



# Bollard

**INSTALLATION AND MAINTENANCE MANUAL**

# The Smarter Approach



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**Better connected systems mean faster turnaround and increased throughput, improved safety and lower operating costs.**

Connecting decades of experience with a new, smarter approach to port and terminal equipment optimization, Trelleborg's marine systems operation helps ports and terminals deploy smart, engineered solutions for port approach, berthing, docking and mooring. This enables better informed real-time and strategic decision making, both onshore and on board the vessel.

From port owners and operators to consulting engineers, Trelleborg works with customers to determine best fit solutions for specific applications, and supply a fully integrated solution. End-to-end service and a comprehensive product portfolio meet and exceed customer needs, enhancing safety and improving efficiency in all marine environments, from conception to completion and beyond.



# Bollard Installation and Maintenance Manual

**Trelleborg has a range of seven bollard styles to ensure the ideal solution for your application.**

All Trelleborg 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, as well as 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 the installation process. It also includes maintenance and inspection guidelines, which ensures the condition of the bollards to be used for your mooring operation.

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# A Smarter Approach at every stage

## A smarter approach to...

### CONSULTATION

Consultation from the earliest project phase to ensure the optimum fender, mooring, navigation and transfer solutions are specified, with full technical support from our global offices.



### CONCEPTS

Conceptual design in your local office – with full knowledge of local standards and regulations, delivered in your language – for optimized port and vessel solutions.



### DESIGN

Concepts are taken to our Engineering Centers of Excellence where our team generates 3D CAD designs, application-engineering drawings, a bill of materials, finite engineering analyses and calculations for both our fender systems and marine technology solutions.



### MANUFACTURE

Our entire product range is manufactured in-house, meaning we have full control over the design and quality of everything we produce. Our strategically located, state-of-the-art facilities ensure our global, industry leading manufacturing capability.



### TESTING

Across our entire product range, stringent testing comes as standard at every step in our in-house manufacturing process. We ensure that life-cycle and performance of our entire product range meets your specifications, and more.



### INSTALLATION

Dedicated project management, from solution design right the way through to on-site installation support. We design products and solutions that always consider ease of installation and future maintenance requirements.



### SUPPORT

Local support on a truly global scale, with customer support teams all over the world. And this service doesn't stop after a product is installed. You have our full support throughout the entire lifetime of your project, including customized training programs, maintenance and on-site service and support.



### THE FUTURE

Deploying the latest in smart technologies to enable fully automated, data-driven decision making that optimizes port and terminal efficiency. At Trelleborg, we're constantly evolving to provide the digital infrastructure our industry increasingly needs.



**When you choose Trelleborg you ensure your expectations will be met, because we deliver a truly end-to-end service – retaining vigilance and full control at every stage.**



# Loading, Unloading and Handling



# Loading, Unloading and Handling

MATERIALS/CONSUMABLES REQUIRED	INFORMATION
<b>Timber / rubber blocks</b>	Bollards should be placed on a timber bolster to avoid damage.
<b>Tarpaulin</b>	Should be heavy-duty waterproof plastic (Refer Storage section)
<b>Crane and rigging equipment</b>	Refer to Appendix – 1.1 & 1.2: Bollard weight and total packing (gross) weight

- Lift a bollard from its neck for ease of placement on its base.
- Do not open or dismantle the packing of the bollards until ready for installation.
- To avoid paint damage, do not handle the bollards with unprotected lift forks or hooks.
- Never drag the bollards along the ground.

## CAUTION

- Never lift a bollard with direct steel contact.
- Bollards should be handled carefully to avoid injuries.
- Do not handle bollards in areas with insufficient lighting to avoid damage to the bollards and the surrounding premises.

- All bollards should be laid on the ground only. If they must be stacked, secure them to avoid tipping them over.
- Always handle bollards at ground level.
- All the above points are also applicable to bollard anchors.

## RECOMMENDATIONS

- Before unloading the shipment, visually inspect the container for signs of any damage incurred during transportation. If significant damage is found, take a photograph as evidence and send it to Trelleborg Marine Systems.
- Bollards must be handled with protective lifting equipment to avoid damage.
- Always lay components carefully on dry firm ground supported by dunnage.
- Never drop the components or lay them directly onto rocky or waterlogged ground.

