HI-TECH ELASTOMERS LTD.

DOCKING AND MOORING

MOORING BOLLARDS (HMB)

Where
Innovation
is Tradition

MOORING BOLLARDS (HMB)

Hi-Tech has a range of seven bollard styles to ensure the ideal solution for your application.

All Hi-Tech's bollards are precision engineered and manufactured in a variety of metals, including premium grade spheroidal graphite ductile iron and cast steel to offer unprecedented levels of service life and resistance to corrosion and impact.

We understand that safety is your number one priority, and provide bespoke safety critical bollards, anchoring and fixing solutions to your exact specifications.

This guide provides detailed and specific information about our full range of solutions including installation, maintenance and specification advice, plus much more.

Take a Smarter Approach to port engineering with Hi-Tech.

HI-TECH ELASTOMERS LTD.
WHERE INNOVATION IS A TRADITION

RANGE AND TECHNICAL INFORMATION

Hi-Tech bollards come in many popular shapes and sizes to suit most docks, jetties and wharves.

Standard material is spheroidal graphite (commonly called SG or ductile iron) which is both strong and resistant to corrosion, meaning Hi-Tech bollards enjoy a long and trouble free service life.

However, with cast steel remaining popular in specific regions Hi-Tech also manufacture cast steel bollards which provide high impact resistance but require regular painting to prevent corrosion.

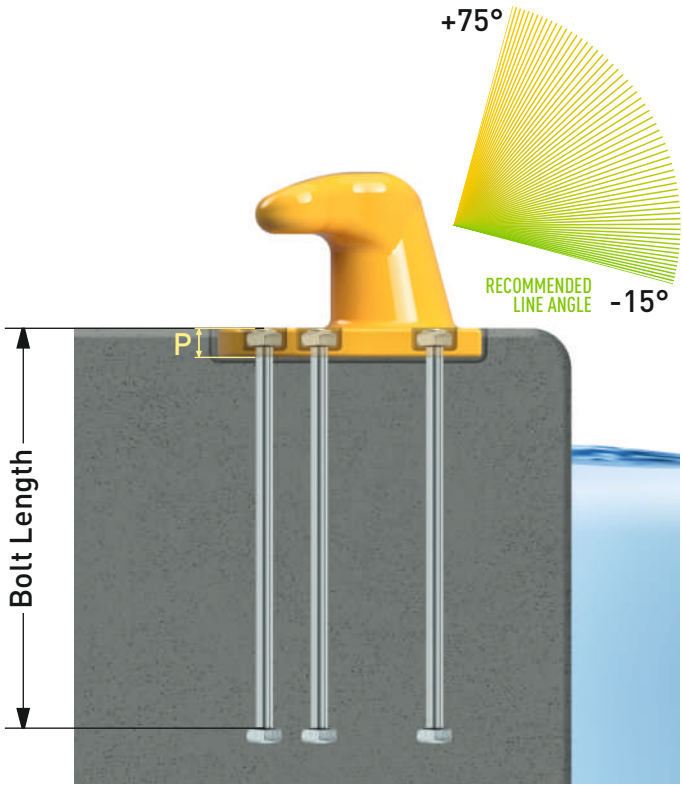
The shape of Hi-Tech bollards has been refined with finite element techniques to optimize the geometry and anchor layout. Even at full working load, Hi-Tech bollards remain highly stable and provide a safe and secure mooring.

FEATURES

- High quality SG iron as standard
- Strong and durable designs
- Very low maintenance
- Large line angles possible
- Standard and custom anchors available

TEE BOLLARD

From small recreational jetties to the largest bulk handling terminals, with a mooring line capacity range from 10 tonnes to 300 tonnes, Tee Bollards cover a vast range of mooring line capacity requirements. Durable ductile cast iron or cast steel allows Hi-Tech's Tee Bollards to withstand harsh environments.

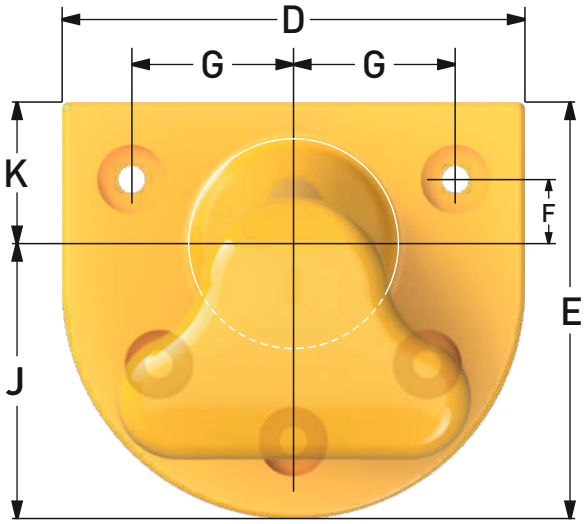


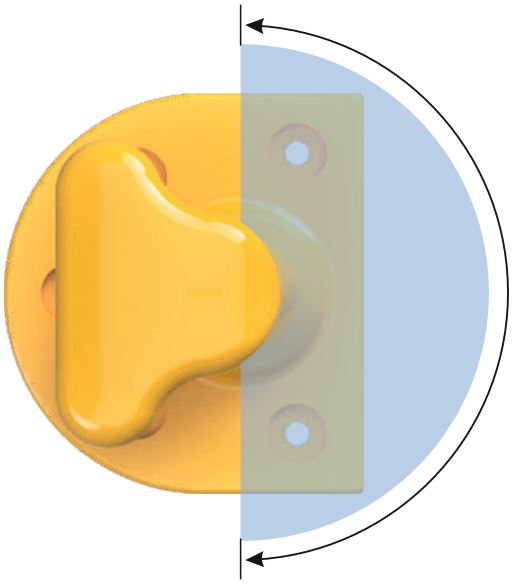
MOORING BOLLARDS (HMB)

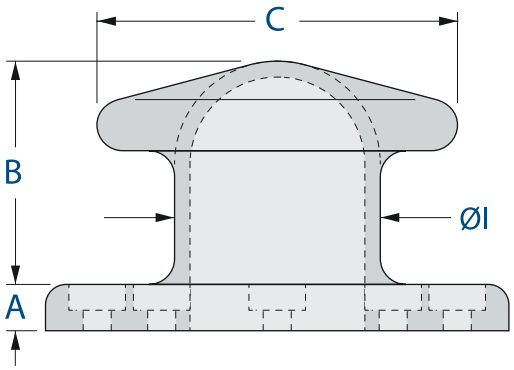
TEE BOLLARD

FEATURES

- General purpose applications up to 300 tons
- Suitable for steeper rope angles



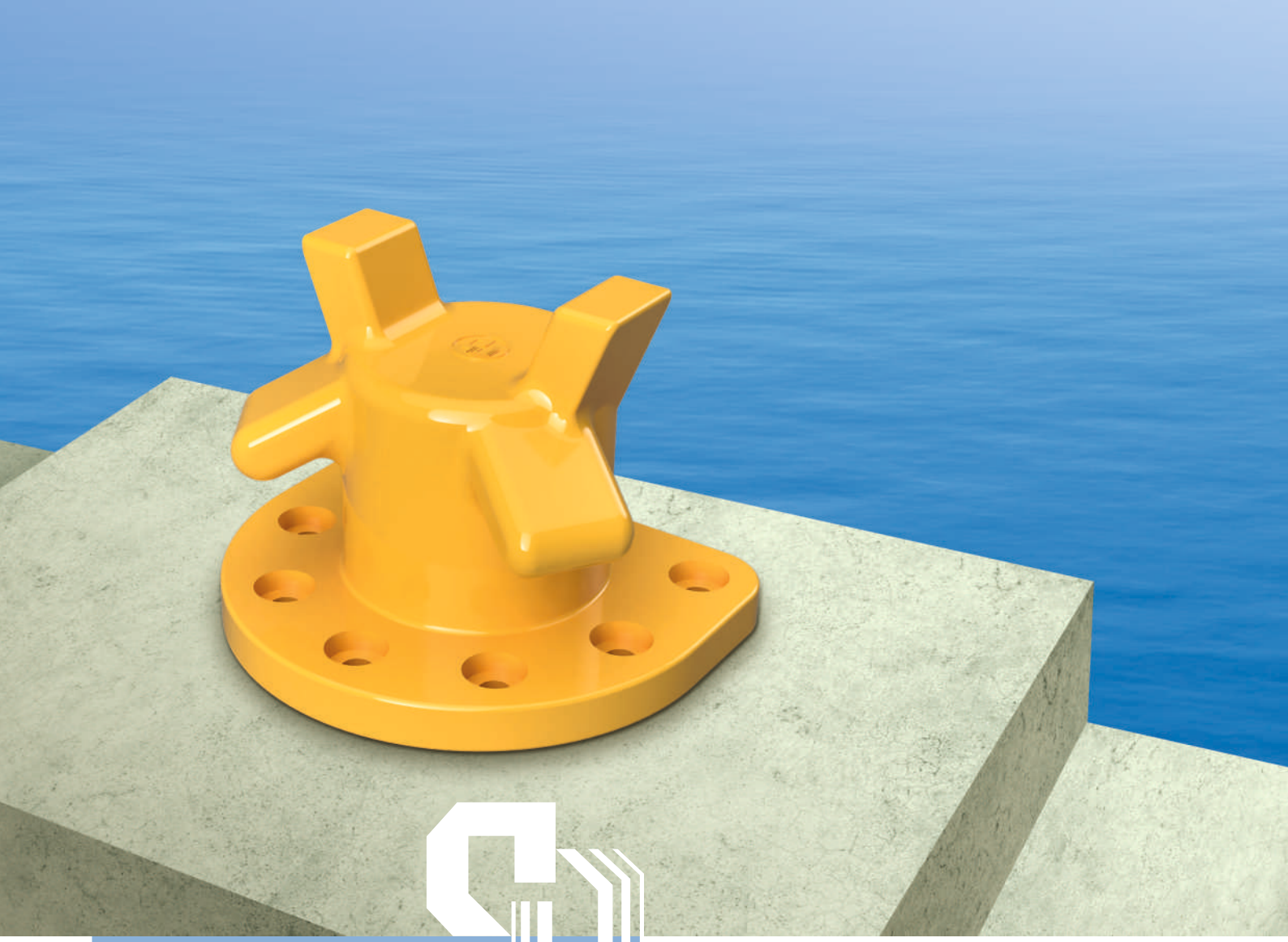




DIMENSION	BOLLARD CAPACITY (tons)											
	10	15	22.5	30	50	80	100	125	150	200	250	300
A	32	40	40	40	50	70	80	80	90	90	120	155
B	205	235	255	255	350	380	410	410	435	500	610	670
C	220	340	350	350	500	550	600	600	700	800	930	980
D	216	410	430	450	640	640	790	850	900	1000	1090	1200
E	236	335	355	375	540	550	640	700	750	850	915	925
F	75	80	90	100	150	160	175	175	200	225	250	200
G	65	155	165	175	250	250	325	325	350	375	425	475
ØI	120	160	180	200	260	280	350	350	400	450	500	500
J	118	205	215	225	320	320	395	425	450	500	545	600
K	118	130	140	150	220	230	245	275	300	350	370	325
Bolts	M20	M24	M30	M30	M36	M42	M42	M48	M48	M56	M64	M64
Bolt Length	450	500	500	500	500	800	800	900	1000	1000	1375	1550
P	47	55	55	55	65	85	95	95	105	105	135	170
Quantity	4	5	5	5	5	6	7	7	7	8	8	10

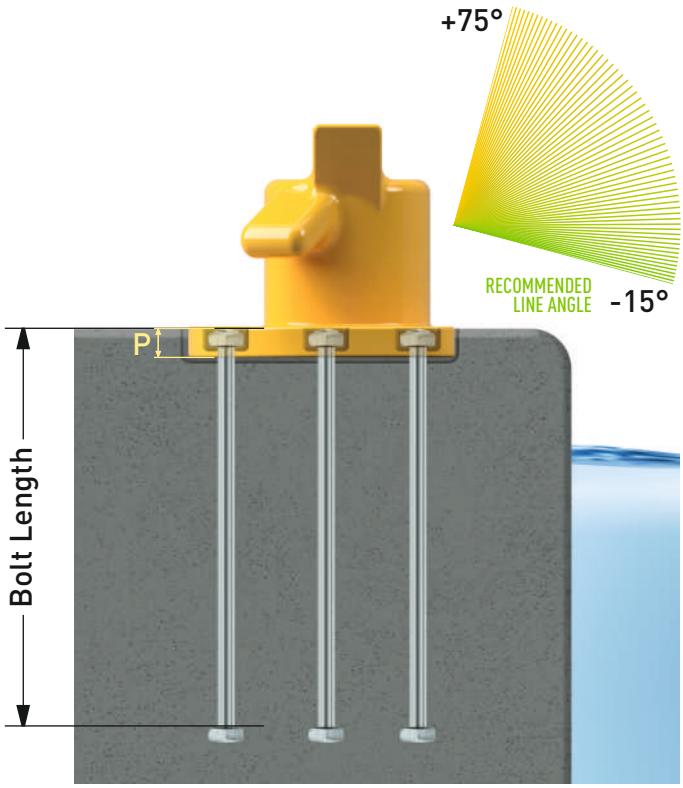
P = bollard base recess mounting depth including grout

[units: mm]



HORN BOLLARD

Horn Bollards also known as Staghorn Bollards are suitable for applications where tidal range variations are large and can handle steep mooring line angles. Due to their complex profile, Horn Bollards are capable of accepting multiple mooring lines. To withstand harsh environments, Hi-Tech's Horn Bollards are made from durable ductile cast iron or cast steel.

