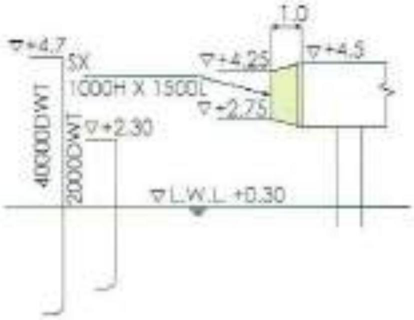
DWT (ton)	Ws (ton)	Cb	Cm	Ce	V (m/sec)	B/E (tonf-m)
40,000	48,586	0.804	1.803	0.5	0.12	32.2
2,000	3,250	0.641	1.772	0.5	0.2	5.9

iv) Selection of fender

= Wrong Selection =

If we select the fender only basing on the calculated berthing energy 32.2 Tonf-m and given space for fender installation, following SH-Fender can be selected as one of the fenders to be installed.

Type of fender	: SX1000H x 1500L (H3)
Performance Rated Deflection	: 52.5%
Reaction Force	: 82.9 Tonf
Energy Absorption	: 34.8 Tonf-m > 32.2 Tonf-m
Surface Pressure	: 49 Tonf/m²

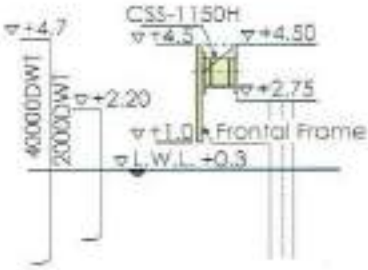


From the above, the small vessel, 2,000 DWT has no contact with the fender. Therefore, the selected fender is not suitable for this application.

= Good Selection =

Alternative 1

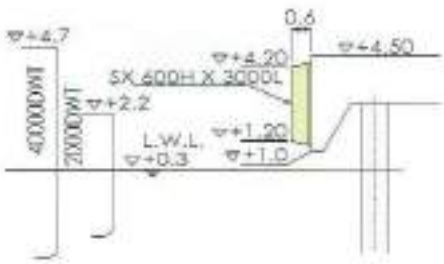
Type of fender	: CSS-1150H (F2)
Performance Rated Deflection	: 52.5%
Reaction Force	: 76.3 Tonf
Energy Absorption	: 38.6 Tonf-m > 32.2 Tonf-m
Frontal Frame	: 1.75 mW x 3.5 mL



= Good Selection =

Alternative 2

Type of fender	: SX 600H x 3000L (H1)
Performance Rated Deflection	: 52.5%
Reaction Force	: 149 Tonf
Energy Absorption	: 37.6 Tonf-m > 32.2 Tonf-m
Surface Pressure	: 74 Tonf/m²



STANDARD SIZE OF VESSELS

Appendix C. Table C-1 — Confidence Limit : 75%

Type	Dead Weight Tonnage (t)	Displa-cement (t)	Length Overall (m)	Length P.P. (m)	Breadth (m)	Depth (m)	Maximum Draft (m)	Wind Lateral Area (m^2)		Wind Front Area (m^2)	
								Full Load Condition	Ballast Condition	Full Load Condition	Ballast Condition
General Cargo Ship	1,000	1,690	67	62	10.8	5.8	3.9	278	342	83	93
	2,000	3,250	83	77	13.1	7.2	4.9	426	541	101	142
	3,000	4,750	95	88	14.7	8.1	5.6	547	708	132	182
	5,000	7,690	111	104	16.9	9.4	6.6	750	993	185	249
	7,000	10,600	123	115	18.6	10.4	7.4	922	1,240	232	307
	10,000	14,800	137	129	20.5	11.6	8.3	1,150	1,570	294	382
	15,000	21,600	156	147	23.0	13.1	9.5	1,460	2,060	385	490
	20,000	28,400	170	161	24.9	14.3	10.4	1,760	2,790	466	585
	30,000	41,600	193	183	27.8	16.2	11.9	2,260	3,250	611	750
	40,000	54,500	211	200	30.2	17.6	13.0	2,700	3,940	740	895
Bulk Carrier*	5,000	6,920	109	101	16.5	8.6	6.2	689	910	221	245
	7,000	9,520	120	111	17.2	9.5	6.9	795	1,090	250	287
	10,000	13,300	132	124	19.2	10.6	7.7	930	1,320	286	340
	15,000	19,600	149	140	21.8	11.9	8.6	1,100	1,630	332	411
	20,000	26,700	161	152	23.6	13.0	9.4	1,240	1,900	369	470
	30,000	37,700	181	172	27.0	14.7	10.6	1,480	2,360	428	569
	50,000	61,100	209	200	32.3	17.1	12.4	1,830	3,090	518	723
	70,000	84,000	231	221	32.3	18.9	13.7	2,110	3,690	585	846
	100,000	118,000	255	246	39.2	21.1	15.2	2,460	4,460	669	1,000
	150,000	173,000	287	278	44.5	23.8	17.1	2,920	5,520	777	1,210
	200,000	227,000	311	303	48.7	25.9	18.6	3,300	6,430	864	1,360
	250,000	280,000	332	324	52.2	27.7	19.9	3,630	7,240	938	1,540
Container Ship**	7,000	10,700	123	115	20.3	9.8	7.2	1,480	1,590	330	444
	10,000	15,100	141	132	22.4	11.3	8.0	1,880	1,990	410	535
	15,000	22,200	166	156	25.0	13.3	9.0	2,490	2,560	524	663
	20,000	29,200	186	175	27.1	14.9	9.9	3,050	3,070	625	771
	25,000	36,100	203	191	28.8	16.3	10.6	3,570	3,520	716	870
	30,000	43,000	218	205	30.2	17.5	11.1	4,060	3,950	800	950
	40,000	56,500	244	231	32.3	19.6	12.2	4,970	4,730	950	1,110
	50,000	69,900	266	252	32.3	21.4	13.0	5,810	5,430	1,090	1,250
	60,000	83,200	286	271	36.5	23.0	13.8	6,610	6,090	1,220	1,370
Oil Tanker	1,000	1,580	61	58	10.2	4.5	4.0	190	280	86	85
	2,000	3,070	76	72	12.6	5.7	4.9	280	422	119	125
	3,000	4,520	87	82	14.3	6.6	5.5	351	536	144	156
	5,000	7,360	102	97	16.8	7.9	6.4	467	726	184	207
	7,000	10,200	114	108	18.6	8.9	7.1	564	885	216	249
	10,000	14,300	127	121	20.8	10.0	7.9	688	1,090	255	303
	15,000	21,000	144	138	23.6	11.6	8.9	860	1,390	309	378
	20,000	27,700	158	151	25.8	12.8	9.6	1,010	1,650	355	443
	30,000	40,800	180	173	29.2	14.8	10.9	1,270	2,090	430	554
	50,000	66,400	211	204	32.3	17.6	12.6	1,690	2,830	548	734
	70,000	91,600	235	227	38.0	19.9	13.9	2,040	3,460	642	884
	100,000	129,000	263	254	42.6	22.5	15.4	2,490	4,270	761	1,080
	150,000	190,000	298	290	48.1	25.9	17.4	3,120	5,430	920	1,340
	200,000	250,000	327	318	52.6	28.7	18.9	3,670	6,430	1,060	1,570
	300,000	366,000	371	363	59.7	33.1	21.2	4,600	8,180	1,280	1,970

*Excerpt from "PIANC Working Group MarCom WG33 Guidelines for the design of Fender Systems:2002"

Appendix C. Table C-1 — Confidence Limit : 75%

Type	Dead Weight Tonnage (t)	Displa-cement (t)	Length Overall (m)	Length P.P. (m)	Breadth (m)	Depth (m)	Maximum Draft (m)	Wind Lateral Area (m²)		Wind Front Area (m²)	
								Full Load Condition	Ballast Condition	Full Load Condition	Ballast Condition
Ro/Ro Ship	1,000	2,190	73	66	14.0	6.2	3.5	880	970	232	232
	2,000	4,150	94	86	16.6	8.4	4.5	1,210	1,320	314	323
	3,000	6,030	109	99	18.3	10.0	5.3	1,460	1,590	374	391
	5,000	9,670	131	120	20.7	12.5	6.4	1,850	2,010	467	497
	7,000	13,200	148	136	22.5	14.5	7.2	2,170	2,350	541	583
	10,000	18,300	169	155	24.6	17.0	8.2	2,560	2,760	632	690
	15,000	26,700	196	180	27.2	20.3	9.6	3,090	3,320	754	836
	20,000	34,800	218	201	29.1	23.1	10.7	3,530	3,780	854	960
	30,000	50,600	252	233	32.2	27.6	12.4	4,260	4,550	1,020	1,160
Passenger Ship	1,000	1,030	64	60	12.1	4.9	2.6	464	486	187	197
	2,000	1,910	81	75	14.4	6.3	3.4	744	770	251	263
	3,000	2,740	93	86	16.0	7.4	4.0	980	1,010	298	311
	5,000	4,320	112	102	18.2	9.0	4.8	1,390	1,420	371	386
	7,000	5,830	125	114	19.8	10.2	5.5	1,740	1,780	428	444
	10,000	8,010	142	128	21.8	11.7	6.4	2,220	2,250	498	516
	15,000	11,500	163	146	23.9	13.7	7.5	2,930	2,950	592	611
	20,000	14,900	180	160	25.7	15.3	8.0	3,560	3,570	669	690
	30,000	21,300	207	183	28.4	17.8	8.0	4,690	4,680	795	818
	50,000	33,600	248	217	32.3	21.7	8.0	6,640	6,580	990	1,010
	70,000	45,300	278	243	35.2	24.6	8.0	8,350	8,230	1,140	1,170
Ferry	1,000	1,230	67	61	14.3	5.5	3.4	411	428	154	158
	2,000	2,430	88	78	17.0	6.8	4.2	656	685	214	221
	3,000	3,620	99	91	18.8	7.7	4.8	862	903	259	269
	5,000	5,970	119	110	21.4	9.0	5.5	1,220	1,280	330	344
	7,000	8,310	134	124	23.2	10.0	6.1	1,530	1,600	387	406
	10,000	11,800	153	142	25.4	11.1	6.8	1,940	2,040	458	482
	15,000	17,500	177	164	28.1	12.6	7.6	2,550	2,690	555	586
	20,000	23,300	196	183	30.2	13.8	8.3	3,100	3,270	636	673
	30,000	34,600	227	212	33.4	15.6	9.4	4,070	4,310	771	819
	40,000	45,900	252	236	35.9	17.1	10.2	4,950	5,240	880	940
Gas Carrier	1,000	2,480	71	66	11.7	5.7	4.6	390	465	133	150
	2,000	4,560	88	82	14.3	7.2	5.7	597	707	195	219
	3,000	6,530	100	93	16.1	8.4	6.4	765	903	244	273
	5,000	10,200	117	109	18.8	10.0	7.4	1,050	1,230	323	361
	7,000	13,800	129	121	20.8	11.3	8.1	1,290	1,510	389	434
	10,000	18,900	144	136	23.1	12.9	9.0	1,800	1,870	474	527
	15,000	27,000	164	154	26.0	14.9	10.1	2,050	2,390	593	658
	20,000	34,800	179	169	28.4	16.5	11.0	2,450	2,840	698	770
	30,000	49,700	203	192	32.0	19.0	12.3	3,140	3,630	870	961
	50,000	78,000	237	226	37.2	22.8	12.3	4,290	4,940	1,150	1,270
	70,000	105,000	263	251	41.2	25.7	12.3	5,270	6,060	1,390	1,530
	100,000	144,000	294	281	45.8	29.2	12.3	6,560	7,510	1,690	1,860