# Storage





# Storage

## 2.1 STORAGE TIMELINE FOR BOLLARD

- Store bollards in a safe area where they will not be exposed to damage.
- Place them carefully on dry ground over wood blocks to avoid paint damage.
- Do not stack bollards on top of each other if this can be avoided. If they must be stacked due to space constraint, use appropriate racks.
- The above points are also applicable to bollard anchors.
- If you come across any fault or problem, report the matter to your regional Trelleborg office immediately for further corrective action.

### Caution

- Get recommendations from Trelleborg if the bollards are to be stored in temperatures below 10°C.
- Before moving the packaging at any time, check first for any signs of damage.
- Bollards should be recoated after 15 years of storage.
- Bollards should be inspected every five years if they are stored as per the above guidelines.

### Recommendation

- Inspect stored bollards and their packaging at least once a month for damage.
- Every package should be clearly and visibly labeled.

## 2.2 PACKAGING AND LABELLING

### 2.2.1 Packaging

Bollards are usually packed in a closed box or fixed with wooden blocks.

- The bollards should be covered with non-transparent PE (polyethylene, double wrapping).
- Avoid any direct contact between two bollards.
- All bollards should be properly fastened in the packaging.
- Check the weight of the package before lifting.
- All bollards must be packed in an upright position.
- Ensure the packaging is labeled with an orientation arrow.
- The lifting provision should be indicated clearly on the packaging with a symbol.
- The packaging should include a caution label against fire.

### Caution

If bollards are removed from the packaging for inspection, testing or any other purpose and are subsequently to be returned to storage for a further period, they must be repackaged and labeled in accordance with section 2.2.2 and the date of the repackaging must be recorded on the container.

# Storage

## 2.2 PACKAGING AND LABELING

### 2.2.2 LABELING

Every package or container should be labelled on at least three sides with the below requisite information and should be visible from the outside of the package without the need to break the seal.

<b>Bollard type / Size</b>	
<b>Bollard weight</b>	
<b>Quantity / Package</b>	
<b>In-box content</b>	
<b>Total weight of package</b>	

## 2.3 INSPECTION AND RECORDING

Visual inspection must be made and recorded for the following once a year.

- Surface penetration and / or scratches
- Cracked, chipped or peeling paint rust or corrosion
- Image on following page is for reference only.





# Installation

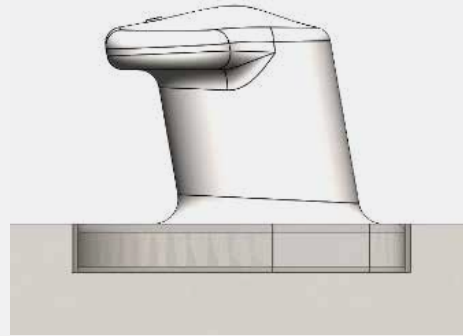


Bollards must be installed correctly for a long and trouble-free service life. The type of installation depends on the type of anchor used to fix the bollards as well as the type of structure on which the bollards are to be installed. Bollards are mostly either recess mounted or surface mounted. The anchors required for each type of installation are listed in the following page. If the type of installation you are planning is not listed, please consult your regional Trelleborg office.

# Installation

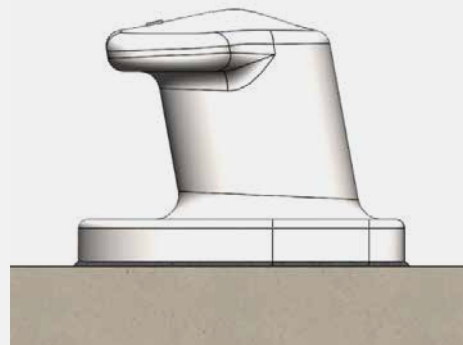
## RECESS MOUNTED

The recess should be prepared in the required dimensions. These dimensions are based on the size of the base of the bollard. The base of the bollard should be set in the recess with the required grout thickness around the base, and the bollard should be fixed with anchors. These can be either cast-in anchors or epoxy / resin anchors.