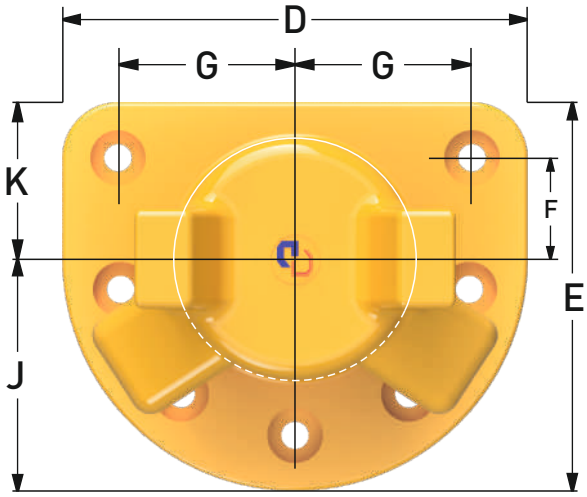


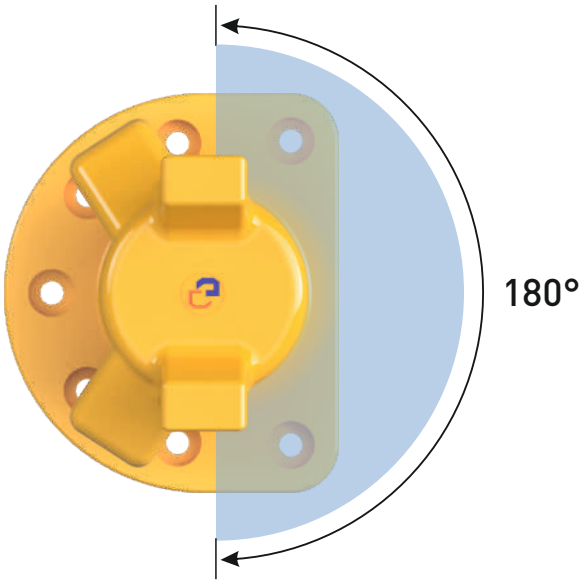
MOORING BOLLARDS (HMB)

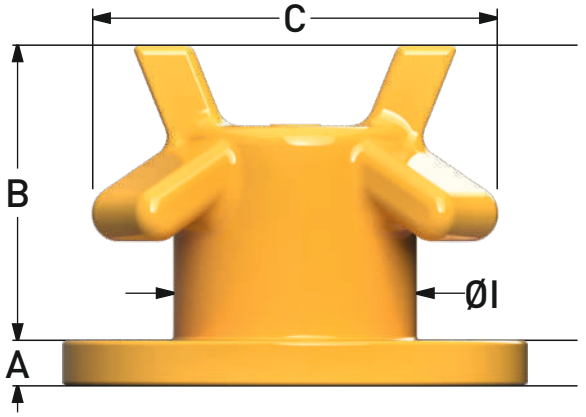
HORN BOLLARD

FEATURES

- General purpose applications up to 250 tons
- Suitable for steep rope angles
- Two lines may share a single bollard (subject to bollard capacity)



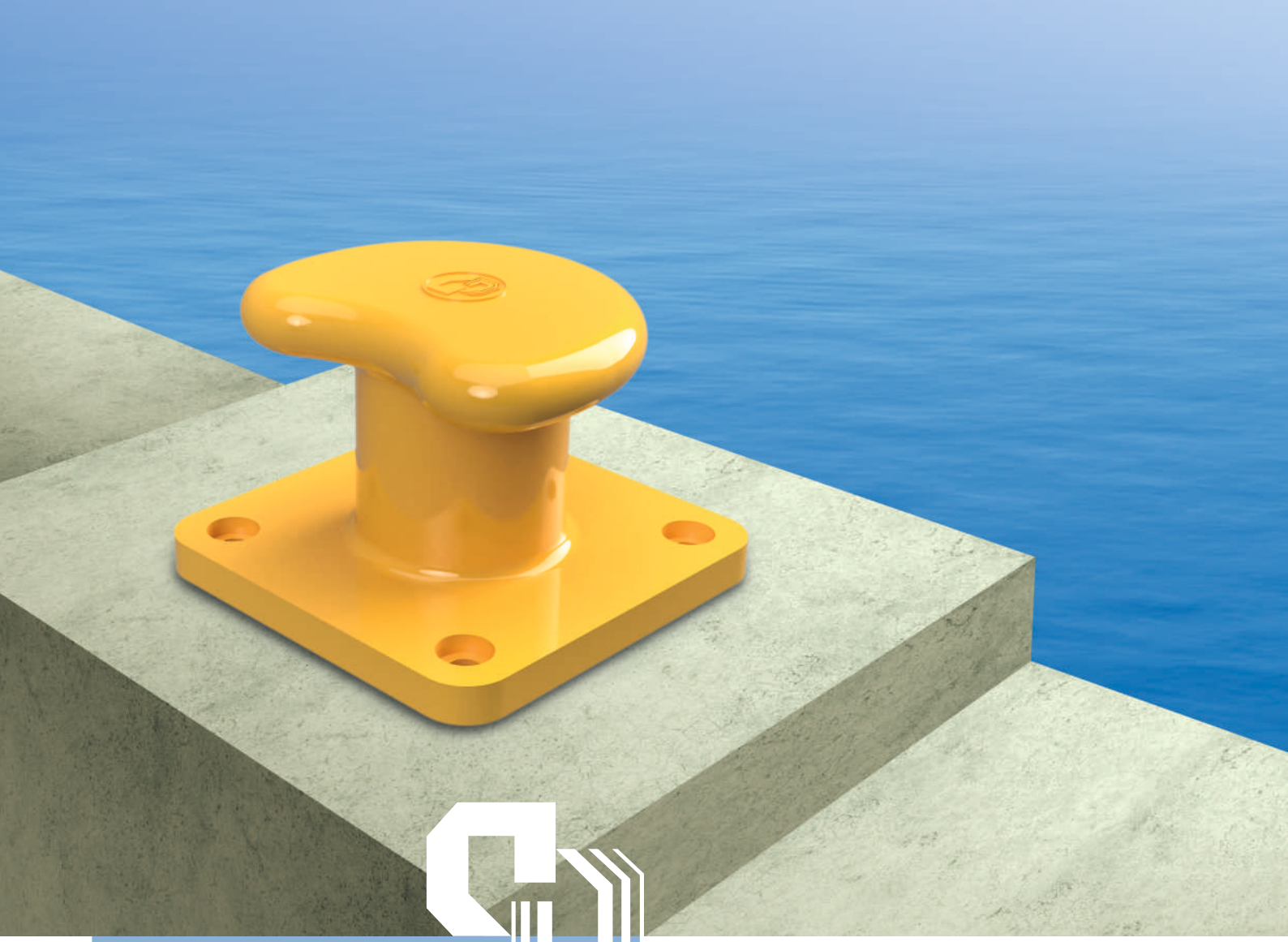




DIMENSION	BOLLARD CAPACITY (tons)								
	15	30	50	80	100	125	150	200	250
A	40	40	50	70	80	80	90	90	120
B	370	410	500	520	570	595	585	660	690
C	400	440	600	660	750	775	850	930	930
D	410	480	640	650	800	820	920	1000	1000
E	335	405	540	560	650	670	770	850	850
F	80	100	150	160	175	175	200	225	225
G	155	175	250	250	325	325	350	375	375
ØI	160	200	260	300	350	375	400	450	450
J	205	240	320	325	400	410	460	500	500
K	130	165	220	235	250	260	310	350	350
Bolts	M24	M30	M36	M42	M42	M48	M48	M56	M64
Bolt Length	500	500	500	800	800	900	1000	1000	1375
P	55	55	65	85	95	95	105	105	135
Quantity	5	5	5	6	7	7	7	8	8

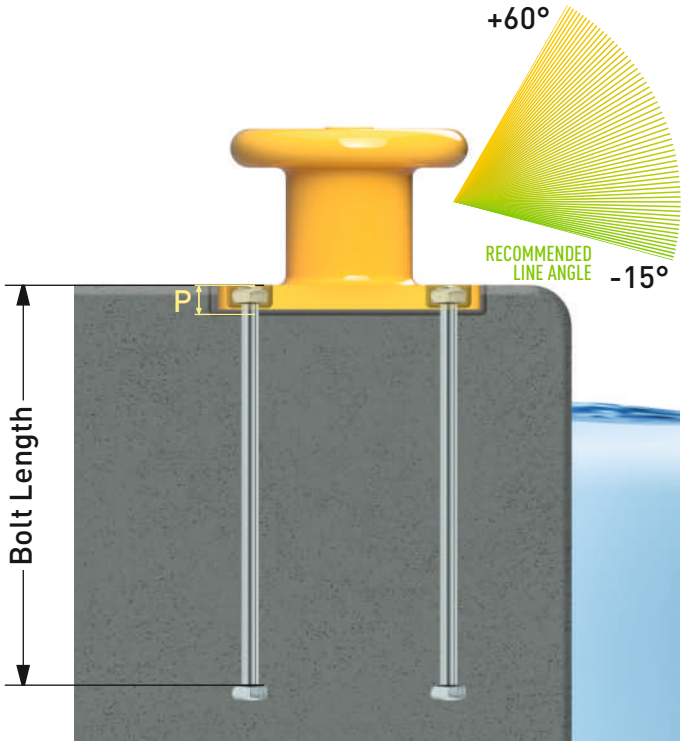
P = bollard base recess mounting depth including grout

[units: mm]



KIDNEY BOLLARD

Kidney Bollards are the perfect choice for warping operations along with berths where vessels need to be re-positioned for loading purposes and are suitable for applications where tidal ranges are small. Hi-Tech's Kidney Bollards cover a large range of mooring line capacity requirements from small harbors to large bulk handling terminals, with a mooring line capacity from 15 tonnes to 200 tonnes.