*) Full Load Condition of Wind Lateral / Front Areas of log carrier don't include the areas of logs on deck.

**) Full Load Condition of Wind Lateral / Front Areas of Container Ships include the areas of containers on deck.

"Excerpt from "PIANC Working Group MarCom WG33 Guidelines for the design of Fender Systems:2002"

Appendix C. Table C-2 VESSEL DISPLACEMENTS. Confidence Limits : 50%, 75%, 95%

Type	Dead Weight Tonnage (t)	Displacement (t)		
		50%	75%	95%
General Cargo Ship	1,000	1,850	1.680	1,850
	2,000	3,040	3,260	3,560
	3,000	4,460	4,750	5,210
	5,000	7,210	7,690	8,440
	7,000	9,900	10,600	11,600
	10,000	13,900	14,800	16,200
	15,000	20,300	21,600	23,700
	20,000	26,600	28,400	31,000
	30,000	39,000	41,600	45,600
	40,000	51,100	54,500	59,800
Bulk Carrier	5,000	6,740	6,920	7,190
	7,000	9,270	9,520	9,880
	10,000	13,000	13,300	13,800
	15,000	19,100	19,600	20,300
	20,000	25,000	25,700	26,700
	30,000	36,700	37,700	39,100
	50,000	59,600	61,100	63,500
	70,000	81,900	84,000	87,200
	100,000	115,000	118,000	122,000
	150,000	168,000	173,000	179,000
	200,000	221,000	227,000	238,000
	250,000	273,000	280,000	291,000
Container Ship	7,000	10,200	10,700	11,500
	10,000	14,300	15,100	16,200
	15,000	21,100	22,200	23,900
	20,000	27,600	29,200	31,400
	25,000	34,300	36,100	38,800
	30,000	10,800	43,000	46,200
	40,000	53,700	56,500	60,800
	50,000	66,500	69,900	75,200
	60,000	79,100	83,200	89,400
Oil Tanker	1,000	1,450	1,580	1,800
	2,000	2,810	3,070	3,480
	3,000	4,140	4,520	5,130
	5,000	6,740	7,360	8,360
	7,000	9,300	10,200	11,500
	10,000	13,100	14,300	16,200
	15,000	19,200	21,000	23,900
	20,000	25,300	27,700	31,400
	30,000	37,300	40,800	46,300
	50,000	60,800	66,400	75,500
	70,000	83,900	91,600	104,000
	100,000	118,000	129,000	146,000
	150,000	174,000	190,000	216,000
	200,000	229,000	250,000	264,000
	300,000	337,000	368,000	418,000
Ro/Ro	1,000	1,970	2,170	2,540
	2,000	3,730	4,160	4,820
	3,000	5,430	6,030	7,010
	5,000	8,710	9,670	11,200
	7,000	11,900	13,200	15,300
	10,000	16,500	18,300	21,300
	15,000	24,000	2,700	31,000
	20,000	31,300	34,800	41,400
	30,000	45,600	50,600	58,800
Passenger	1,000	850	1,030	1,350
	2,000	1,680	1,910	2,500
	3,000	2,270	2,740	3,590
	5,000	3,580	4,320	5,650
	7,000	4,830	5,830	7,630
	10,000	6,640	8,010	10,500
	15,000	9,630	11,600	15,000
	20,000	12,300	14,900	19,400
	30,000	17,700	21,300	27,900
	50,000	27,900	33,600	44,000
	70,000	37,600	45,300	59,300
Ferry	1,000	810	1,230	2,240
	2,000	1,600	2,430	4,430
	3,000	2,390	3,620	6,590
	5,000	3,940	5,970	10,900
	7,000	5,480	8,310	15,100
	10,000	7,770	11,800	21,500
	15,000	11,600	17,500	31,900
	20,000	15,300	23,300	42,300
	30,000	22,800	34,600	63,000
	40,000	30,300	45,900	83,500
Gas Carrier	1,000.0	2,210.0	2,480	2,910
	2,000	4,080	4,560	5,370
	3,000	5,830	6,530	7,680
	5,000	9,100	10,200	12,000
	7,000	12,300	13,800	16,200
	10,000	16,900	18,900	22,200
	15,000	24,100	27,000	31,700
	20,000	31,100	34,800	40,900
	30,000	44,400	49,700	58,500
	50,000	69,700	78,000	91,600
	70,000	94,000	105,000	124,000
	100,000	128,000	144,000	169,000

*Excerpt from "PIANC Working Group MarCom WG33 Guidelines for the design of Fender Systems:2002"

BATANGAS

BATAAN

BOHOL

HICOR CELL TYPE FENDER

HICOR

Introduction

In recent years while the economic blocks have expanded increasingly wider, the maritime distribution industry has entered into the era of high-speed distribution in large quantities, in which large-scale container ships are taking the initiative. Accordingly, the development and production of larger and faster vessels has raised the demand for lighter weight of the hull structure. This has also affected how a fender should serve as a crucial supporter in ensuring safe moorings of ships; as a result, the main stream has been shifting from the conventional types of fenders to the ones with higher absorbed energy and with lower reaction force. These allow less shock to be transmitted to the outer plank of the hull.

Conventionally, fender materials have been selected with priority given to whether or not they have sufficient ability to absorb the energy coming from a mooring ship. With progressing competition among harbor operators, however, there has been a growing tendency to place more priority over the cause no damage to the hull structure.

In particular, to select fenders intended for large scale container ships, considerations such as a "allowable hull pressure", "flexibility to widely-opened flare of the" or "easier maintenance check to important in addition to the conventional requirements" absorption of the berthing energy", relation between the pier strength and the fender's reaction force" and "durability of the fender". The "Circle Fender with Frontal Panel" is furnished with frontal frame whose front surface is covered with the resin sheet that allows a low co-efficient of friction. For a permissible surface pressure of the hull structure, surface reaction force of the fender (ton/m) can be adjusted simply by regulating the size of the frontal panel. For "flexibility to a flare angle of the hull", it employs a structure that enables the generated load to be received on its flat portions. The Circle Fender with Frontal Panel, whose rubber structure has no direct will suffer from rubbings or flaws. This fender which is designed appropriately, can give excellent durability to allow a service life of about 15 years only by applying a simple and easy maintenance check on the product.

TOLEDO POWER PLANT JETTY,
TOLEDO CITY, CEBU

HICOR CELL TYPE FENDER

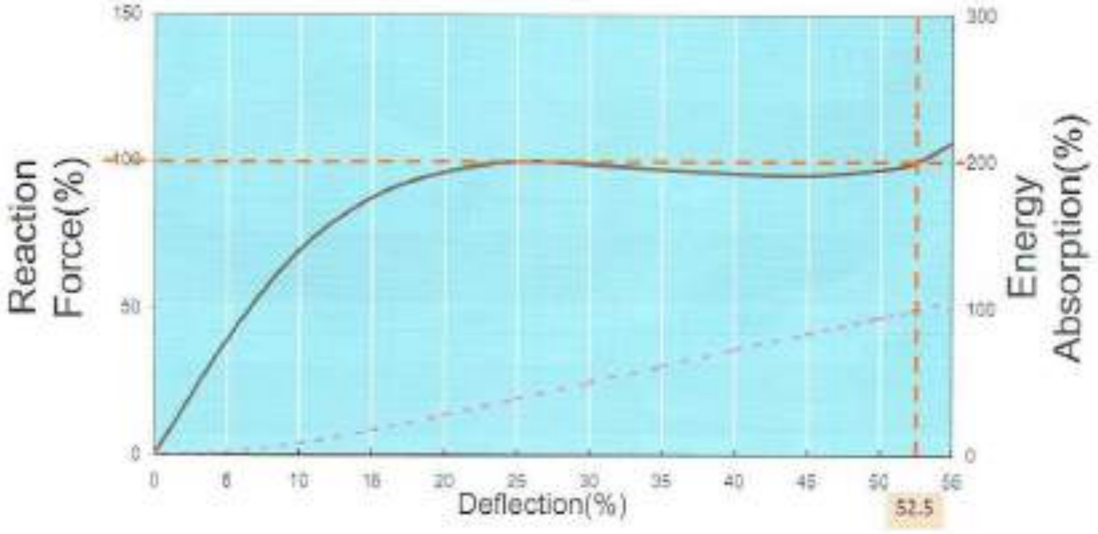
TOLEDO POWER PLANT JETTY,
TOLEDO CITY, CEBU