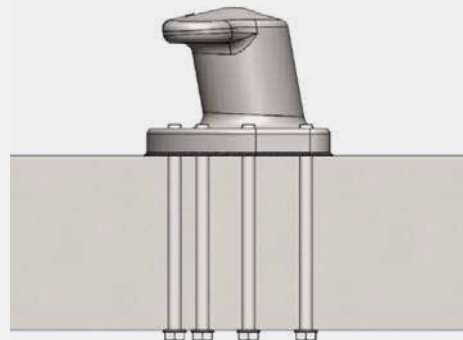
## SURFACE MOUNTED

Unlike recess-mounted installations, no preparation is required for surface-mounted installations. Grouting should be prepared depending on the length, width and thickness. Grout should be used to install the bollard with proper alignment so as to utilize the maximum capacity of the bollard for a long and trouble-free service life. The anchors can be installed either with cast-in anchors or with epoxy / resin anchors.



## CUSTOM MOUNTED

The bollard is surface-mounted on a steel structure. The steel structure is designed by a jetty designer to cater to the load of the designated capacity of the bollard. Anchors for this type of application vary depending on the structure of the steel on which the bollard is to be installed. Trelleborg must review the design and drawings of the structure on which the bollard is to be installed.



# Installation

## 3.1 ANCHOR INSTALLATION

Refer to the general guidelines for anchor installation.

- | Anchor installation should be carried out by qualified personnel and under the supervision of the person responsible for technical matters of the site.
- | Anchor installation should be in accordance with the manufacturer's specifications and drawings.
- | Use anchors which are supplied by the manufacturer or as per the approved drawings.
- | Check the strength class of the concrete in which the anchor is to be installed.
- | The concrete base must not have any significant voids.
- | The anchorage depth must be marked.
- | The edge distance and spacing should not be less than the specified values as per the bollard manufacturer's calculations.
- | The anchor hole should be hammer-drilled with a diamond core drill bit.
- | If the drill hole is aborted, the hole should be filled with mortar.
- | For an overhead installation, piston plugs must be used. Embedded metal parts must be fixed during the curing time, e.g. with wedges.
- | For injection of the mortar in bore holes  $\leq 250$  mm, piston plugs must be used.

### 3.1.1 CAST-IN ANCHOR INSTALLATION

Anchors need to be installed at their designated position before the concrete is poured. Steel reinforcements have to be provided to the anchors.

MATERIALS/CONSUMABLES REQUIRED	INFORMATION
Reinforced concrete block	With adequate compressive strength
Steel reinforcement bar	Used to anchor template/Cage Hold Down Bolts
EQUIPMENT REQUIRED	INFORMATION
Anchors	Supplied by Trelleborg
Anchor bolt template	Supplied by Trelleborg/Others
Spanner	Suitable to the supplied anchor size
RECOMMENDED PERSONAL PROTECTIVE EQUIPMENT	INFORMATION
General PPE	As per site/plant requirements



# Installation

## 3.1 ANCHOR INSTALLATION

### 3.1.1 CAST-IN ANCHOR INSTALLATION

Step 1. Mark embedment length on all anchors used for each bollard.

Step 2. Use two anchor templates to locate and align the anchors vertically straight. (Ref. Fig. 5)

As shown in the image, place one anchor template on the head of the anchor and fix another template below the marking of the embedment length.

Restrain the top template temporarily to avoid any movement.

Reinforce the anchors with steel bars as per ACI318.11. The reinforcement design can be carried out by a jetty designer.

Step 3. Start pouring the concrete as per the instruction of the supervisor.

#### Caution :

In the case of a recess mounted bollard, use a cover boundary to stop the concrete being poured on the required recess for the bollard.

Step 4. Provide enough time to cure the concrete.

#### Caution :

Do not touch the anchors until the desired curing time required for the concrete has passed.

Check the required protrusion height of each anchor.

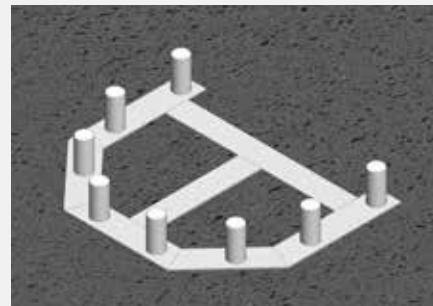
Step 5. After pouring, use the template to check the final anchor locations as per the relevant drawings.