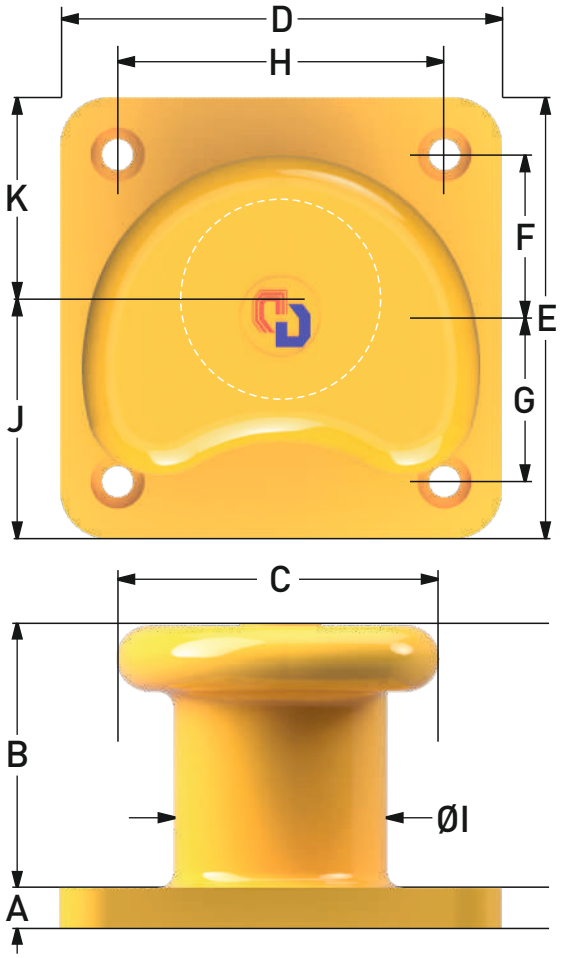


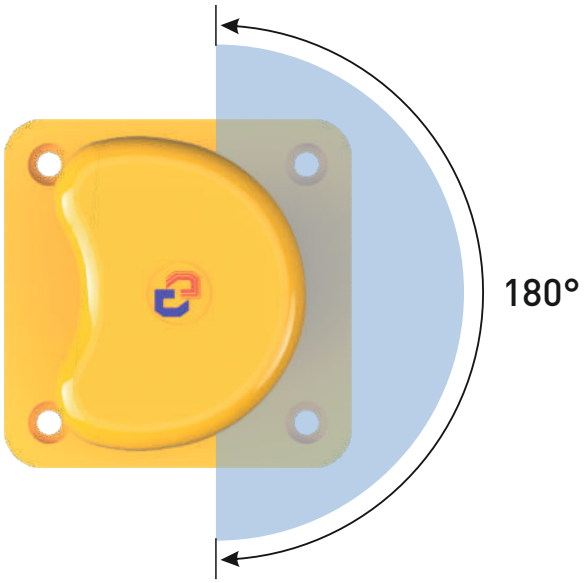
MOORING BOLLARDS (HMB)

KIDNEY BOLLARD

FEATURES

- General purpose applications up to 200 tons
- Avoid steep rope angles where possible
- Suitable for warping operations





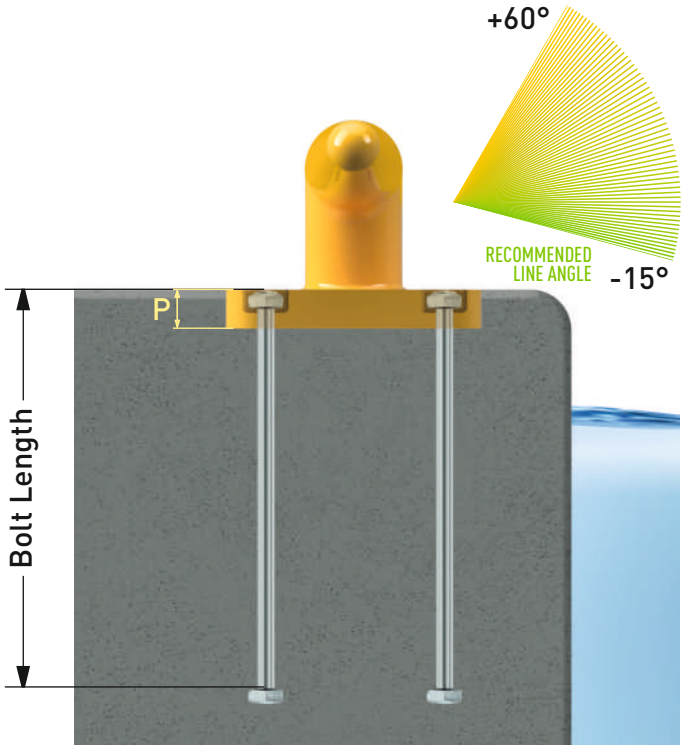
DIMENSION	BOLLARD CAPACITY (tons)							
	15	30	50	80	100	125	150	200
A	40	40	50	70	70	80	80	90
B	260	280	320	330	350	375	405	435
C	340	370	480	530	550	640	728	800
D	320	360	540	560	590	680	760	1000
E	320	360	540	460	490	580	660	850
F	-	-	-	-	175	210	250	300
G	-	-	-	-	175	210	250	300
F+G	220	260	400	320	350	420	500	600
H	220	260	400	420	450	520	600	750
ØI	160	200	260	280	300	325	400	450
J	160	180	270	280	295	340	380	475
K	160	180	270	180	195	240	280	375
L	-	-	-	-	50	50	50	50
Bolts	M24	M30	M36	M42	M42	M48	M48	M56
Bolt Length	500	500	500	800	800	1000	1000	1000
P	55	55	65	85	85	95	95	105
Quantity	4	4	4	5	7	7	7	7

P = bollard base recess mounting depth including grout

[units: mm]

CLEAT BOLLARD

Cleat Bollards suit marine mooring applications for light commercial use or recreational marina use as well as mounting on vessels. Hi-Tech's Cleat Bollards are made from durable ductile cast iron or cast steel to withstand harsh environments.

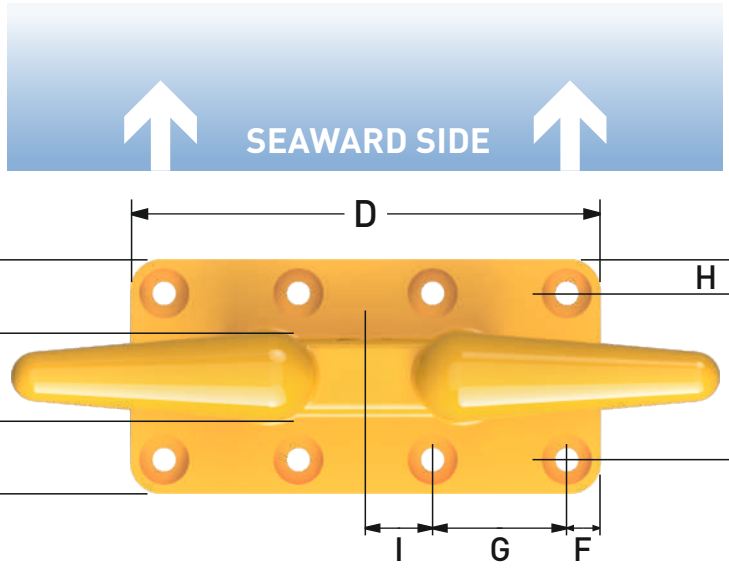


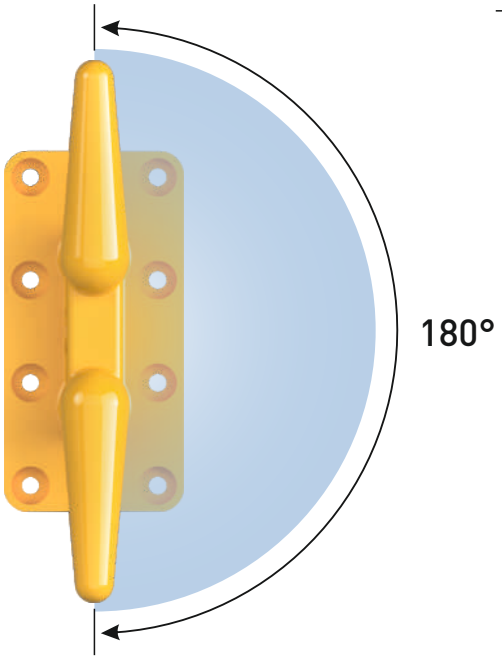
MOORING BOLLARDS (HMB)

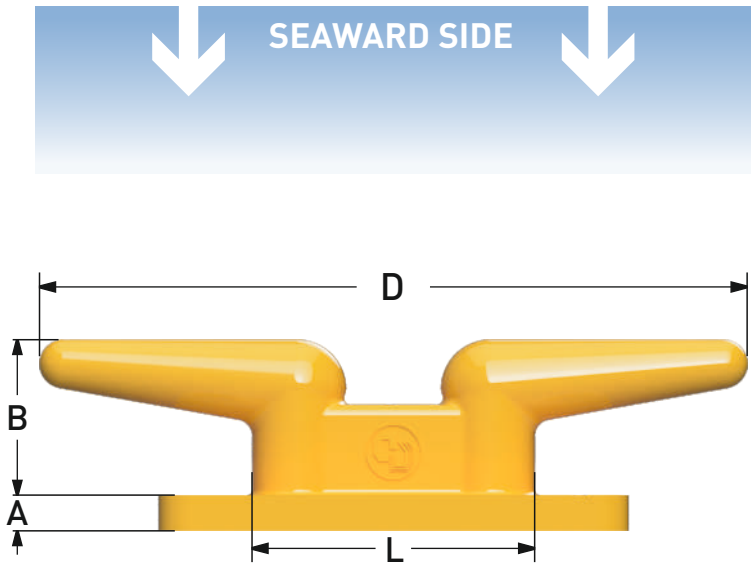
CLEAT BOLLARD

FEATURES

- General purpose applications up to 35 tons
- Suitable for steep rope angles
- Suitable for small wharves or jetties and marinas







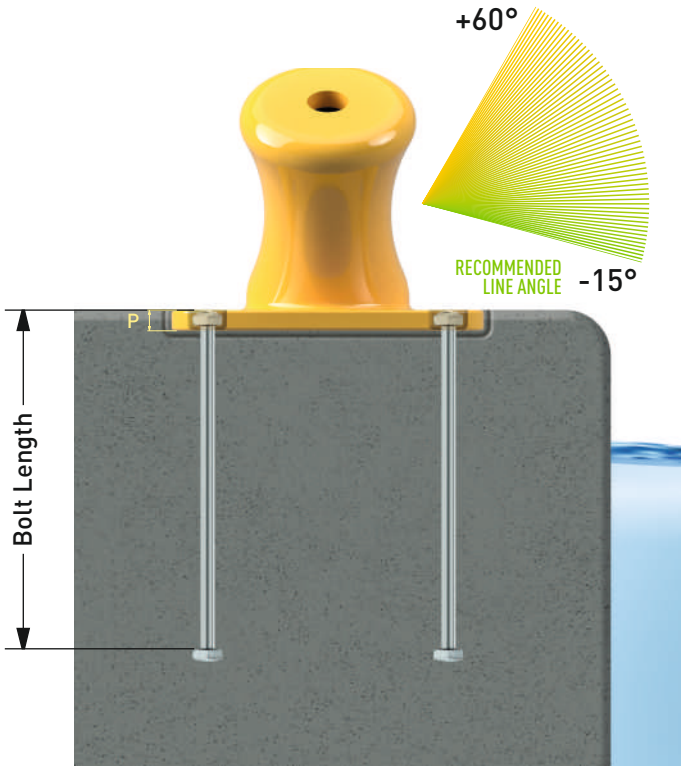
DIMENSION	BOLLARD CAPACITY (tons)				
	15	20	25	30	35
A	30	40	45	45	50
B	165	180	210	250	270
C	510	665	810	960	1120
D	410	510	610	660	840
E	220	280	310	310	400
F	40	50	50	45	60
G	165	205	255	190	240
H	40	50	50	45	60
J	140	180	210	220	280
K	90	110	130	150	170
L	235	280	325	370	430
Bolt	M20	M24	M24	M24	M30
Bolt Length	350	460	460	460	460
P	45	55	60	60	65
Quantity	6	6	6	8	8

P = bollard base recess mounting depth including grout
I = 1/2 dimension G

[units: mm]

DOUBLE BITT BOLLARD

Double Bitt Bollards or Twin Horn Bollards have been designed with a narrow base footprint to fit into spaces on wharves that have limited work area and are capable of accepting multiple mooring lines due to their twin horn profile. These bollards are durable and can withstand harsh environment.