HICOR CELL TYPE FENDER

Velocity Factor

CSS	0.1m/sec VF		0.12m/sec VF		0.2m/sec VF		0.25m/sec VF		0.3m/sec VF		CSS
	R/F	E/A	R/F	E/A	R/F	E/A	R/F	E/A	R/F	E/A	
400	0.968	0.967	0.983	0.982	1.023	1.024	1.040	1.042	1.055	1.057	400
500	0.968	0.966	0.982	0.981	1.023	1.024	1.041	1.043	1.055	1.058	500
600	0.968	0.966	0.982	0.981	1.023	1.024	1.041	1.043	1.056	1.059	600
800	0.967	0.965	0.982	0.981	1.024	1.025	1.042	1.044	1.057	1.060	800
1000	0.967	0.965	0.982	0.981	1.024	1.025	1.043	1.045	1.058	1.061	1000
1150	0.967	0.965	0.982	0.981	1.024	1.025	1.043	1.045	1.058	1.061	1150
1250	0.967	0.965	0.982	0.980	1.024	1.025	1.043	1.045	1.058	1.062	1250
1450	0.967	0.964	0.981	0.980	1.024	1.026	1.043	1.046	1.059	1.062	1450
1600	0.966	0.964	0.981	0.980	1.024	1.026	1.043	1.046	1.059	1.062	1600
1700	0.966	0.964	0.981	0.980	1.024	1.026	1.043	1.046	1.059	1.063	1700
1800	0.966	0.964	0.981	0.980	1.024	1.026	1.044	1.046	1.059	1.063	1800
2000	0.966	0.964	0.981	0.980	1.024	1.026	1.044	1.047	1.060	1.063	2000
2250	0.966	0.963	0.981	0.980	1.025	1.026	1.044	1.047	1.060	1.064	2250
2500	0.966	0.963	0.981	0.980	1.025	1.026	1.044	1.047	1.060	1.064	2500
3000	0.966	0.963	0.981	0.980	1.025	1.027	1.044	1.048	1.060	1.065	3000

PERFORMANCE CURVE



HICOR

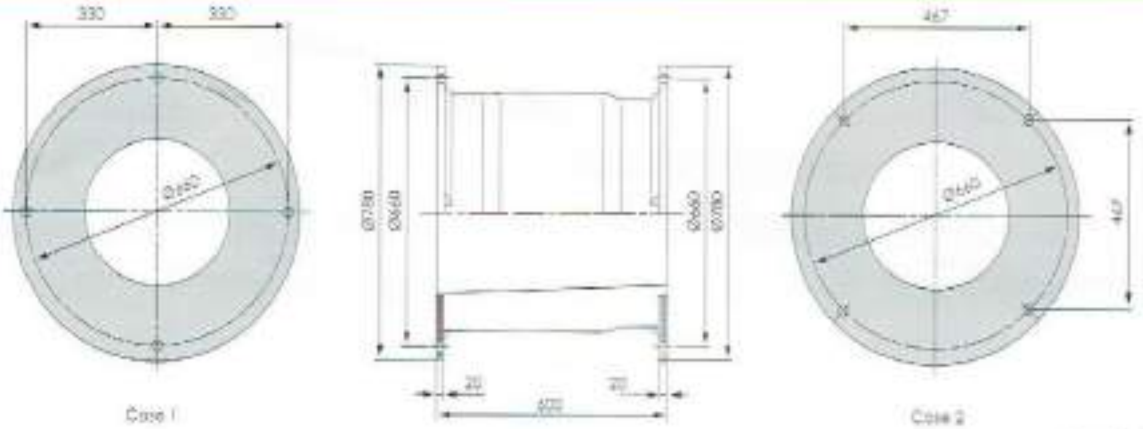
500H

Case 1 Case 2

Weight: 110kg

500H		F4	F3	F2	F1	F0
0	E/A(kN-m)	17.9	21.4	25.5	30.5	36.4
	R/F(kN)	78.3	93.5	111	133	159
1	E/A(kN-m)	18.5	22.0	26.3	31.4	37.5
	R/F(kN)	80.6	96.3	115	137	163
2	E/A(kN-m)	19.0	22.7	27.1	32.3	38.6
	R/F(kN)	83.0	99.2	118	141	168
3	E/A(kN-m)	19.6	23.4	27.9	33.3	39.7
	R/F(kN)	85.5	102	122	145	173
4	E/A(kN-m)	20.2	24.1	28.7	34.3	40.9
	R/F(kN)	88.1	105	125	150	179
5	E/A(kN-m)	20.8	24.8	29.6	35.3	45.0
	R/F(kN)	90.7	108	129	154	197
Bolt Size: X4pcs		M20	M20	M20	M20	M22

600H



Case 1 Case 2

Weight: 200kg

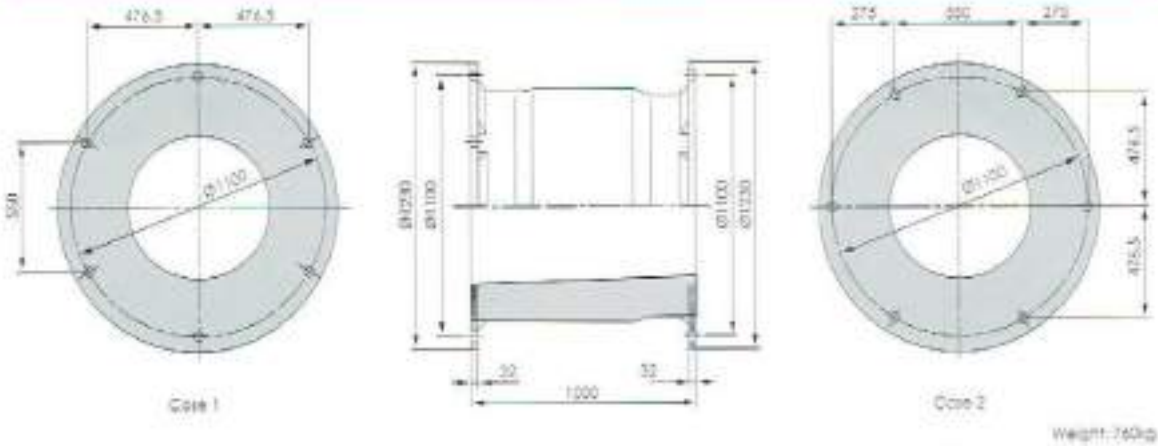
600H		F4	F3	F2	F1	F0
0	E/A(kN-m)	30.9	36.9	44.0	52.6	62.8
	R/F(kN)	112	134	160	192	229
1	E/A(kN-m)	31.8	38.0	45.4	54.2	64.7
	R/F(kN)	116	138	165	197	236
2	E/A(kN-m)	32.8	39.1	46.7	55.8	66.6
	R/F(kN)	119	142	170	203	243
3	E/A(kN-m)	33.8	40.3	48.1	57.5	68.6
	R/F(kN)	123	147	175	209	250
4	E/A(kN-m)	34.8	41.5	49.6	59.2	70.7
	R/F(kN)	126	151	180	216	258
5	E/A(kN-m)	35.8	42.8	51.1	61.0	77.7
	R/F(kN)	130	156	186	222	283
Bolt Size: X4pcs		M22	M22	M22	M24	M24

800H

Weight:438kg

800H		F4	F3	F2	F1	F0
0	E/A(kN-m)	73.1	87.3	105	125	149
	R/F(kN)	200	239	285	341	407
1	E/A(kN-m)	75.3	89.9	108	129	153
	R/F(kN)	206	246	294	351	419
2	E/A(kN-m)	77.6	92.6	111	132	158
	R/F(kN)	212	253	303	362	432
3	E/A(kN-m)	79.9	95.4	114	136	163
	R/F(kN)	219	261	312	372	445
4	E/A(kN-m)	82.3	98.3	118	141	168
	R/F(kN)	225	269	321	384	458
5	E/A(kN-m)	84.8	102	121	145	184
	R/F(kN)	232	277	331	395	504
Bolt Size: X6pcs		M22	M22	M22	M24	M24

1000H



Weight:760kg

1000H		F4	F3	F2	F1	F0
0	E/A(kN-m)	143	171	204	243	290
	R/F(kN)	313	374	446	533	636
1	E/A(kN-m)	147	176	210	251	299
	R/F(kN)	322	385	460	549	655
2	E/A(kN-m)	152	181	216	258	308
	R/F(kN)	332	396	473	565	675
3	E/A(kN-m)	156	187	223	266	317
	R/F(kN)	342	408	488	582	695
4	E/A(kN-m)	161	192	229	274	327
	R/F(kN)	352	421	502	600	716
5	E/A(kN-m)	166	198	236	282	359
	R/F(kN)	363	433	517	618	788
Bolt Size: X6pcs		M30	M30	M30	M30	M36

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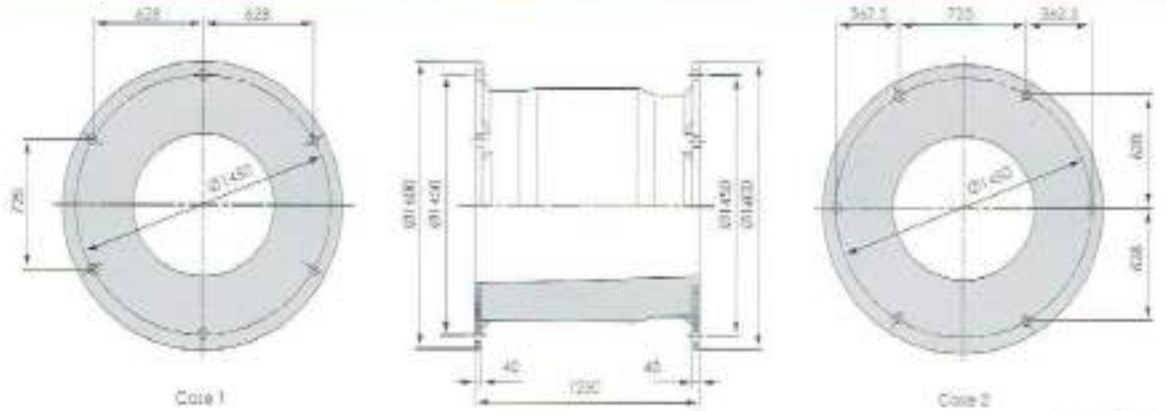
1150H