**STEP 1**



**STEP 2**



**STEP 5**

# Installation

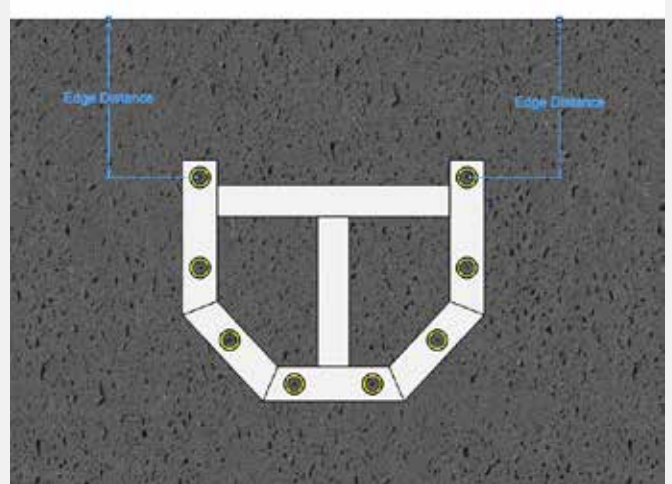
## 3.1 ANCHOR INSTALLATION

### 3.1.2 EPOXY/RESIN ANCHOR INSTALLATION

Fully threaded anchors are used with resin/epoxy bond materials to achieve a bond between the anchors and the existing concrete. The detailed procedure is as follows:

#### Step 1. Marking

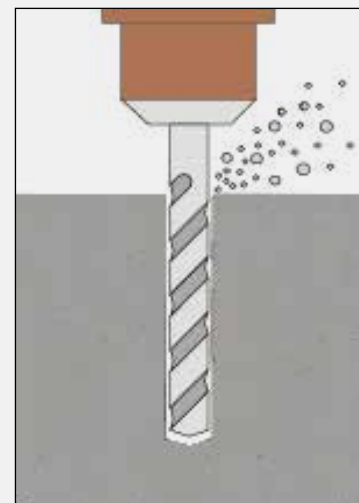
- Clean the area first and use an anchor template to mark the positions of the holes on the jetty surface. Use a marker pen to highlight the marked holes.
- Measure the distance from the jetty edge to the first anchor as per the drawings.
- Clean the area again and measure each distance to be verified with the bollard drawing.



**STEP 1**

#### Step 2. Drilling / Coring

- Set the drilling machine in such a way that the drill bit axis and the center of the marking hole are aligned.
- Use a bubble gauge meter to verify that the drill bit is perfectly vertical.
- Use a continuous flow of water to reduce heat generation between the drill bit and the concrete.
- Slowly drill the hole up to the required depth.



**STEP 2**

#### **Caution :**

- Marking on the drill bit helps to determine the depth of the hole. Diamond coring is permissible when a diamond core drilling machine and the corresponding core bit are used.
- Verify that the depth and diameter of the holes are within the tolerance ranges mentioned in the relevant anchor layout drawing.

# Installation

## 3.1 ANCHOR INSTALLATION

### 3.1.2 EPOXY/RESIN ANCHOR INSTALLATION

#### Step 2. Drilling / Coring

Once the hole has been cored to the desired depth and diameter, roughen the surface of the core hole using a rotary hammer drill bit.

(Roughing the surface of the hole is a recommendation and not a requirement.)

#### Recommendation:

Proper core bit setting must be done so that the base concrete can be secured.

#### Step 3. Cleaning

Starting from the bottom surface of each hole, use a pressurised water flow to clean the holes.