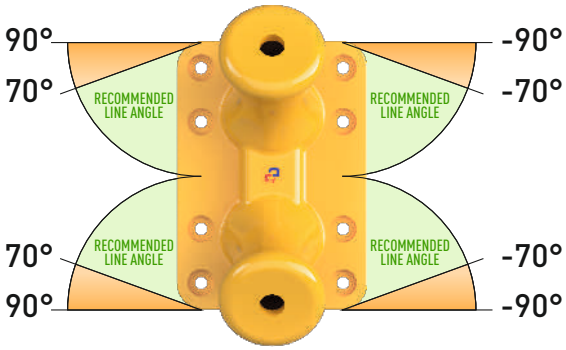


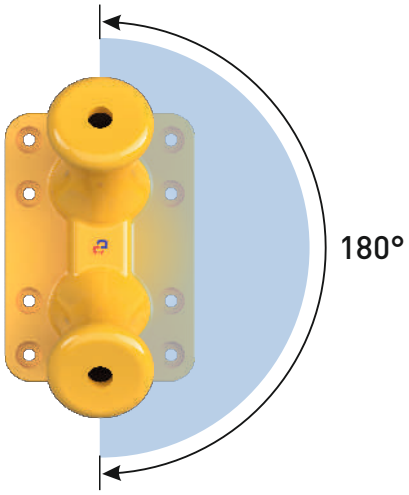
MOORING BOLLARDS (HMB)

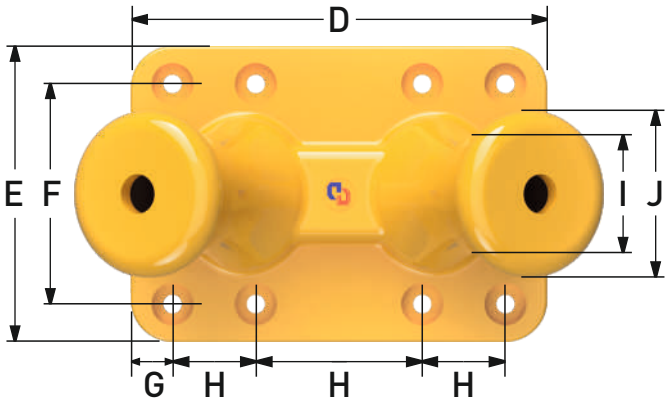
DOUBLE BITT BOLLARD

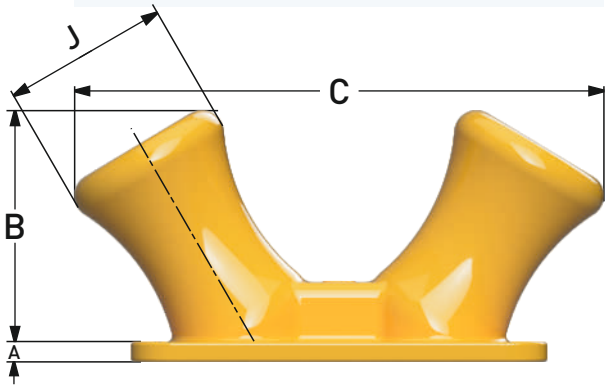
FEATURES

- General purpose applications up to 200 tons
- Suitable for mooring multiple lines (subject to bollard capacity)
- Concrete filled (optional)









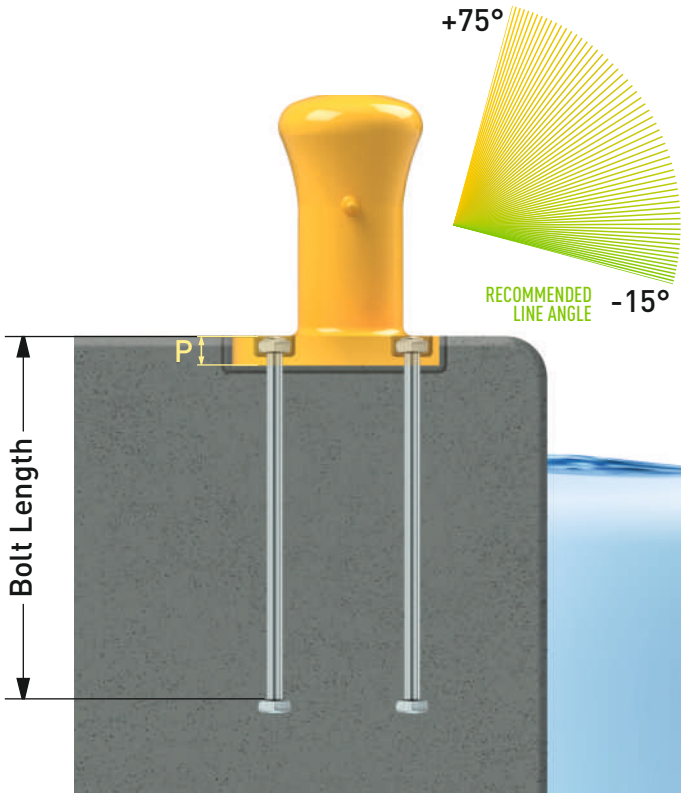
DIMENSION	BOLLARD CAPACITY (tons)							
	20	30	50	75	100	125	150	200
A	20	20	25	40	50	60	60	60
B	300	350	420	510	600	700	750	840
C	680	780	950	1140	1330	1535	1670	1860
D	540	610	720	870	1020	1170	1270	1430
E	280	310	360	440	520	590	640	720
F	190	220	270	330	390	440	490	530
G	45	45	45	55	65	75	75	95
H	150	180	210	190	222.5	255	280	310
I	150	180	210	250	300	340	370	410
J	210	240	310	350	410	470	510	570
Bolt	M20	M22	M30	M36	M42	M42	M48	M56
Bolt Length	300	300	450	500	600	750	850	1070
P	35	35	40	55	65	75	75	75
Quantity	8	8	8	10	10	10	10	10

P = bollard base recess mounting depth including grout

[units: mm]

SINGLE BITT BOLLARD

Single Bitt Bollards are suitable for applications where tidal range variations are large, specially harsh environments and can handle steep mooring line angles. Hi-Tech's Single Bitt Bollards are capable of accepting multiple mooring lines and have been designed to fit onto exciting bolt patterns for older-style pillar bollards.

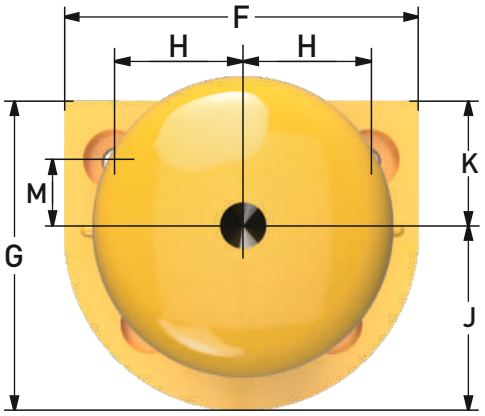


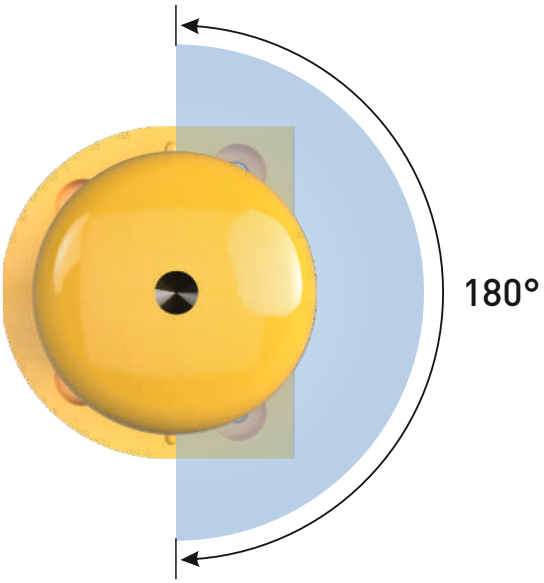
MOORING BOLLARDS (HMB)

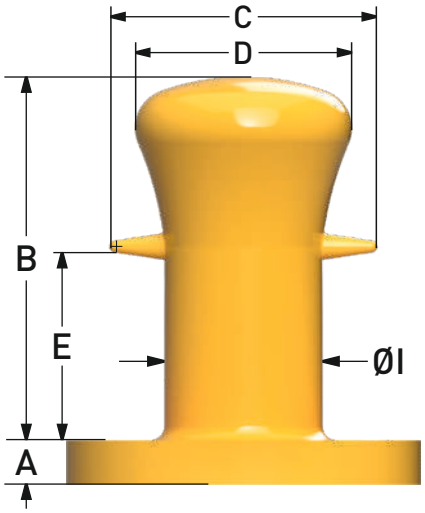
SINGLE BITT BOLLARD

FEATURES

- General purpose applications up to 200 tons
- Avoid steep rope angles where possible
- Suitable for warping operations
- 360 degree horizontal line angle use
- Can be utilized from all sides of jetty



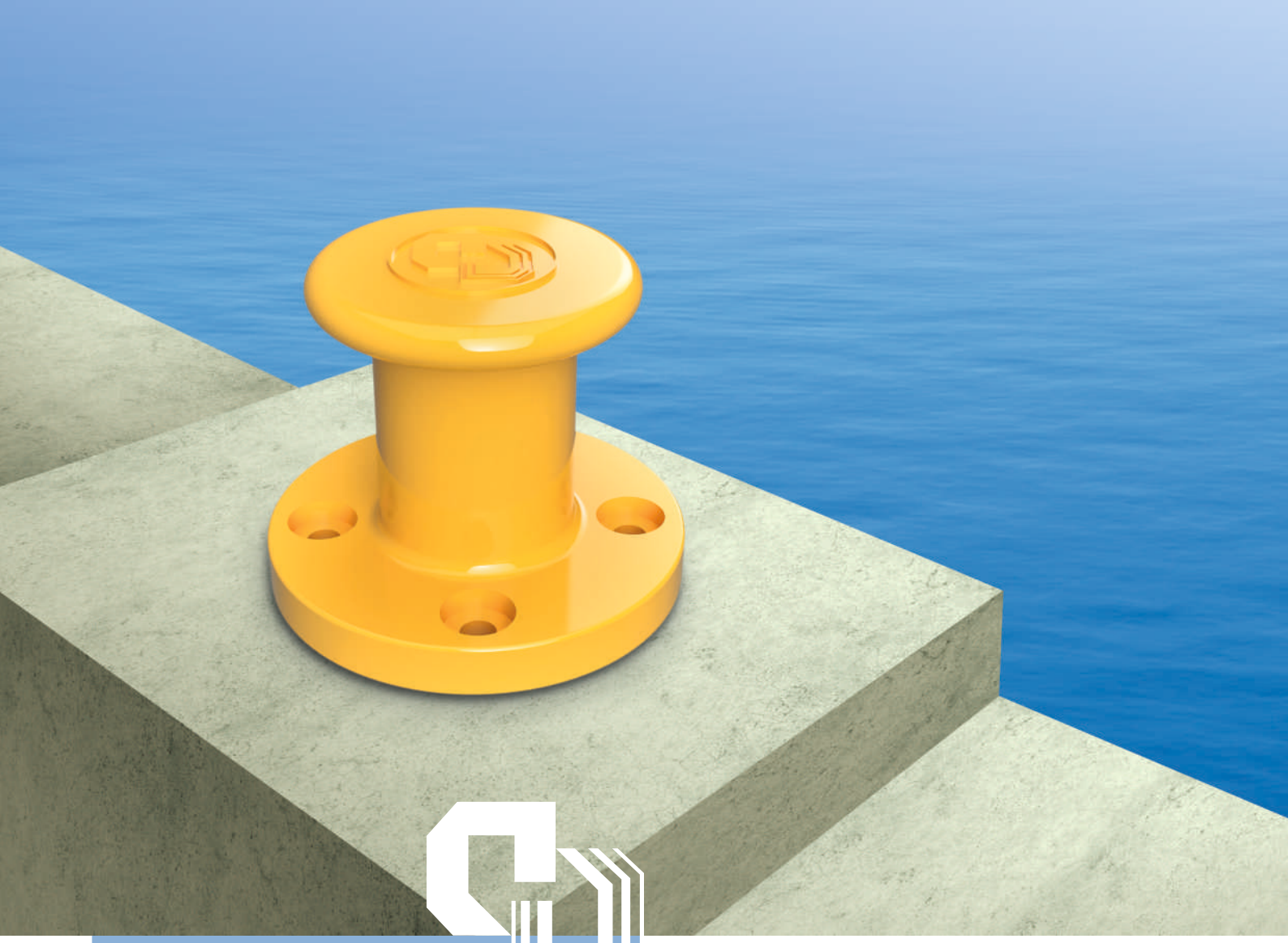




DIMENSION	BOLLARD CAPACITY (tons)						
	20	30	20	30	20	30	20
A	45	60	70	80	80	100	110
B	370	490	630	740	790	900	1000
C	260	340	450	500	550	650	750
D	220	260	340	390	415	460	530
E	145	160	260	285	325	380	465
F	360	420	530	650	760	900	990
G	315	380	480	580	685	810	890
H	130	160	205	250	290	345	380
ØI	160	200	260	290	320	370	430
J	180	210	265	325	380	450	495
K	135	170	215	255	305	360	395
M	75	120	155	180	215	255	280
Bolt	M24	M30	M36	M42	M48	M56	M56
Bolt Length	400	500	600	600	750	1000	1000
P	60	75	85	95	95	115	125
Quantity	4	5	6	6	7	7	8