Weight: 1205kg

1150H		F4	F3	F2	F1	F0
0	E/A(kN-m)	217	259	309	369	441
	R/F(kN)	414	494	590	705	842
1	E/A(kN-m)	224	267	319	381	454
	R/F(kN)	426	509	608	726	867
2	E/A(kN-m)	230	275	328	392	468
	R/F(kN)	439	524	626	748	893
3	E/A(kN-m)	237	283	338	404	482
	R/F(kN)	452	540	645	770	920
4	E/A(kN-m)	244	292	348	416	496
	R/F(kN)	466	556	664	793	947
5	E/A(kN-m)	252	300	359	428	546
	R/F(kN)	480	573	684	817	1042
Bolt Size: X6pcs		M30	M30	M36	M36	M36

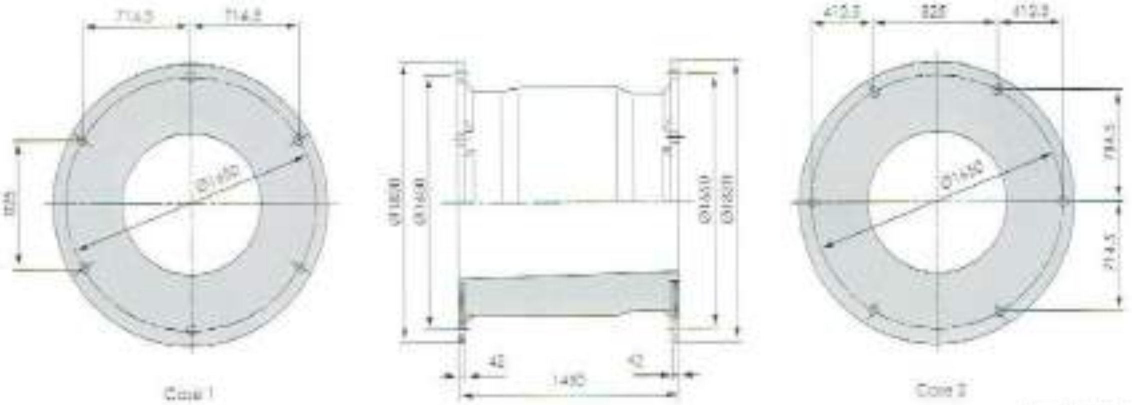
1250H



Weight: 1550kg

1250H		F4	F3	F2	F1	F0
0	E/A(kN-m)	279	333	397	474	566
	R/F(kN)	489	584	697	833	995
1	E/A(kN-m)	287	343	409	488	583
	R/F(kN)	504	602	718	858	1024
2	E/A(kN-m)	296	353	421	503	600
	R/F(kN)	519	620	740	884	1055
3	E/A(kN-m)	304	363	434	518	618
	R/F(kN)	534	638	762	910	1087
4	E/A(kN-m)	314	374	447	534	637
	R/F(kN)	550	657	785	937	1119
5	E/A(kN-m)	323	386	460	550	701
	R/F(kN)	567	677	809	966	1231
Bolt Size: X6pcs		M30	M36	M36	M36	M36

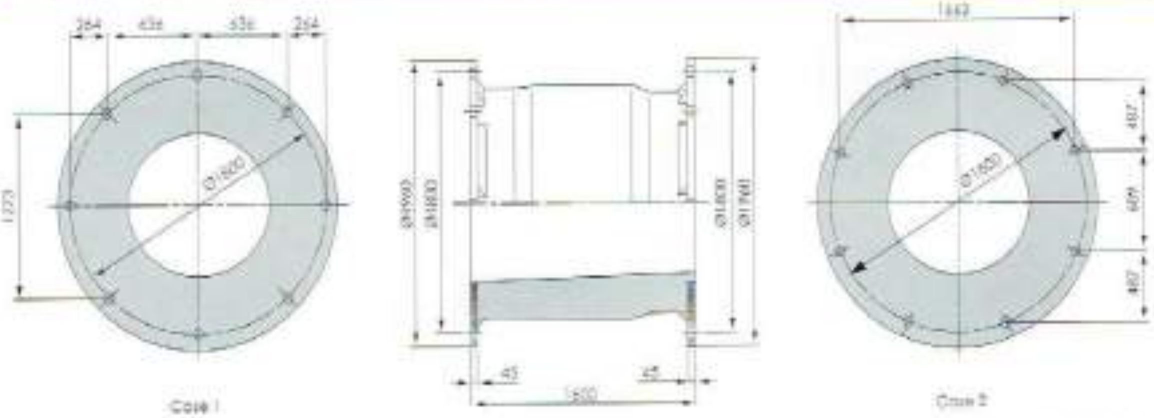
1450H



Weight: 2350kg

CSS1450H		F4	F3	F2	F1	F0
0	E/A(kN-m)	434	519	619	739	883
	R/F(kN)	658	786	939	1121	1338
1	E/A(kN-m)	447	534	638	761	909
	R/F(kN)	678	810	967	1155	1379
2	E/A(kN-m)	461	550	657	784	936
	R/F(kN)	698	834	996	1189	1420
3	E/A(kN-m)	475	567	677	808	964
	R/F(kN)	719	859	1026	1225	1463
4	E/A(kN-m)	489	584	697	832	993
	R/F(kN)	741	885	1057	1262	1507
5	E/A(kN-m)	504	601	718	857	1093
	R/F(kN)	763	911	1088	1299	1657
Bolt Size: X6pcs		M36	M36	M42	M42	M42

600H



Weight: [illegible]

CSS1600H		F4	F3	F2	F1	F0
0	E/A(kN-m)	583	696	831	992	1185
	R/F(kN)	802	957	1143	1365	1630
1	E/A(kN-m)	601	717	856	1022	1221
	R/F(kN)	826	986	1177	1406	1679
2	E/A(kN-m)	619	739	882	1053	1257
	R/F(kN)	850	1015	1213	1448	1729
3	E/A(kN-m)	637	761	908	1084	1295
	R/F(kN)	876	1046	1249	1491	1781
4	E/A(kN-m)	656	784	936	1117	1334
	R/F(kN)	902	1077	1287	1536	1834
5	E/A(kN-m)	676	807	964	1150	1467
	R/F(kN)	929	1110	1325	1582	2018
Bolt Size: X8pcs		M36	M36	M36	M42	M42

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1700H

Weight: 3730kg

1700H		F4	F3	F2	F1	F0
0	E/A(kN-m)	699	835	997	1190	1421
	R/F(kN)	905	1081	1290	1541	1840
1	E/A(kN-m)	720	860	1027	1226	1463
	R/F(kN)	932	1113	1329	1587	1895
2	E/A(kN-m)	742	886	1057	1262	1507
	R/F(kN)	960	1146	1369	1635	1952
3	E/A(kN-m)	764	912	1089	1300	1552
	R/F(kN)	989	1181	1410	1684	2011
4	E/A(kN-m)	787	939	1122	1339	1599
	R/F(kN)	1019	1216	1452	1734	2071
5	E/A(kN-m)	810	968	1155	1379	1759
	R/F(kN)	1049	1253	1496	1786	2278
Bolt Size: X8pcs		M36	M36	M42	M42	M42

1800H

Weight: 4550kg

1800H		F4	F3	F2	F1	F0
0	E/A(kN-m)	830	990	1183	1412	1686
	R/F(kN)	1015	1212	1447	1728	2063
1	E/A(kN-m)	854	1020	1218	1454	1736
	R/F(kN)	1045	1248	1490	1779	2125
2	E/A(kN-m)	880	1051	1255	1498	1789
	R/F(kN)	1076	1285	1535	1833	2189
3	E/A(kN-m)	906	1082	1292	1543	1842
	R/F(kN)	1109	1324	1581	1888	2254
4	E/A(kN-m)	934	1115	1331	1589	1897
	R/F(kN)	1142	1364	1628	1944	2322
5	E/A(kN-m)	962	1148	1371	1637	2087
	R/F(kN)	1176	1405	1677	2003	2554
Bolt Size: X8pcs		M42	M42	M42	M48	M48

2000H

weight: [illegible]

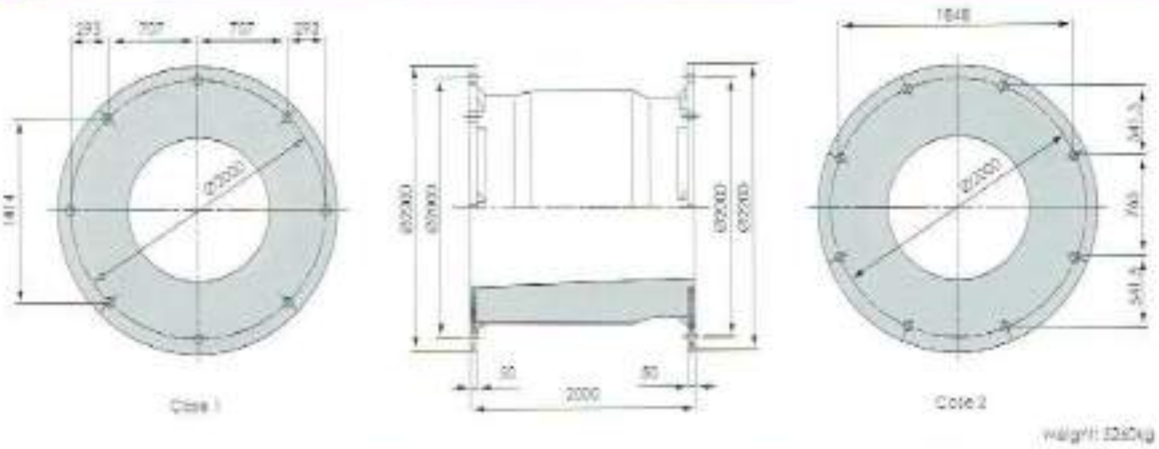
2000H		F4	F3	F2	F1	F0
0	E/A(kN-m)	1137	1358	1621	1935	2311
	R/F(kN)	1253	1496	1786	2133	2547
1	E/A(kN-m)	1171	1398	1670	1994	2380
	R/F(kN)	1290	1541	1840	2197	2623
2	E/A(kN-m)	1206	1440	1720	2053	2452
	R/F(kN)	1329	1587	1895	2263	2702
3	E/A(kN-m)	1242	1483	1771	2115	2525
	R/F(kN)	1369	1635	1952	2331	2783
4	E/A(kN-m)	1280	1528	1824	2178	2601
	R/F(kN)	1410	1684	2010	2401	2867
5	E/A(kN-m)	1318	1574	1879	2244	2861
	R/F(kN)	1452	1734	2071	2473	3153
Bolt Size: X8pcs		M48	M48	M48	M56	M56