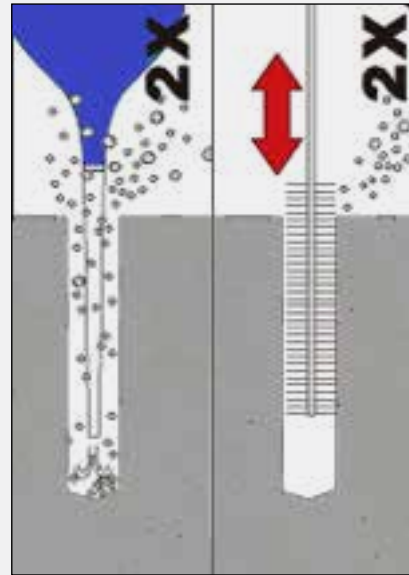
Run a flow of water continuously into the holes until the water runs out clear.

Brush two times with the specified brush size (brush  $\varnothing \geq$  bore hole  $\varnothing$ , see Table 7 in Hilti manual) by inserting the steel brush (Hilti HIT-RB or equivalent) to the back of the hole (use an extension if needed) in a twisting motion and removing it.

The brush must produce natural resistance as it enters the bore hole.

Blow oil-free compressed air (with min. 6bar / 90 psi pressure) two times inside the drilled hole, starting from the bottom surface of the hole (use a nozzle extension if needed) over the hole length until the return air stream is free of noticeable dust and water.

Alternate the cleaning by water and air two more times.



#### STEP 3



# Installation

## 3.1 ANCHOR INSTALLATION

### 3.1.2 EPOXY/RESIN ANCHOR INSTALLATION

#### Step 4. Injection

■ Insert foil pack in foil pack holder. Do not use damaged foil packs and/or damaged or unclean foil pack holders. Attach new mixer prior to dispensing a new foil pack (snug fit).

■ Tightly attach Hilti(HIT-RE-M) or equivalent mixer to foil pack manifold. Do not modify the mixer in any way. Make sure the mixing element is in the mixer. Use only the mixer supplied with the adhesive.

■ Insert foil pack holder with foil pack into HIT-dispenser. Push release trigger, retract plunger and insert foil pack holder into the appropriate Hilti dispenser.

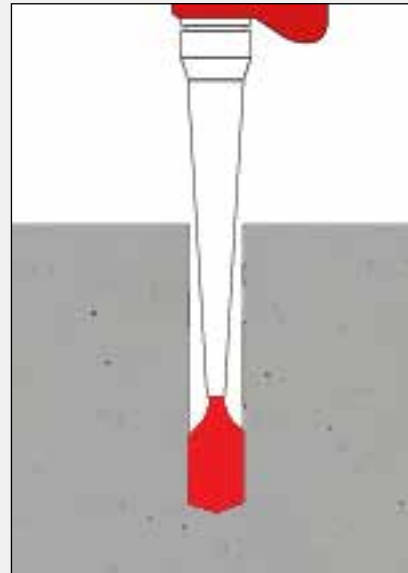
■ Discard initial adhesive. The foil pack opens automatically as dispensing is initiated. Depending on the size of the foil pack an initial amount of adhesive must be discarded.

■ Discard quantities are 3 strokes for 330 ml foil pack, 4 strokes for 500 ml foil pack and 65 ml for 1400 ml foil pack.

■ Inject adhesive start from the bottom of the bore hole without forming air voids. Slowly withdraw the mixer with each trigger pull.

■ Continue filling the bore hole either up to recommended amount of adhesive or until hole fills 2/3 full.

■ It is required to ensure that the annular gap between the anchor and the concrete is filled with adhesive along the embedment length.



**STEP 4**

# Installation

## 3.1 ANCHOR INSTALLATION

### 3.1.2 EPOXY / RESIN ANCHOR INSTALLATION

Step 5. Setting anchors

Before use, clean each anchor with water and dry them completely with oil-free air. Verify that the element is dry and free of oil and other contaminants.

Anchors must be twisted slowly and inserted into the core, which is filled with epoxy / resin.

Mark and set the element to the required embedment depth until working time TWORK has elapsed. The working time TWORK is given in the table below.

After installing an anchor, the annular gap must be filled with epoxy / resin adhesive. If the borehole is not filled along the embedment depth, the installation should be rejected.

Use an anchor template to stop the movement of anchors right after installation.

Leave anchors to cure for the curing time (TCURE) mentioned in Table 2.