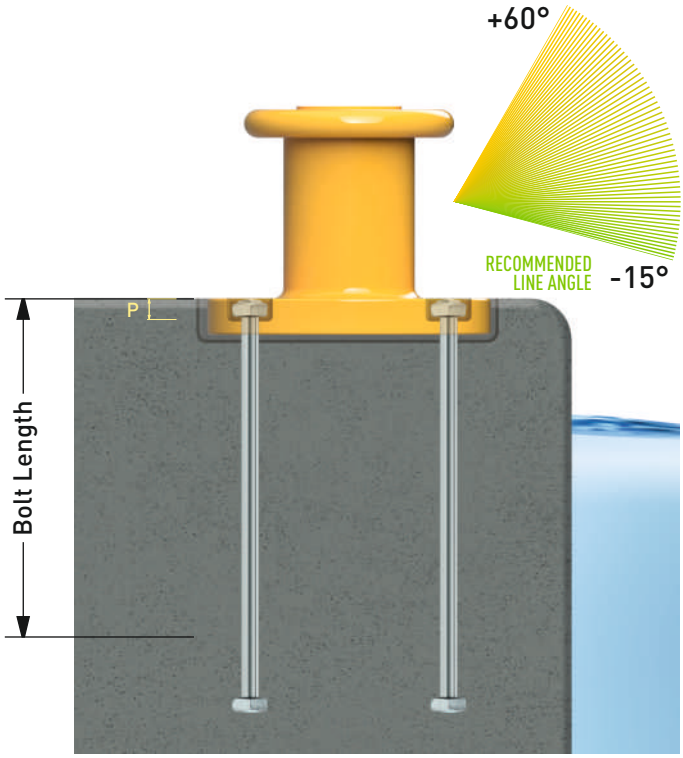
P = bollard base recess mounting depth including grout

[units: mm]



PILLAR BOLLARD

Pillar Bollards are suitable for applications where tidal ranges are small and are suited to warping operations along with berths where vessels need to be re-positioned for loading purposes. Hi-Tech's Pillar Bollards can also be placed on jetties where vessels berth on both sides of the jetty structure dute to their 360-degeree line load range. These bollards are also suitable for harsh environments.

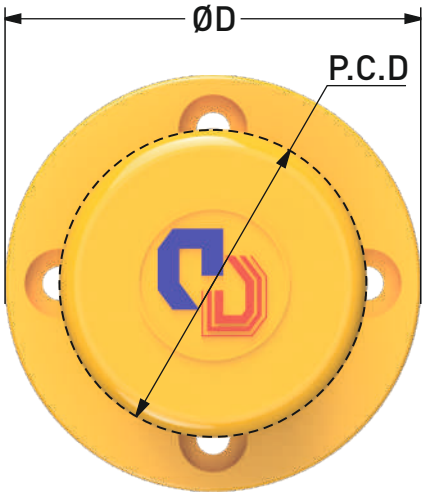


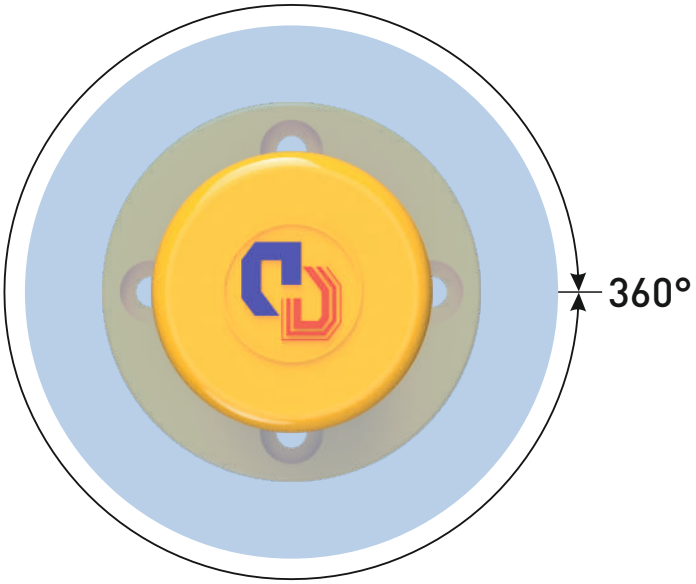
MOORING BOLLARDS (HMB)

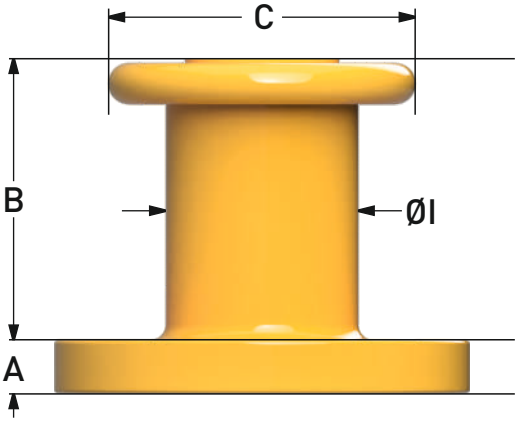
PILLAR BOLLARD

FEATURES

- General purpose applications up to 200 tons
- Suitable for mooring multiple lines (subject to bollard capacity)
- Concrete filled (optional)







DIMENSION	BOLLARD CAPACITY (tons)							
	20	30	50	75	100	125	150	200
A	35	40	50	60	70	70	80	90
B	180	280	320	350	380	410	450	480
C	200	300	390	430	500	580	680	740
ØD	270	420	500	580	630	700	800	900
P.C.D	190	300	365	450	490	550	600	700
ØI	125	200	240	280	320	360	400	450
Bolt	M20	M24	M36	M36	M42	M48	M56	M64
Bolt Length	350	400	550	800	1000	1000	1000	1000
P	50	55	65	75	85	85	95	105
Quantity	4	4	4	7	7	7	8	8

P = bollard base recess mounting depth including grout

[units: mm]

MOORING BOLLARDS (HMB)

BOLLARD MATERIALS AND MANUFACTURE

DESIGN

Bollards and holding down bolts are designed with a minimum factor of safety against failure of 3.0 for Spheroidal Graphite (SG) cast iron material grade 65-45-12.

Designs are typically based on the following:

STANDARD	TITLE
BS 5950:2000	Structural use of steelwork
BS 6349: 1-4 (2013): Part 4	Marine structures
AS 3990:1993	Mechanical equipment design

Detailed calculations can be supplied on request. Different factors of safety can be used to suit other national standards and regulations.

MATERIALS

Hi-Tech bollards are offered in Spheroidal Graphite cast Iron (SG Iron), referred to as Ductile cast Iron, because of its superior strength and resistance to corrosion. Ductile cast iron combines the best attributes of grey cast iron and cast steel without the disadvantages.

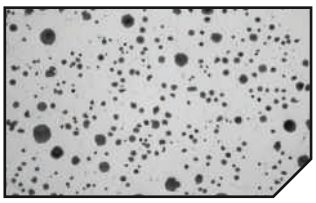
STANDARD	TITLE	TITLE
Ductile Cast Iron (Spheroidal Graphite)	• Lowest service life cost • High strength • Good impact resistance • High corrosion resistance	
Grey Cast Iron	• Low cost per weight • Excellent corrosion resistance	• Low strength • Low impact resistance
Cast Steel	• High strength • High impact resistance • Good cost per weight	Needs regular maintenance to prevent corrosion

The standard material for Hi-Tech bollards is ASTM A536 Grade 65/45/12 Spheroidal Graphite Cast Iron.

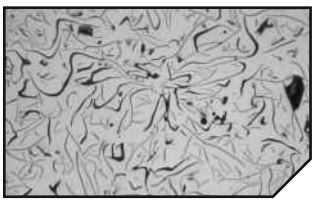
This material has been selected as it has superior corrosion resistance over cast steel and is the best consolidation of price, performance and material strength.

Ductile cast iron is the preferred material for all bollard applications. Grey cast iron is cheaper per unit weight, but the need for thicker wall sections and poor impact strength outweighs this. cast steel remains popular in some countries but needs regular painting to prevent corrosion.

MICRO STRUCTURE



Ductile cast iron (SG)



Grey iron

SG IRON VS CAST STEEL BOLLARDS

There is a perception that a stronger material means a stronger bollard. When steel is selected however, the bollards are generally made smaller to achieve the same SWL capacity and safety factors. Smaller bollards have the disadvantage of having a smaller bend radii for the mooring lines. As longevity of mooring ropes is a factor of their loading cycle and bend radii, decreased mooring line life can be expected.

Where cast steel bollards must be used, please contact Hi-Tech for pricing, availability and lead time. It may be possible to utilize the relevant SG iron pattern for a cast steel bollard.

DUCTILE CAST IRON (SPHEROIDAL GRAPHITE)	GREY CAST IRON	CAST STEEL
Lowest service life cost	Low cost per weight	Good cost per weight
High strength	Low strength	High strength
Good impact resistance	Low impact resistance	High impact resistance
High corrosion resistance	Excellent corrosion resistance	Regular maintenance to prevent corrosion

MOORING BOLLARDS (HMB)

BOLLARD MATERIALS AND MANUFACTURE

MATERIAL SPECIFICATION

Hi-Tech bollards are produced to the highest specifications. The table gives indicative standards and grades but many other options are available on request.

MATERIALS	STANDARD(S)*	GRADE(S)*
Ductile Cast Iron (Spheroidal Graphite Iron)	BS EN 1563 ASTM A 536	EN-GJS-450 or 500 65-45-12 or 80-55-6
Cast Steel	ASTM A148 IS 1030	80-50 340-570
Anchor Bolts (galvanized)	ISO 898 BS 3692 ASTM	Gr 8.8 (galvanized) Gr 8.8 (galvanized) ASTM F1554 Gr 105 (galvanized)
Blasting (standard) Blasting (high performance)†	SSPC-SP10 NACS no. 2	SA2.5
Paint (standard) Paint (high performance)†	BS 3416 ISO 12944	High build epoxy (300 microns)

* In all cases equivalent alternative standards may apply.
† Please contact Hi-Tech for other grades and high performance paint systems.

QUALITY ASSURANCE

Bollards are safety critical items and quality is paramount. Independant 3rd party witnessing of test is available at additional cost on request. A typical quality documentation package will include:

- Dimensioned drawings of bollard and accessories
- Bollard and anchorage calculations (if required)
- Inspection and test plan
- certificate of conformance
- Physical, chemical and materials properties report for casting and anchorages
- Installation instructions

COATING SYSTEMS

Bollards are supplied as factory standard with a protective coating suitable for most projects.

High performance epoxy or other specified paint systems can be factory applied on request in a choice of colors and thicknesses. Standard available coatings include (uncoated, zinc oxide primer or high performance epoxy).