2250H

weight: [illegible]

2250H		F4	F3	F2	F1	F0
0	E/A(kN-m)	1618	1931	2306	2753	3288
	R/F(kN)	1586	1893	2261	2700	3224
1	E/A(kN-m)	1666	1989	2375	2836	3386
	R/F(kN)	1633	1950	2329	2781	3320
2	E/A(kN-m)	1716	2049	2446	2921	3488
	R/F(kN)	1682	2009	2399	2864	3420
3	E/A(kN-m)	1768	2110	2520	3009	3593
	R/F(kN)	1733	2069	2470	2950	3523
4	E/A(kN-m)	1821	2174	2595	3099	3700
	R/F(kN)	1785	2131	2545	3038	3628
5	E/A(kN-m)	1875	2239	2673	3192	4070
	R/F(kN)	1838	2195	2621	3130	3991
Bolt Size: X10pcs		M48	M48	M48	M56	M56

2000H



2000H		F4	F3	F2	F1	F0
0	E/A(kN-m)	1137	1358	1621	1935	2311
	R/F(kN)	1253	1496	1786	2133	2547
1	E/A(kN-m)	1171	1398	1670	1994	2380
	R/F(kN)	1290	1541	1840	2197	2623
2	E/A(kN-m)	1206	1440	1720	2053	2452
	R/F(kN)	1329	1587	1895	2263	2702
3	E/A(kN-m)	1242	1483	1771	2115	2525
	R/F(kN)	1369	1635	1952	2331	2783
4	E/A(kN-m)	1280	1528	1824	2178	2601
	R/F(kN)	1410	1684	2010	2401	2867
5	E/A(kN-m)	1318	1574	1879	2244	2861
	R/F(kN)	1452	1734	2071	2473	3153
Bolt Size: X8pcs		M48	M48	M48	M56	M56

CELL TYPE FENDER

BATANGAS PORT

HICOR
MANUFACTURING
CORPORATION

HICOR V-TYPE FENDER

HICOR

V-SHAPED FENDER

V-type fender

A conventional cylindrical type fender absorbed energy through compressive deformation, while this V-type fender materialized a revolutionary improved energy absorption efficiency by adding the compressive deformation to bucking deformation.

Once again, the introduction of a stationary system with anchor bolts improved the durability remarkably.

This fender is used most widely in the world harbors as "multi purpose type" fender.

Features

1) Excellent energy absorption efficiency
2) Excellent durability and stability

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V FENDER PERFORMANCE

Fender Performance At 45% Design Deflection (Rated Performance Data)

Size	V1		V2		V3		V4		LENGTH Up to	Size
	Reaction Force	Energy Absorption	Reaction Force	Energy Absorption	Reaction Force	Energy Absorption	Reaction Force	Energy Absorption		
	(tonf)	(tonf-m)	(tonf)	(tonf-m)	(tonf)	(tonf-m)	(tonf)	(tonf-m)	mm	
150	12.8	0.641	11.3	0.563	8.44	0.422	5.63	0.281	3500	150
200	17.1	1.14	15.0	1.00	11.3	0.750	7.50	0.500	3500	200
250	21.4	1.78	18.8	1.56	14.1	1.17	9.38	0.781	3500	250
300	25.7	2.57	22.5	2.25	16.9	1.69	11.3	1.13	3500	300
400	34.2	4.56	30.0	4.00	22.5	3.00	15.0	2.00	3500	400
500	42.8	7.13	37.5	6.25	28.1	4.69	18.8	3.13	3000	500
600	51.3	10.3	45.0	9.00	33.8	6.75	22.5	4.50	3000	600
800	68.4	18.2	60.0	16.0	45.0	12.0	30.0	8.00	3000	800
1000	85.5	28.5	75.0	25.0	56.3	18.8	37.5	12.5	3000	1000

Size	V1		V2		V3		V4		LENGTH Up to	Size
	Reaction Force	Energy Absorption	Reaction Force	Energy Absorption	Reaction Force	Energy Absorption	Reaction Force	Energy Absorption		
	(kN)	(kN-m)	(kN)	(kN-m)	(kN)	(kN-m)	(kN)	(kN-m)	mm	
150	126.0	6.29	111	5.52	82.8	4.14	55.2	2.76	3500	150
200	168	11.2	147	9.81	111	7.35	73.5	4.90	3500	200
250	210	17.5	184	15.3	138	11.5	92.0	7.66	3500	250
300	252	25.2	221	22.1	166	16.6	111	11.1	3500	300
400	335	44.7	294	39.2	221	29.4	147	19.6	3500	400
500	420	69.9	368	61.3	276	46.0	184	30.7	3000	500
600	503	101	441	88.3	331	66.2	221	44.1	3000	600
800	671	178	588	157	441	118	294	78.5	3000	800
1000	838	279	735	245	552	184	368	123	3000	1000

Performance Per Meter Length with 45% Deflection

*** Specification will be changed without prior notice.**

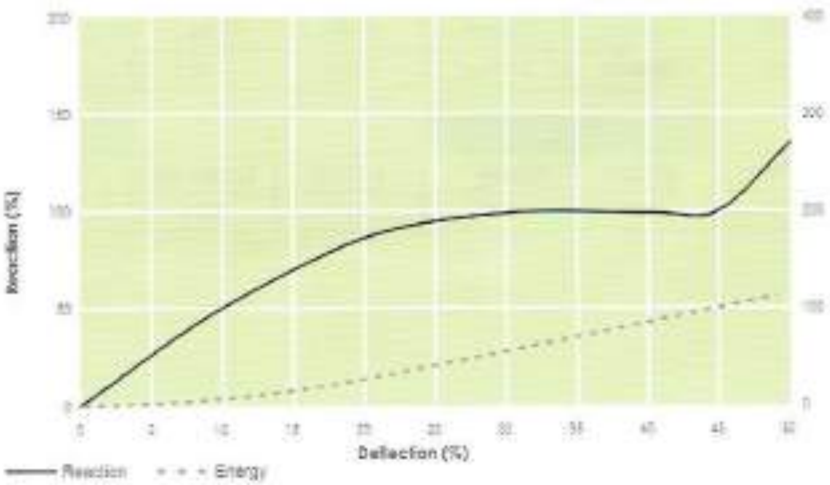
* Special Rubber Grade can be available due to design condition.

*PERFORMANCE TOLERANCE ± 10%

Intermediate deflection

Def(%)	R/F	E/A
0%	0%	0%
10%	50%	7%
20%	86%	28%
30%	99%	56%
40%	99%	85%
45%	100%	100%
50%	135%	118%

PERFORMANCE CURVE



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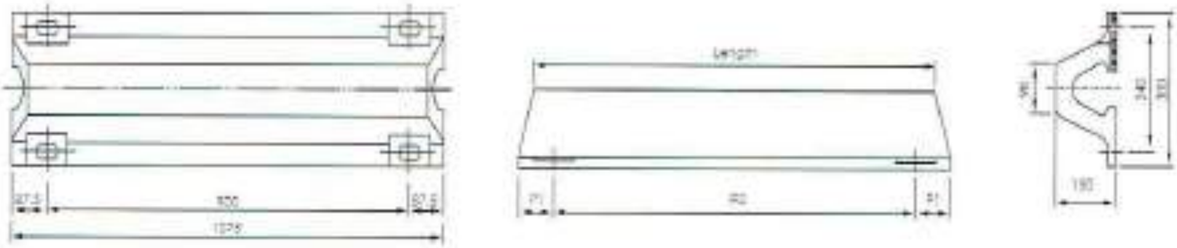
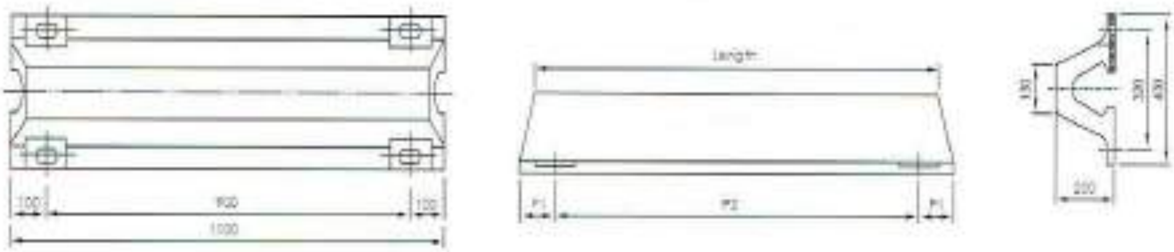
V150H



Length	P1	P2	Weight	No. Bolt	Bolt Size
1000L	87.5mm	900mm	34kg	4	M20 ~ M24
1500L	87.5mm	700mm	50kg	6	
2000L	92.5mm	630mm	66kg	8	
2500L	87.5mm	800mm	82kg	8	
3000L	87.5mm	725mm	98kg	10	
3500L	87.5mm	680mm	114kg	10	

V1		V2		V3		V4	
R/F(kN)	E/A(kN-m)	R/F(kN)	E/A(kN-m)	R/F(kN)	E/A(kN-m)	R/F(kN)	E/A(kN-m)
126	6.29	111	5.52	82.8	4.14	55.2	2.76

V200H



Length	P1	P2	Weight	No. Bolt	Bolt Size
1000L	100mm	900mm	60kg	4	M20 ~ M24
1500L	100mm	700mm	89kg	6	
2000L	105mm	630mm	117kg	8	
2500L	100mm	800mm	146kg	8	
3000L	100mm	725mm	175kg	10	
3500L	100mm	680mm	203kg	10	

V1		V2		V3		V4	
R/F(kN)	E/A(kN-m)	R/F(kN)	E/A(kN-m)	R/F(kN)	E/A(kN-m)	R/F(kN)	E/A(kN-m)
168	11.2	147	9.81	111	7.35	73.5	4.90