**Caution :** Do not touch the anchors during curing time.

TEMPERATURE IN ANCHORAGE BASE [°C]	MAXIMUM WORKING TIME(TWORK) [MINUTES]	MINIMUM CURING TIME (TCURE) [HOURS]
5 to 9	120	72
10 to 14	90	48
15 to 19	30	24
20 to 29	20	12
30 to 39	12	8
40	12	4

**Note :**

- Cover anchors with a suitable cap to avoid damage.
- Check that the protrusion length is outside of the concrete structure.
- Cover the area, marking with the word "Caution".
- Ensure all anchors are straight and level.

# Installation

## 3.2 GROUTING AND BOLLARD PLACEMENT

Grouting is needed to provide a flat surface on a deck to align the bollard horizontally. Cement-based grout is made of water and cement in a ratio recommended by the grout manufacturers. Use the grout manufacturer's data sheet for each stage of grouting. Grout should be non-shrink grout with a minimum strength of 60 MPa.

- █ Adequately roughen the surface of the concrete deck.
- █ Use pressurized air flow to remove all debris.
- █ The base flange of the bollard should be aligned, shimmed and cleaned of all grease, dirt, loose rust and scale.
- █ Use removable shims to leave a gap between the bollard base flange and the concrete surface.
- █ Shims must be corrosion free if using non-removable shims.
- █ Check the alignment of the bollards by using a bubble meter.
- █ Use boundary forms to isolate the area for grouting.
- █ It should be sturdy and caulked oiled approximately 15 mm around the edge of the base of the bollard.
- █ Follow the grout manufacturer's procedure for filling the grout.
- █ Place the grout at least 5 mm (1/4") above the bottom of the base flange of the bollard to ensure the complete filling of the void.
- █ Cover immediately with wet rags or curing compound.
- █ Provide a 45° angle to the grout periphery prior to the curing of the grout.
- █ All cement-based grouts should be cured according to the guidelines of the grout manufacturer.
- █ Lift the bollard as per the handling procedure mentioned in Section 1 and place it in its designated position.








# Installation





## 3.3 TORQUEING TO ANCHORS

After the grout is fully cured and the bollard is placed, fix the anchor with the Hex Nut/Hex Bolt as per the drawing. Use the torque value as tabulated below to fasten the anchors.

TYPE OF BOLLARD	TON CAPACITY	BOLT SIZE (METRIC)	BOLT TENSILE AREA	PRETENSION FORCE (kN)	TORQUE REQUIREMENT (N.m)	% UTILIZATION OF PROOF STRESS (Gr. 8.8)
<b>Tee Bollard</b> 	10	M20	245	25	120	16%
	15	M24	352	30	216	13%
	22.5	M30	560	45	270	13%
	30	M30	560	60	360	17%
	50	M36	816	100	720	19%
	80	M42	1,120	130	1,092	18%
	100	M42	1,120	140	1,176	20%
	125	M48	1,473	175	1,680	19%
	150	M48	1,473	210	2,016	22%
	200	M56	2,029	240	2,688	18%
	250	M64	2,675	300	3,840	18%
	300	M64	2,675	300	3,840	18%
<b>Horn Bollard</b> 	15	M24	352	35	168	16%
	30	M30	560	60	360	17%
	50	M36	816	100	720	19%
	80	M42	1,120	130	1,092	18%
	100	M42	1,120	140	1,176	20%
	125	M48	1,473	170	1,632	18%
	150	M48	1,473	210	2,016	22%
	200	M56	2,029	240	2,688	18%
	250	M64	2,675	300	3,840	18%
<b>Kidney Bollard</b> 	15	M24	352	40	192	18%
	30	M30	560	80	480	22%
	50	M36	816	120	864	23%
	80	M42	1,120	150	1,260	21%
	100	M42	1,120	140	1,176	20%
	125	M48	1,473	170	1,632	18%
	150	M48	1,473	210	2,016	22%
	200	M56	2,029	280	3,136	22%