Bollard are also available and supplied with Hot Dip Galvanized (HDG) on special request basis. High strength stainless steel anchors may be available on request.

Wear and abrasion from ropes means paint coatings need regular maintenance. Ductile iron bollards are far less susceptible to corrosion than cast steel bollards, which can rust quickly and will need frequent painting to retain full strength.

Bitumous coatings (coal tar) are no longer commercially available and in most countries no longer allowed in marine installation. They have been discontinued on Hi-Tech bollards.

Polyethylene molded bollards are molded with high strength Polyurethane. It gives higher corrosion resistance as well as far superior abrasion resistance. It can be molded in almost any shape, size and color.

MOORING BOLLARDS (HMB)

BOLLARD SELECTION

SELECTION

Bollards should be selected and arranged according to local regulations or recognized design standards. The design process should consider:

- Mooring pattern(s)
- Changes in draft due to loading and discharge
- Wind and current forces
- Swell, wave and tidal forces
- Mooring line types, sizes and angles
- Ice forces (where relevant)

Mooring loads should be calculated where possible, but in the absence of information then the following table can be used as an approximate guideline.

DISPLACEMENT	APPROX. BOLLARD RATING
Up to 2,000 tons	10 tons
2,000–10,000 tons	30 tons
10,000–20,000 tons	60 tons
20,000–50,000 tons	80 tons
50,000–100,000 tons	100 tons
100,000–200,000 tons	150 tons
Over 200,000 tons	200 tons

Where strong winds, currents or other adverse loads are expected, bollard capacity should be increased by 25% or more.

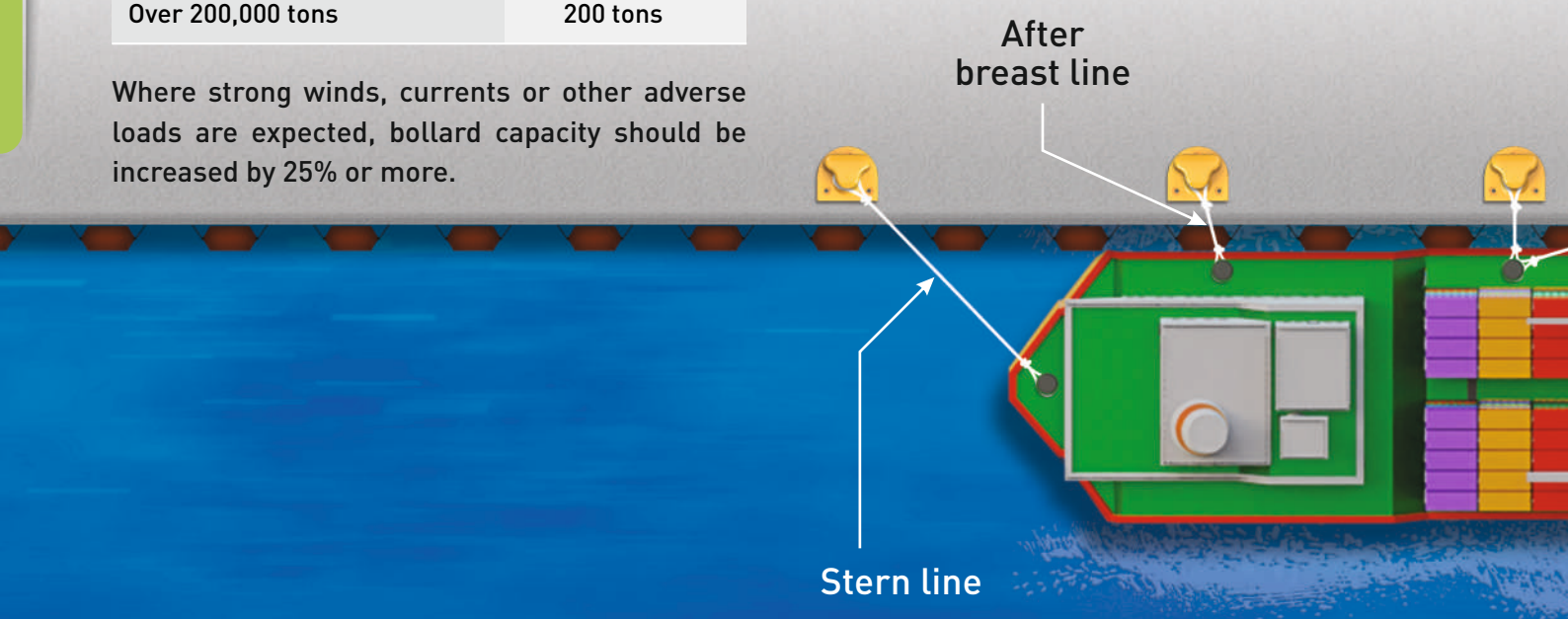
MOORING LINE ANGLES

Mooring line angles are normally calculated as part of a comprehensive mooring simulation. Standards and guidelines such as BS6349: Part 4, RoM

0.2-90 and PIANc suggest mooring line angles are kept within the limits given in the table below. In some cases much larger line angles can be expected.

Hi-Tech bollards can cope with horizontal angles of ± 90° and vertical angles up to 75°. Please check with your local office about applications where expected line angles exceed those given in the table as these may need additional design checks on anchorages and concrete stresses.

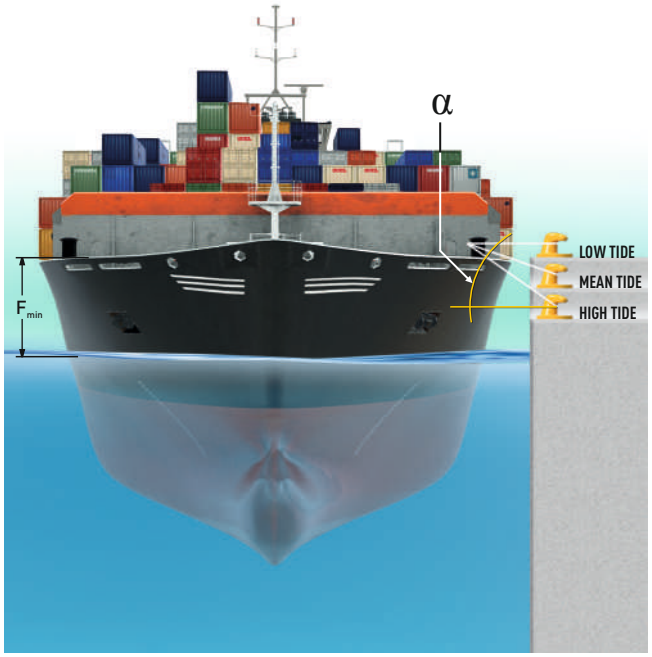
SUGGESTED LINE ANGLES (BS6349, ROM 0.2-90, PIANC)	
Head & stern lines*	45° ± 15°
Breast lines*	90° ± 30°
Spring lines*	5 – 10°
Vertical line angle (α)	<30°



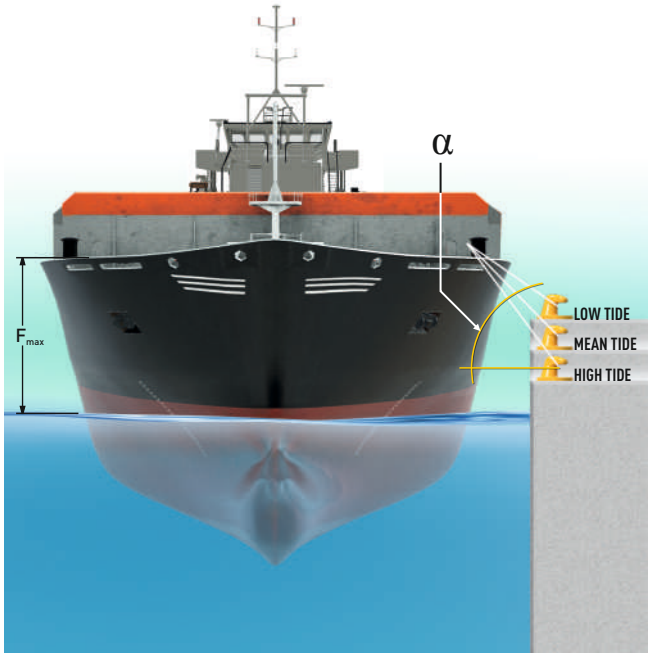
MOORING BOLLARDS (HMB)

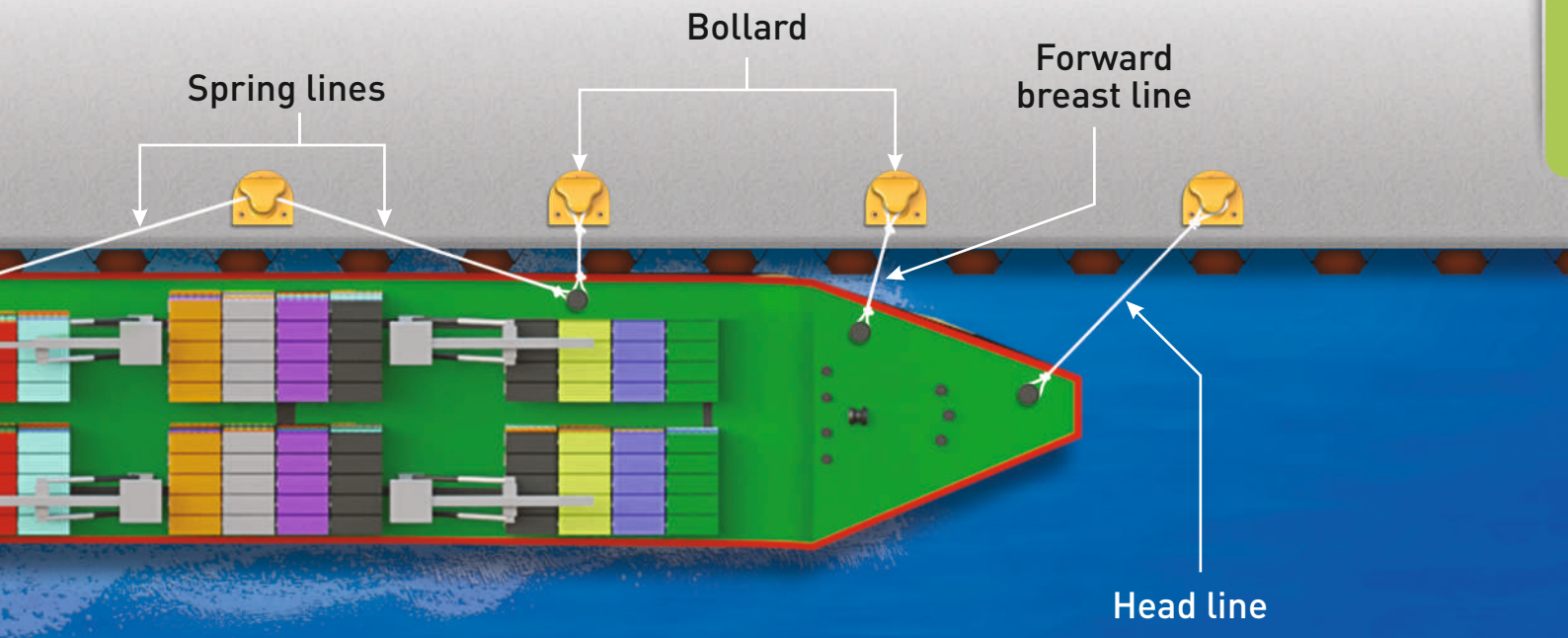
BOLLARD SELECTION

FULLY LADEN CASE



LIGHT DRAFT CASE





MOORING BOLLARDS (HMB)

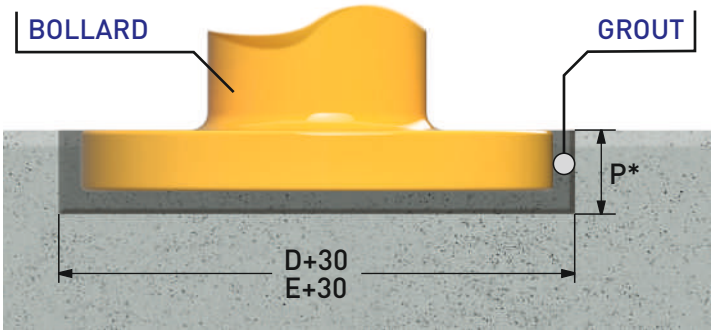
BOLLARD INSTALLATION

INTRODUCTION

Bollards must be installed correctly for a long and trouble-free service life. Anchors should be accurately set out with the supplied template.