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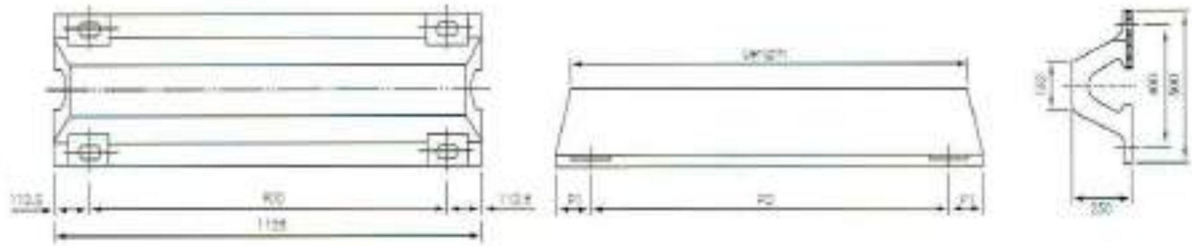
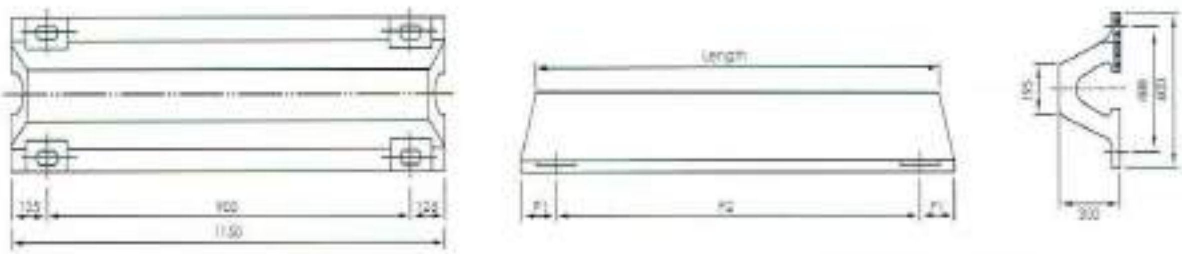
V250H



Length	P1	P2	Weight	No. Bolt	Bolt Size
1000L	112.5mm	900mm	87kg	4	M20 ~ M24
1500L	112.5mm	700mm	128kg	6	
2000L	117.5mm	630mm	169kg	8	
2500L	112.5mm	800mm	210kg	8	
3000L	112.5mm	725mm	250kg	10	
3500L	112.5mm	680mm	291kg	10	

V1		V2		V3		V4	
R/F(kN)	E/A(kN-m)	R/F(kN)	E/A(kN-m)	R/F(kN)	E/A(kN-m)	R/F(kN)	E/A(kN-m)
210	17.5	184	15.3	138	11.5	92.0	7.66

V300H

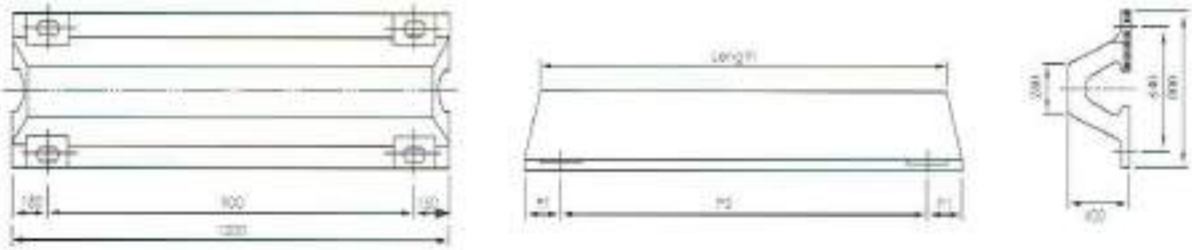


Length	P1	P2	Weight	No. Bolt	Bolt Size
1000L	125mm	900mm	133kg	4	M20 ~ M30
1500L	125mm	700mm	194kg	6	
2000L	130mm	630mm	254kg	8	
2500L	125mm	800mm	316kg	8	
3000L	125mm	725mm	377kg	10	
3500L	125mm	680mm	438kg	10	

V1		V2		V3		V4	
R/F(kN)	E/A(kN-m)	R/F(kN)	E/A(kN-m)	R/F(kN)	E/A(kN-m)	R/F(kN)	E/A(kN-m)
252	25.2	221	22.1	166	16.6	111	11.1

HICOR

V400H



Length	P1	P2	Weight	No. Bolt	Bolt Size
1000L	150mm	900mm	245kg	4	M24 ~ M36
1500L	150mm	700mm	354kg	6	
2000L	155mm	630mm	463kg	8	
2500L	150mm	800mm	575kg	8	
3000L	150mm	725mm	684kg	10	
3500L	150mm	680mm	793kg	10	

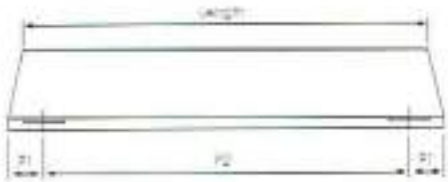
V1		V2		V3		V4	
R/F(kN)	E/A(kN-m)	R/F(kN)	E/A(kN-m)	R/F(kN)	E/A(kN-m)	R/F(kN)	E/A(kN-m)
335	44.7	294	39.2	221	29.4	147	19.6

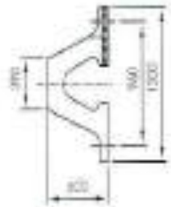
V500H

Length	P1	P2	Weight	No. Bolt	Bolt Size
1000L	175mm	900mm	364kg	4	M27 ~ M36
1500L	175mm	700mm	523kg	6	
2000L	180mm	630mm	682kg	8	
2500L	175mm	800mm	844kg	8	
3000L	175mm	725mm	1,003kg	10	
3500L	175mm	680mm	1,159kg	10	

V1		V2		V3		V4	
R/F(kN)	E/A(kN-m)	R/F(kN)	E/A(kN-m)	R/F(kN)	E/A(kN-m)	R/F(kN)	E/A(kN-m)
420	69.9	368	61.3	276	46.0	184	30.7

V600H

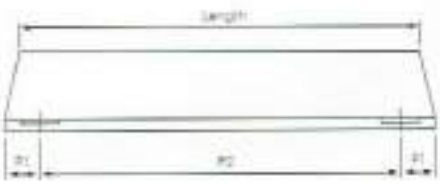


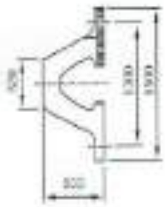


Length	P1	P2	Weight	No. Bolt	Bolt Size
1000L	200mm	900mm	526kg	4	M30 ~ M42
1500L	200mm	700mm	750kg	6	
2000L	205mm	630mm	945kg	8	
2500L	200mm	800mm	1,204kg	8	
3000L	200mm	725mm	1,428kg	10	

V1		V2		V3		V4	
R/F(kN)	E/A(kN-m)	R/F(kN)	E/A(kN-m)	R/F(kN)	E/A(kN-m)	R/F(kN)	E/A(kN-m)
503	101	441	88.3	331	66.2	221	44.1

V800H



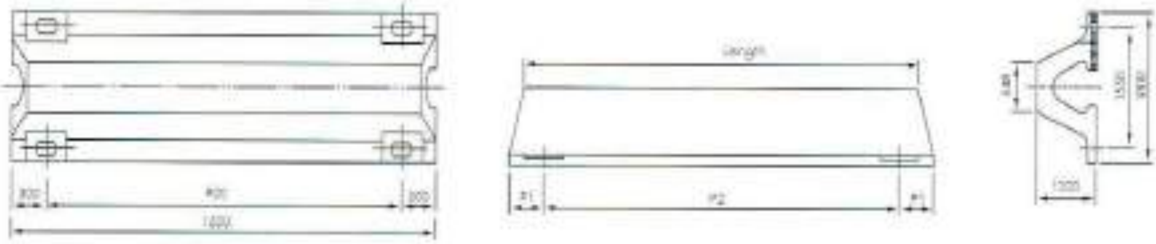


Length	P1	P2	Weight	No. Bolt	Bolt Size
1000L	250mm	900mm	890kg	4	M30 ~ M48
1500L	250mm	700mm	1,255kg	6	
2000L	255mm	630mm	1,620kg	8	
2500L	250mm	800mm	1,993kg	8	
3000L	250mm	725mm	2,358kg	10	

V1		V2		V3		V4	
R/F(kN)	E/A(kN-m)	R/F(kN)	E/A(kN-m)	R/F(kN)	E/A(kN-m)	R/F(kN)	E/A(kN-m)
671	178	588	157	441	118	294	78.5

HICOR

V1000H



Length	P1	P2	Weight	No. Bolt	Bolt Size
1000L	300mm	900mm	1,389kg	4	M36 ~ M48
1500L	300mm	700mm	1,935kg	6	
2000L	305mm	630mm	2,482kg	8	
2500L	300mm	800mm	3,041kg	8	
3000L	300mm	725mm	3,588kg	10	

V1		V2		V3		V4	
R/F(kN)	E/A(kN-m)	R/F(kN)	E/A(kN-m)	R/F(kN)	E/A(kN-m)	R/F(kN)	E/A(kN-m)
838	279	735	245	552	184	368	123