# Installation

## 3.3 TORQUEING TO ANCHORS

TYPE OF BOLLARD	TON CAPACITY	BOLT SIZE (METRIC)	BOLT TENSILE AREA	PRETENSION FORCE (kN)	TORQUE REQUIREMENT (N.m)	% UTILIZATION OF PROOF STRESS (Gr. 8.8)
<b>Cleat Bollard</b> 	15	M20	245	100	720	64%
	20	M24	352	125	900	55%
	25	M24	352	155	744	69%
	30	M24	352	155	744	69%
	35	M30	560	160	960	45%
<b>Double Bitt Bollard</b> 	20	M20	245	30	216	19%
	30	M22	303	40	288	21%
	50	M30	560	60	432	17%
	75	M36	816	75	540	14%
	100	M42	1,120	100	720	14%
	125	M42	1,120	120	864	17%
	150	M48	1,473	150	1,080	16%
	200	M56	2,029	190	1,368	15%
<b>Single Bitt Bollard</b> 	15	M24	352	30	216	13%
	30	M30	560	60	432	17%
	50	M36	816	85	612	16%
	75	M42	1,120	120	864	17%
	100	M48	1,473	150	1,080	16%
	150	M56	2,029	210	1,512	16%
	200	M56	2,029	240	1,728	18%
<b>Pillar Bollard</b> 	10	M20	245	30	216	19%
	15	M24	352	40	288	18%
	30	M36	816	80	576	15%
	50	M36	816	80	576	15%
	75	M42	1,120	110	792	15%
	100	M48	1,473	140	1,008	15%
	150	M56	2,029	190	1,368	15%
	200	M64	2,675	240	1,728	14%



# Inspection and Maintenance



Bollards supplied are maintenance free. However, inspection is required every three months or when they are subjected to abnormal actions such as being knocked by other equipment or used for other applications. Relevant corrective action should be taken based on the findings to ensure the correct maintenance of the bollards. The table on the right can be used as a guideline for the inspection process.



## Bollard Inspection and Maintenance Guidelines

S/NO	INSPECTION TYPE	VISUAL OBSERVATIONS	CORRECTIVE ACTION	REMARKS
1	Examine for visual damage such as surface penetration and / or scratches on the surface of the bollard.	Check the relevant required minimum dimensions as per the manufacturer's drawing.	If less than the minimum requirement is found, check the design calculations with the manufacturer of the bollard.	
2	Examine the condition of the paint on the bollard for cracks, chips and/or peeling.	Inspect for cracks, chipping and / or peeling.	Make the necessary repairs as per the Paint Repair or Touch-up procedure, or contact the manufacturer for guidelines.	
3	Examine for surface rust or corrosion in the paint.	Inspect for surface pitting or cracks.	Make the necessary repairs as per the Paint Repair or Touch-up procedure.	
4	Inspect the barrel thickness as per the bollard product drawing.	Compare the inspected thickness with the manufacturing drawing of the bollard.	If found to be less than the minimum required, check the design calculation with the bollard manufacturer.	
5	Inspect all dimensions as per the product drawing of the bollard.	Compare all dimensions with the manufacturing drawing of the bollard.	Provide an inspection report to the manufacturer of bollard to examine.	
6	Inspect to see if any anchor bolts have loosened.	Check with a torque wrench for the desired value of torque.	If bolts are found to have loosened, tighten the anchor bolt with the required torque value.	
7	Inspect for damage or deformation of anchor bolts.	Visually inspect threads for any wear or damage.	If any damage is found, provide the manufacturer with a detailed explanation of the damage for further examination.	
8	Examine the coating system of the anchor bolts and other fasteners.	Visually inspect the fasteners' HDG coating.	Apply Zinc coating to the desired DFT as per the bollard manufacturer's advice.	

The site operator or owner may carry out general maintenance or repairs to the equipment supplied, as outlined in this manual. For any major repairs, please consult the bollard manufacturers, otherwise the warranty will be void.

## **DISCLAIMER**

Trelleborg AB has made every effort to ensure that the technical specifications and product descriptions in this catalog are correct.

The responsibility or liability for errors and omissions cannot be accepted for any reason whatsoever. Customers are advised to request a detailed specification and certified drawing prior to construction and manufacture. In the interests of improving the quality and performance of our products and systems, we reserve the right to make specification changes without prior notice. All dimensions, material properties and performance values quoted are subject to normal production and testing tolerances. This catalog supersedes the information provided in all previous editions. If in doubt, please check with Trelleborg Marine Systems.

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