Bollards can be recessed (as shown) or surface mounted. once the grout has reached full strength, anchors can be fully tightened. Mastic is often applied around exposed threads to ease future removal.

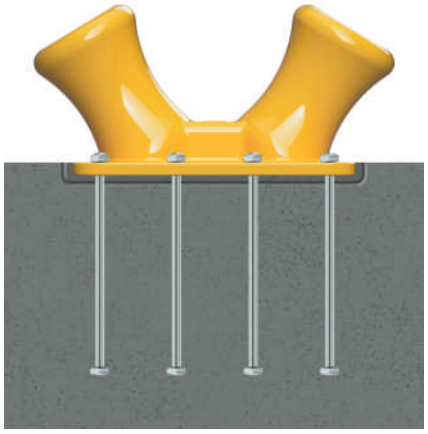
CONCRETE RECESS



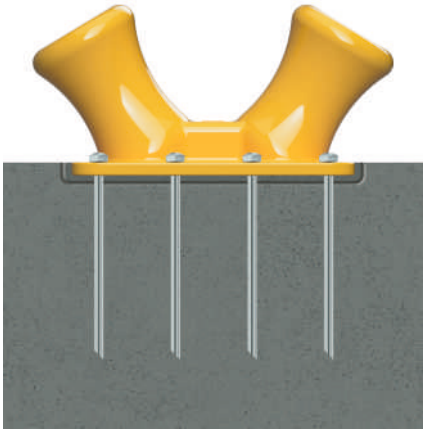
* refer to dimensions tables

Recessing the bollard is generally recognized as superior to surface mounting. Recessing the base prevents the bollard from working loose on its bolts or cracking the grout bed – especially relevant for high use locations.

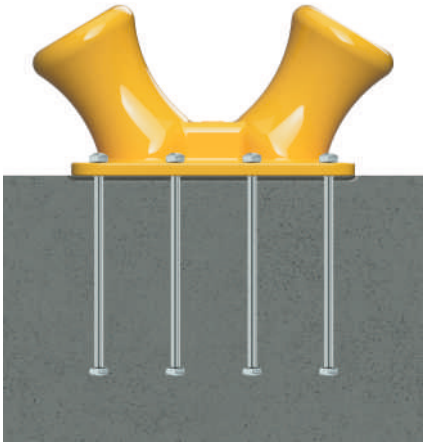
FIXING OPTIONS



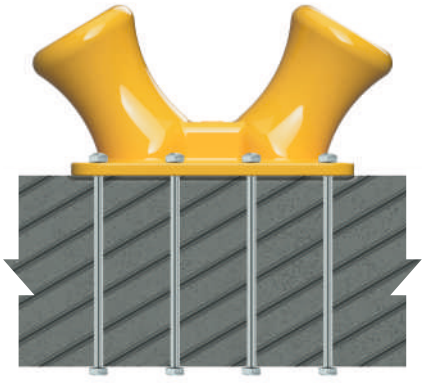
Recess Mounting Type



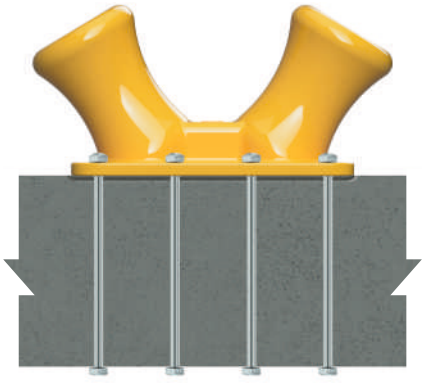
Retrofit Mounting Type
(using EC 2 epoxy anchors)



Surface Mounting Type



Steelwork Mounting Type



Through Bolting Type

MOORING BOLLARDS (HMB)

BOLLARD MAINTENANCE

Like all equipment in the marine environment, regular inspection and maintenance is critical to achieving maximum life expectancy.

Hi-Tech recommends regular scheduled berth equipment inspection, including bollards. Key items that need to be focused on during the inspection and maintenance include:

PROTECTIVE COATING

Bollards are supplied as factory standard with a protective coating suitable for most projects. High performance epoxy or other specified paint systems are usually applied at the factory on request in a choice of colors and thicknesses.

Wear and abrasion from ropes means paint coatings need regular maintenance. Like all epoxy coating systems, maintenance is integral to increasing life expectancy. Hi-Tech recommends regular inspection of the bollards

Repair and upkeep of the coating system is dependent upon the coating system selected. Hi-Tech tries to utilize commercially available coating systems to ensure local products can be sourced and system repair procedures are in line with the coating system manufacturers guidelines.

HOLD DOWN BOLTS

Holding down bolt anchor sets are crucial to bollard performance. Nut or bolt should be tightened manually using a 1m long spanner or multiplier as per applicable torque table. Ensuring correct torque settings during installation will optimize the performance of the bollards and hold down bolts. These are critical to be checked during installation.

Visual checks on hold down bolts should be undertaken during regular maintenance to ensure no loosening of bolts has occurred.

GROUT

Installation and grout filling requires extra care to avoid damage to factory applied coatings. Similarly regular inspection and possible repair of grout under and around the bollard is critical to the ongoing integrity of bollard performance. Replacement is recommended should grout be cracked or damaged.

BOLLARD MATERIALS

Ductile iron bollards are far less susceptible to corrosion than cast steel bollards, which can rust quickly and will need frequent painting to retain full strength. Regular inspection of the bollard materials is recommended.

Hi-Tech is happy to assist in providing inspection services on berthing and mooring equipment.

MOORING BOLLARDS (HMB)

TORQUE TABLE

TYPE OF BOLLARD	TON CAPACITY	BOLT SIZE (Metric)	Loading @ SWL X 1.5			Loading @ SWL X 1.25		
			PRETENSION FORCE (kN)	TORQUE REQUIREMENT (N.m)	% UTILIZATION OF PROOF STRESS	PRETENSION FORCE (kN)	TORQUE REQUIREMENT (N.m)	% UTILIZATION OF PROOF STRESS
TEE BOLLARD								
	10	M20	90.4	325	58%	75.4	271	48%
	15	M24	108.4	468	48%	90.4	391	40%
	22.5	M30	162.5	878	45%	135.5	732	38%
	30	M30	216.6	1170	60%	180.6	975	50%
	50	M36	360.9	2339	69%	300.8	1949	58%
	80	M42	481.1	3637	67%	401.0	3031	56%
	100	M42	515.5	3897	72%	429.6	3248	60%
	125	M48	644.3	5567	68%	536.9	4639	57%
	150	M48	773.1	6680	82%	644.3	5567	68%
	200	M56	901.9	9091	69%	751.6	7576	58%
	250	M64	1127.3	12987	66%	939.5	10823	55%
	300	M64	1082.2	12467	63%	901.9	10390	53%
HORN BOLLARD								
	15	M24	108.4	468	48%	90.4	391	40%
	30	M30	216.6	1170	60%	180.6	975	50%
	50	M36	360.9	2339	69%	300.8	1949	58%
	80	M42	481.1	3637	67%	401.0	3031	56%
	100	M42	515.5	3897	72%	429.6	3248	60%
	125	M48	644.3	5567	68%	536.9	4639	57%
	150	M48	773.1	6680	82%	644.3	5567	68%
	200	M56	901.9	9091	69%	751.6	7576	58%
	250	M64	1127.3	12987	66%	939.5	10823	55%
KIDNEY BOLLARD								
	15	M24	135.5	585	60%	113.0	488	50%
	30	M30	270.7	1462	76%	225.7	1219	63%
	50	M36	451.1	2923	86%	375.9	2436	72%
	80	M42	577.3	4364	81%	481.1	3637	67%
	100	M42	515.5	3897	72%	429.6	3248	60%
	125	M48	644.3	5567	68%	536.9	4639	57%
	150	M48	773.1	6680	82%	644.3	5567	68%
	200	M56	1030.7	10390	79%	859.0	8658	66%

Torque requirement = K x Fp.c x D (N.m)
K = friction co-efficient
Fp.c = pretension force (kN)
D = Bolt Size (mm)

Note:

- Above recommended torque table is designed by applying different load factors on the bollard safe working load.
- Mooring forces are largely affected by the environmental conditions. Torque selection should be done carefully by considering actual mooring forces so that the concrete structure remains free from unwanted long duration localized stresses.
- Torque value calculated considering with K = 0.18
- K = 0.18, For Hot Dip Galvanized bolts.
- K = 0.15, For bolts with normal metric thread and clean and light oiled surface (like manufacturer usually deliver).
- K = 0.12, For bolts with normal metric thread of which the thread of bolt and nut are lightly greased with a Molyslip screw thread passo (or similar).
- Appropriate K value should be considered as per lubricant manufacture's data sheet

MOORING BOLLARDS (HMB)

Loading @ SWL x 1.0			Loading @ SWL X 0.8			Loading @ SWL X 0.6		
PRETENSION FORCE (kN)	TORQUE REQUIREMENT (N.m)	% UTILIZATION OF PROOF STRESS	PRETENSION FORCE (kN)	TORQUE REQUIREMENT (N.m)	% UTILIZATION OF PROOF STRESS	PRETENSION FORCE (kN)	TORQUE REQUIREMENT (N.m)	% UTILIZATION OF PROOF STRESS
60.4	217	38%	48.3	174	31%	36.3	131	23%
72.4	313	32%	58.0	250	26%	43.5	188	19%
108.4	586	30%	86.8	469	24%	65.2	352	18%
144.5	780	40%	115.7	625	32%	86.8	469	24%
240.7	1560	46%	192.6	1248	37%	144.5	936	28%
320.8	2426	45%	256.7	1941	36%	192.6	1456	27%
343.7	2599	48%	275.0	2079	38%	206.3	1560	29%
429.6	3712	46%	343.7	2970	36%	257.9	2228	27%
515.5	4454	55%	412.4	3563	44%	309.4	2673	33%
601.3	6062	46%	481.1	4850	37%	360.9	3638	28%
751.6	8659	44%	601.3	6928	35%	451.1	5196	26%
721.6	8312	42%	577.3	6651	34%	433.0	4989	25%
72.4	313	32%	58.0	250	26%	43.5	188	19%
144.5	780	40%	115.7	625	32%	86.8	469	24%
240.7	1560	46%	192.6	1248	37%	144.5	936	28%
320.8	2426	45%	256.7	1941	36%	192.6	1456	27%
343.7	2599	48%	275.0	2079	38%	206.3	1560	29%
429.6	3712	46%	343.7	2970	36%	257.9	2228	27%
515.5	4454	55%	412.4	3563	44%	309.4	2673	33%
601.3	6062	46%	481.1	4850	37%	360.9	3638	28%
751.6	8659	44%	601.3	6928	35%	451.1	5196	26%
90.4	391	40%	72.4	313	32%	54.3	235	24%
180.6	975	50%	144.5	780	40%	108.4	586	30%
300.8	1949	58%	240.7	1560	46%	180.6	1170	35%
385.0	2910	54%	308.0	2329	43%	231.1	1747	32%
343.7	2599	48%	275.0	2079	38%	206.3	1560	29%
429.6	3712	46%	343.7	2970	36%	257.9	2228	27%
515.5	4454	55%	412.4	3563	44%	309.4	2673	33%
687.2	6927	53%	549.8	5542	42%	412.4	4157	32%

MOORING BOLLARDS (HMB)