PHILIPPINE PORTS AUTHORITY PMO-MIZAMIS,MIZAMIS PORT

HICOR V-TYPE RUBBER DOCK FENDER

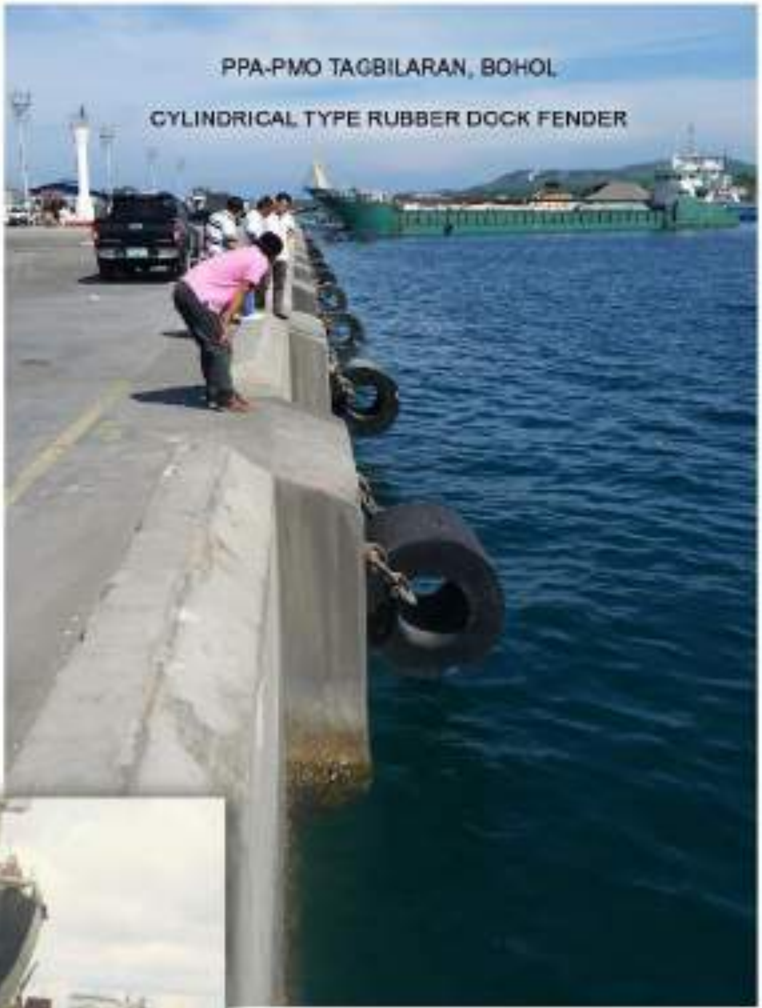
OTHER TYPES OF HICOR FENDER

M-TYPE
PI-TYPE
CYLINDRICAL
HYPER OMEGA
SQUARE TYPE
D-TYPE
CORNER FENDER

HICOR

HICOR PI-TYPE FENDER

HICOR CYLINDRICAL-TYPE FENDER



HICOR M-TYPE FENDER

HICOR

HICOR PI-TYPE FENDER

HICOR PI-TYPE FENDER

ACTUAL COMPRESSION TEST AT HICOR PLANT

HICOR D-TYPE FENDER

HICOR D-type fender provide an excellent barrier against damage from all sizes and shapes of vessels. They provide easy installation because of its flat back feature. Non-standard sizes and customer specific versions can also be produced with short lead times.

MAIN APPLICATION

HICOR D-type fenders suites a wide variety of general purpose application.

- Jetties and Wharves
- Workboats and service crafts
- Mooring pontoon protection
- Inland waterways
- General Purpose application.

PORT OF TAGBILARAN,
PPA BOHOL
HICOR D-TYPE FENDERS

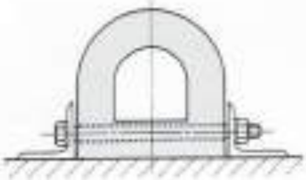
HICOR RUBBER

D-TYPE FENDERS

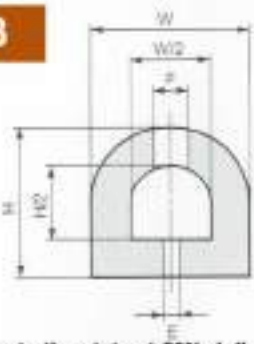
HICOR D-TYPE FENDERS

THIS TYPE OF RUBBER FENDER IS SUITABLE FOR WHARVES AND QUAYS WHERE IT ACTS AS A GREAT PROTECTIVE MEDIUM FOR VESSEL BERTHINGS. THE FLAT BACK OF THIS TYPE OF FENDER FACILITATES EASY INSTALLATION ON VARIOUS SURFACES.

DD-TYPE A



DD-TYPE B



TYPE A

Note: Performance refers to the state at 50% deflection.

Item	150H	200H	250H	300H	350H	400H	500H	600H
H	150	200	250	300	350	400	500	600
W	150	200	250	300	350	400	500	600
B	30	35	45	55	65	75	95	120
C (Ø)	27	30	33	36	40	45	50	55
Bolt size	W 7/8	W 1	W 1 1/8	W 1 1/4	W 1 3/8	W 1 1/2	W 1 3/4	W 2
Bolt pitch	400 - 470	400 - 470	390 - 470	530 - 700	530 - 700	520 - 600	510 - 640	500 - 750
Reaction/m (ton)	14.3	19.0	23.8	28.5	33.5	38.0	47.9	57.1
Energy/m (ton-m)	0.357	0.631	0.989	1.42	1.91	2.52	3.95	5.67

TYPE B

Note: Performance refers to the state at 40% deflection.

Item	150H	200H	250H	300H	350H	400H	500H	600H
H	150	200	250	300	350	400	500	600
W	150	200	250	300	350	400	500	600
E (Ø)	27	30	33	36	40	45	50	55
F (Ø)	60	65	75	80	85	95	105	115
Bolt size	W 7/8	W 1	W 1 1/8	W 1 1/4	W 1 3/8	W 1 1/2	W 1 3/4	W 2
Bolt pitch	400 - 470	400 - 470	390 - 470	530 - 700	530 - 700	520 - 600	510 - 640	500 - 750
Reaction/m (ton)	7.21	9.61	12.0	14.4	16.8	19.2	24.0	28.8
Energy/m (ton-m)	0.206	0.364	0.570	0.819	1.08	1.45	2.27	3.26

HICOR MANUFACTURING CORPORATION

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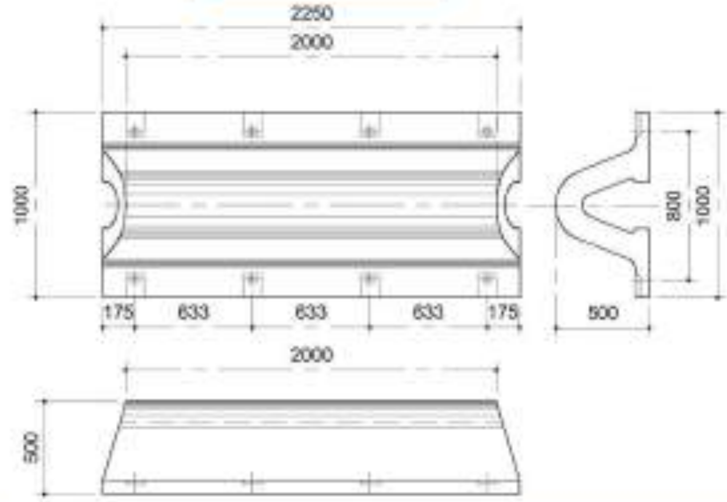
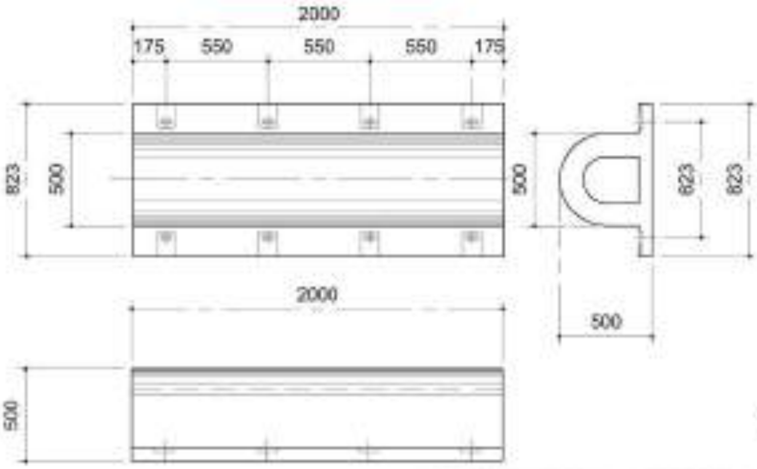
WE BUILD PRODUCTS THAT BUILD CONFIDENCE...

HICOR DV-TYPE FENDERS

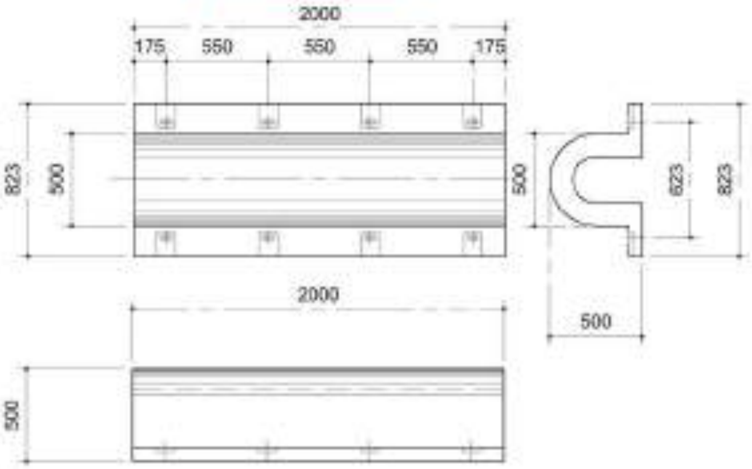
DV-TYPE 1



DV-TYPE 2



DV-TYPE 3



DV-TYPE FENDER PERFORMANCE

Note: Performance refers to the state at 50% deflection

Size	V1		V2		V3		V4		LENGTH Up to	Size
	Reaction Force	Energy Absorption	Reaction Force	Energy Absorption	Reaction Force	Energy Absorption	Reaction Force	Energy Absorption		
	[kN]	[kN-m]	[kN]	[kN-m]	[kN]	[kN-m]	[kN]	[kN-m]	mm	
150	126.0	6.29	111	5.52	82.8	4.14	55.2	2.76	3500	150
200	168	11.2	147	9.81	111	7.35	73.5	4.90	3500	200
250	210	17.5	184	15.3	138	11.5	92.0	7.66	3500	250
300	252	25.2	221	22.1	166	16.6	111	11.1	3000	300
400	335	44.7	294	39.2	221	29.4	147	19.6	3000	400
500	420	69.9	368	61.3	276	46.0	184	30.7	3000	500
600	503	101	441	88.3	331	66.2	221	44.1	3000	600
800	671	179	588	157	441	118	294	78.5	3000	800
1000	838	279	735	245	552	184	368	123		1000