TORQUE TABLE

TYPE OF BOLLARD	TON CAPACITY	BOLT SIZE (Metric)	Loading @ SWL X 1.5			Loading @ SWL X 1.25		
			PRETENSION FORCE (kN)	TORQUE REQUIREMENT (N.m)	% UTILIZATION OF PROOF STRESS	PRETENSION FORCE (kN)	TORQUE REQUIREMENT (N.m)	% UTILIZATION OF PROOF STRESS
CLEAT BOLLARD								
	15	M 20	90.4	325	58%	75.4	271	48%
	20	M 24	120.5	520	53%	100.4	434	45%
	25	M 24	150.5	650	67%	125.5	542	56%
	30	M 24	135.5	585	60%	113.0	488	50%
	35	M 30	158.0	853	44%	131.7	711	37%
DOUBLE BITT BOLLARD								
	20	M 20	90.4	325	58%	75.4	271	48%
	30	M 22	135.5	537	70%	113.0	447	58%
	50	M 30	225.7	1219	63%	188.1	1016	52%
	75	M 36	270.7	1754	52%	225.7	1462	43%
	100	M 42	360.9	2728	50%	300.8	2274	42%
	125	M 42	451.1	3410	63%	375.9	2842	52%
	150	M 48	541.2	4676	57%	451.1	3897	48%
	200	M 56	721.6	7273	56%	601.3	6062	46%
SINGLE BITT BOLLARD								
	15	M 24	135.5	585	60%	113.0	488	50%
	30	M 30	216.6	1170	60%	180.6	975	50%
	50	M 36	300.8	1949	58%	250.7	1625	48%
	75	M 42	451.1	3410	63%	375.9	2842	52%
	100	M 48	515.5	4454	55%	429.6	3712	46%
	150	M 56	773.1	7793	60%	644.3	6494	50%
	200	M 56	901.9	9091	69%	751.6	7576	58%
PILLAR BOLLARD								
	10	M 20	90.4	325	58%	75.4	271	48%
	15	M 24	135.5	585	60%	113.0	488	50%
	30	M 36	270.7	1754	52%	225.7	1462	43%
	50	M 36	257.9	1671	49%	214.9	1393	41%
	75	M 42	386.7	2923	54%	322.3	2436	45%
	100	M 48	515.5	4454	55%	429.6	3712	46%
	150	M 56	676.5	6819	52%	563.8	5683	43%
	200	M 64	901.9	10390	53%	751.6	8659	44%

Torque requirement = K x Fp.c x D (N.m)
K = friction co-efficient
Fp.c = pretension force (kN)
D = Bolt Size (mm)

Note:

- Above recommended torque table is designed by applying different load factors on the bollard safe working load.
- Mooring forces are largely affected by the environmental conditions. Torque selection should be done carefully by considering actual mooring forces so that the concrete structure remains free from unwanted long duration localized stresses.
- Torque value calculated considering with K = 0.18
- K = 0.18, For Hot Dip Galvanized bolts.
- K = 0.15, For bolts with normal metric thread and clean and light oiled surface (like manufacturer usually deliver).
- K = 0.12, For bolts with normal metric thread of which the thread of bolt and nut are lightly greased with a Molyslip screw thread passo (or similar).
- Appropriate K value should be considered as per lubricant manufacture's data sheet

MOORING BOLLARDS (HMB)

Loading @ SWL x 1.0			Loading @ SWL X 0.8			Loading @ SWL X 0.6		
PRETENSION FORCE (kN)	TORQUE REQUIREMENT (N.m)	% UTILIZATION OF PROOF STRESS	PRETENSION FORCE (kN)	TORQUE REQUIREMENT (N.m)	% UTILIZATION OF PROOF STRESS	PRETENSION FORCE (kN)	TORQUE REQUIREMENT (N.m)	% UTILIZATION OF PROOF STRESS
60.4	217	38%	48.3	174	31%	36.3	131	23%
80.4	347	36%	64.4	278	29%	48.3	209	21%
100.4	434	45%	80.4	347	36%	60.4	261	27%
90.4	391	40%	72.4	313	32%	54.3	235	24%
105.4	569	29%	84.4	456	24%	63.4	342	18%
60.4	217	38%	48.3	174	31%	36.3	131	23%
90.4	358	47%	72.4	287	37%	54.3	215	28%
150.5	813	42%	120.5	651	34%	90.4	488	25%
180.6	1170	35%	144.5	936	28%	108.4	703	21%
240.7	1820	34%	192.6	1456	27%	144.5	1092	20%
300.8	2274	42%	240.7	1820	34%	180.6	1365	25%
360.9	3118	38%	288.8	2495	31%	216.6	1872	23%
481.1	4850	37%	385.0	3880	30%	288.8	2911	22%
90.4	391	40%	72.4	313	32%	54.3	235	24%
144.5	780	40%	115.7	625	32%	86.8	469	24%
200.6	1300	38%	160.5	1040	31%	120.5	781	23%
300.8	2274	42%	240.7	1820	34%	180.6	1365	25%
343.7	2970	36%	275.0	2376	29%	206.3	1783	22%
515.5	5196	40%	412.4	4157	32%	309.4	3119	24%
601.3	6062	46%	481.1	4850	37%	360.9	3638	28%
60.4	217	38%	48.3	174	31%	36.3	131	23%
90.4	391	40%	72.4	313	32%	54.3	235	24%
180.6	1170	35%	144.5	936	28%	108.4	703	21%
172.0	1114	33%	137.6	892	26%	103.3	669	20%
257.9	1949	36%	206.3	1560	29%	154.8	1170	22%
343.7	2970	36%	275.0	2376	29%	206.3	1783	22%
451.1	4547	35%	360.9	3638	28%	270.7	2729	21%
601.3	6928	35%	481.1	5543	28%	360.9	4158	21%

MOORING BOLLARDS (HMB)

BOLLARD INFORMATION

STANDARD DESIGNS

The standard bollard range has been developed based on the requirements of many facilities throughout the world. Some clients may request different designs based on factors such as familiarity and history.

However the Hi-Tech range meets most functional mooring requirements. The AutoMoor, SmartMoor and ReadyMoor Quick Release Hooks are also available for instances where a more advanced safety solution is required.

CUSTOM DESIGNS

As well as our standard bollard range, we also offer custom-built bollards. Whatever your project, we will design and deliver bespoke solutions to your exact specifications.

CALCULATIONS

Bollards are provided with engineering calculations, which describe bolt group pullout forces, shear loadings and bolt tensions.

JETTY DESIGN

Qualified marine structural engineers or consultants should access the suitability of including bollards as part of a new or existing jetty structural design. This includes concrete or steel structure reinforcement for additional tensile and shear loads, reduced edge distances, and fastening / anchor-bolt arrangements.

JETTY DESIGN

calculations are based on a concrete strength of 40MPa as this is commonly used at many new facilities.

A higher safety factor has been applied to the concrete strength to allow for special variations in jetty structures, which means that it is acceptable to use 30MPa concrete. However, the safety factor for this part of the system is reduced. The jetty designer is responsible for the final design of the jetty, including steel reinforcement, edge distances, shear bracing and concrete strength.

BOLLARD SELECTION

The engineering required to select, locate and orientate bollards is dependent on a range of parameters including vessel size, local weather, bathometry, currents, tides and the jetty configuration. The analysis to determine the layout of the jetty is the responsibility of the jetty designer and not the bollard supplier.

TECHNICAL SUPPORT

Technical advice, design and enquiries should be directed to your local Hi-Tech Marine Systems office.

GROUT TYPE

Hi-Tech recommends a non shrink grout, either cementious or epoxy type, with a minimum compressive strength of 60MPa.

For recessed bollards, Hi-Tech recommends low viscosity high flow grouts to ensure full penetration around and under the base plate.

HOLDING DOWN BOLT SPECIFICATION

The holding down bolts are described in the product list and each general arrangement drawing.

The bolts are all ISo 898-1 Grade 8.8 and hot dip galvanized, with one nut and washer set. It should be noted that the testing criteria in most fastener codes are not applicable due to the sheer size of the bollard bolts. Proportional testing methods are used at half the bolt radius according to ASTM F606.

HOLDING DOWN BOLT GRADES

Standard bollards use grade 8.8 bolts only. Alternative bolt materials can be used but re-engineering, including calculations and drawings are required. Any modification to holding down bolt materials should be reviewed and approved by a qualified and certified engineer.

HI-TECH ELASTOMERS LTD.
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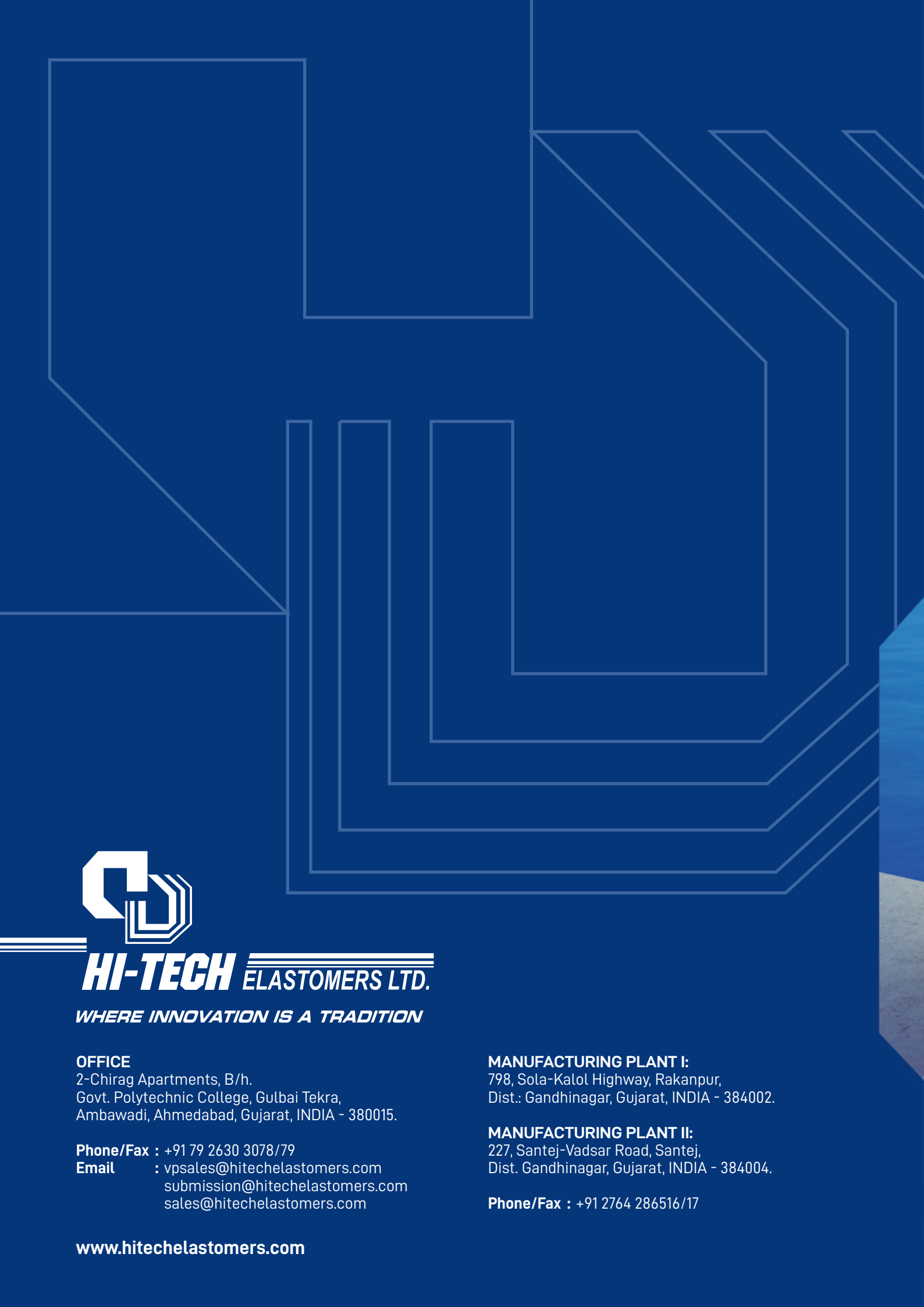
PRODUCT INSTALLATION PICTURES



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