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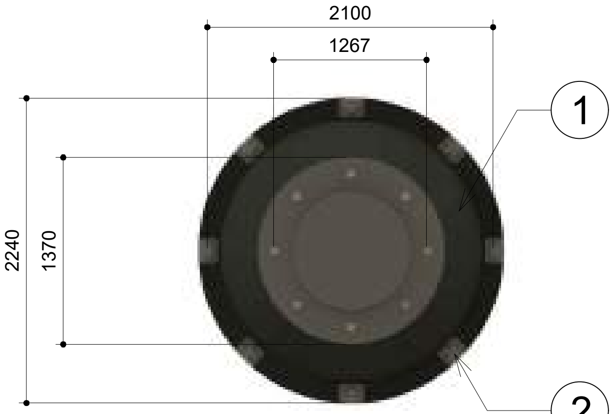
HICOR SUPER CONE TYPE FENDERS

H-SCN- 1400H FENDERS



SUPER CONE
FENDER 1400H

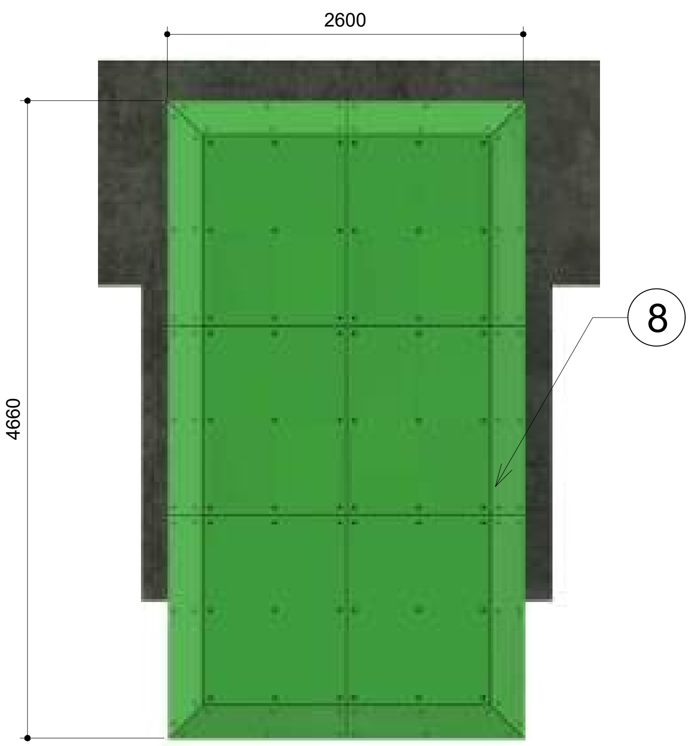
SUPER CONE FENDER 1400H WITH 4660mm(H)X2600mm(W) FRONT PANEL

MATERIAL SCHEDULE

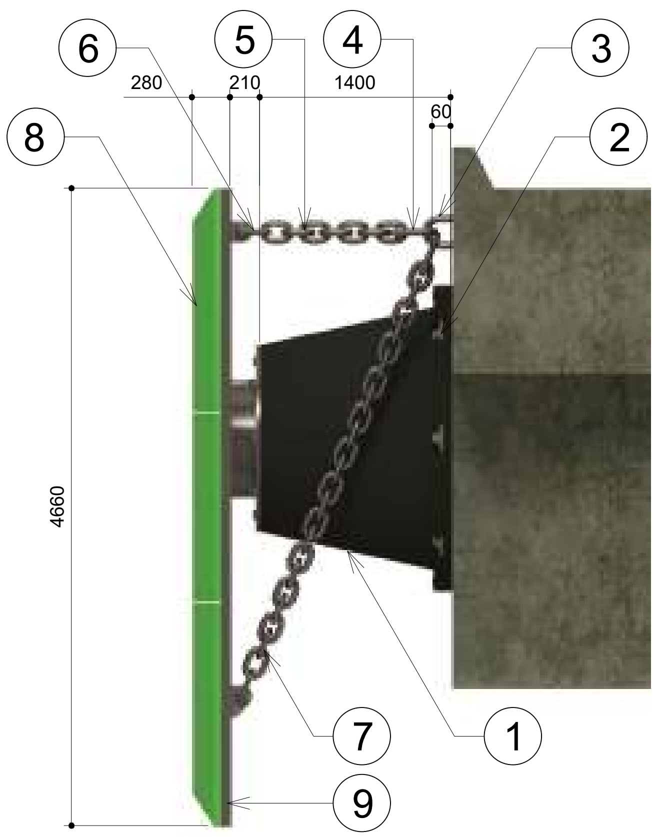
MARK	DESCRIPTION	MATERIAL
1	[illegible]	[illegible]
2	[illegible]	[illegible]
3	[illegible]	[illegible]
4	[illegible]	[illegible]
5	[illegible]	[illegible]
6	[illegible]	[illegible]
7	[illegible]	[illegible]
8	[illegible]	[illegible]
9	[illegible]	[illegible]

PERFORMANCE TABLE TOLERANCE = ±10

MARK	DEFLECTION	REACTION FORCE (KN)	ENERGY ABSORPTION (KN-M)
H-SCN-1400H	[illegible]	[illegible]	[illegible]



FRONT PANEL



SIDE VIEW

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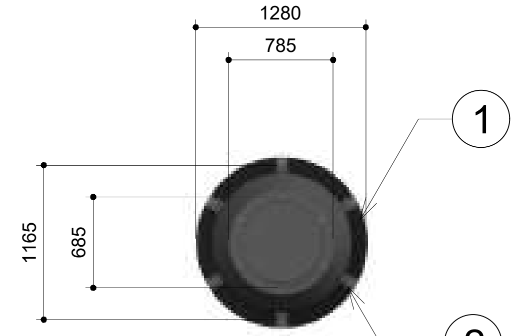
HICOR SUPER CONE TYPE FENDERS

H-SCN- 800H FENDERS



SUPER CONE FENDER 800H

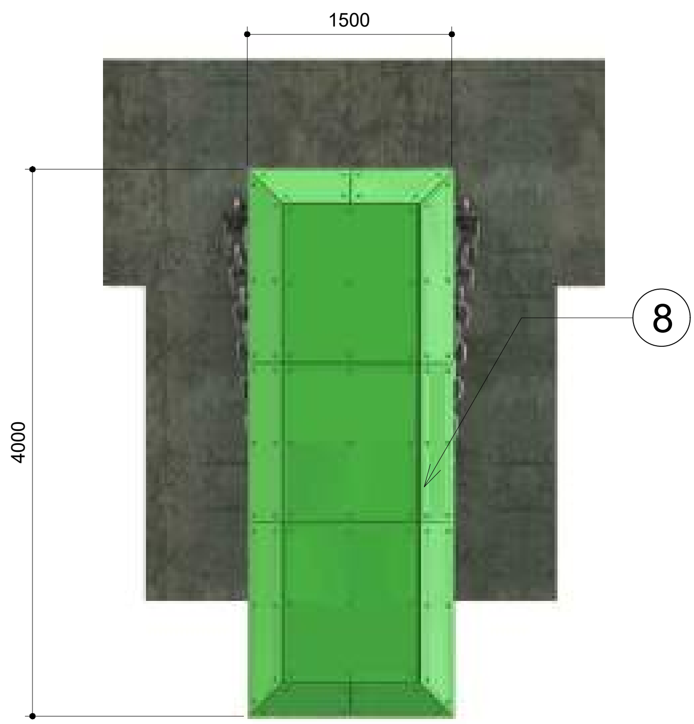
SUPER CONE FENDER 800H WITH 4000mm(H)X1500mm(W) FRONT PANEL

MATERIAL SCHEDULE

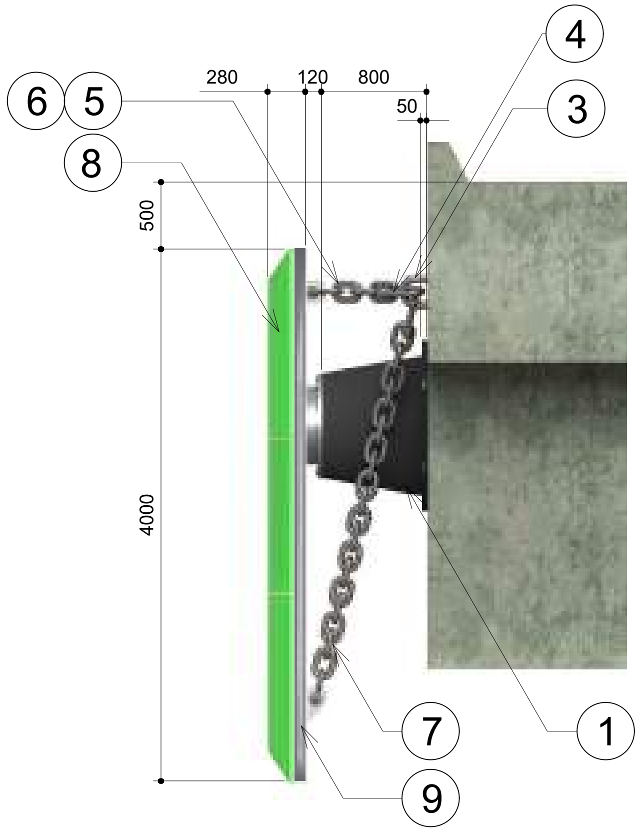
[illegible]	[illegible]	[illegible]
1	[illegible]	[illegible]
2	[illegible]	[illegible]
3	[illegible]	[illegible]
4	[illegible]	[illegible]
5	[illegible]	[illegible]
6	[illegible]	[illegible]
7	[illegible]	[illegible]
8	[illegible]	[illegible]
9	[illegible]	[illegible]

PERFORMANCE TABLE

[illegible]	DEFLECTION	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]



FRONT PANEL



SIDE VIEW

HICOR MANUFACTURING CORPORATION

HICOR MARINE FENDERS

HICOR MANUFACTURING CORPORATION


HICOR MANUFACTURING
CORPORATION
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