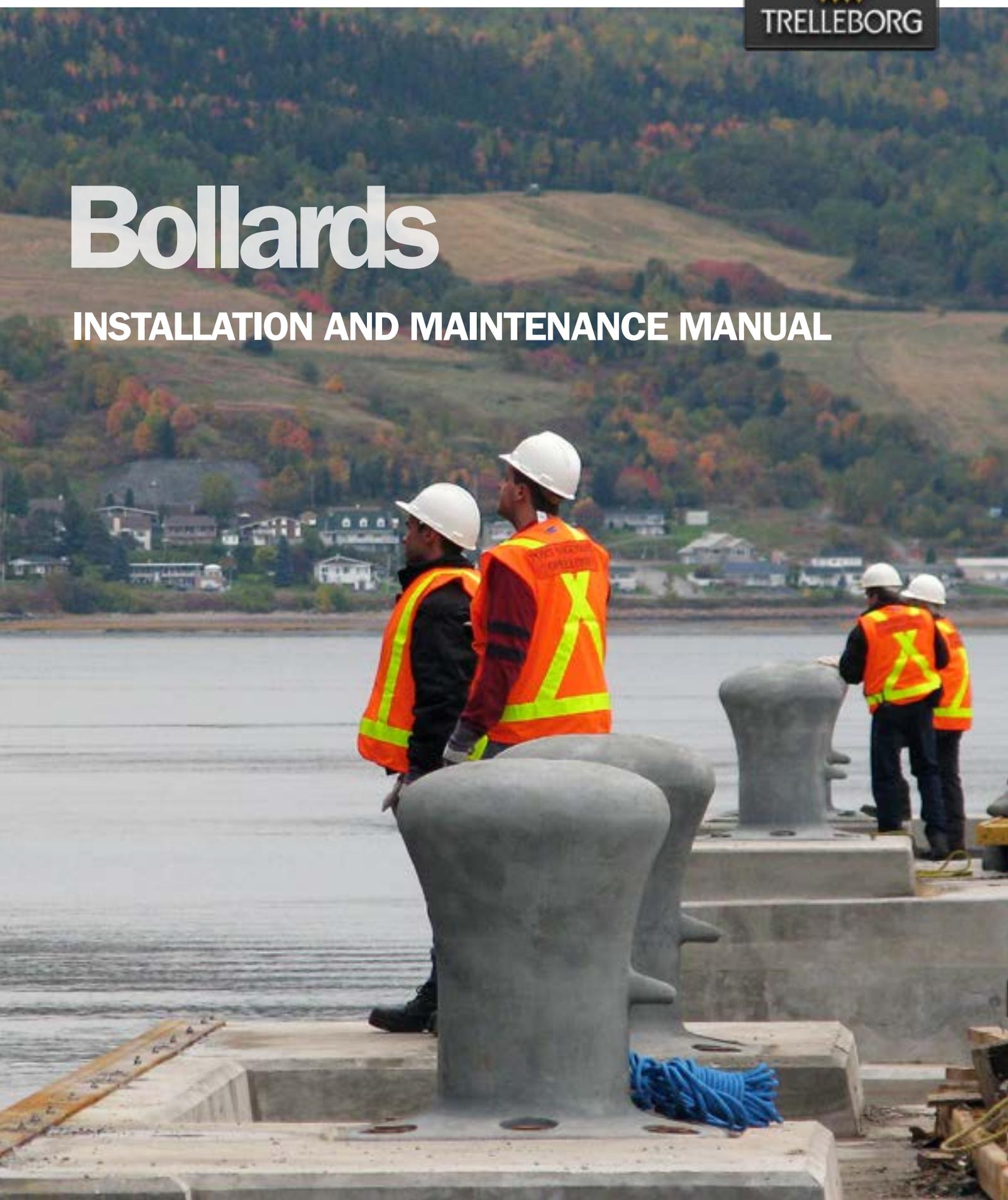


Bollards

INSTALLATION AND MAINTENANCE MANUAL





Bollard installation and maintenance manual

At Trelleborg, we understand that reliable port infrastructure is crucial for your operations. That's why we've designed and engineered a range of seven bollard styles to provide the perfect solution for your port applications.

Our standard bollards are engineered and manufactured from premium grade cast steel, providing superior service life and resistance to impact.

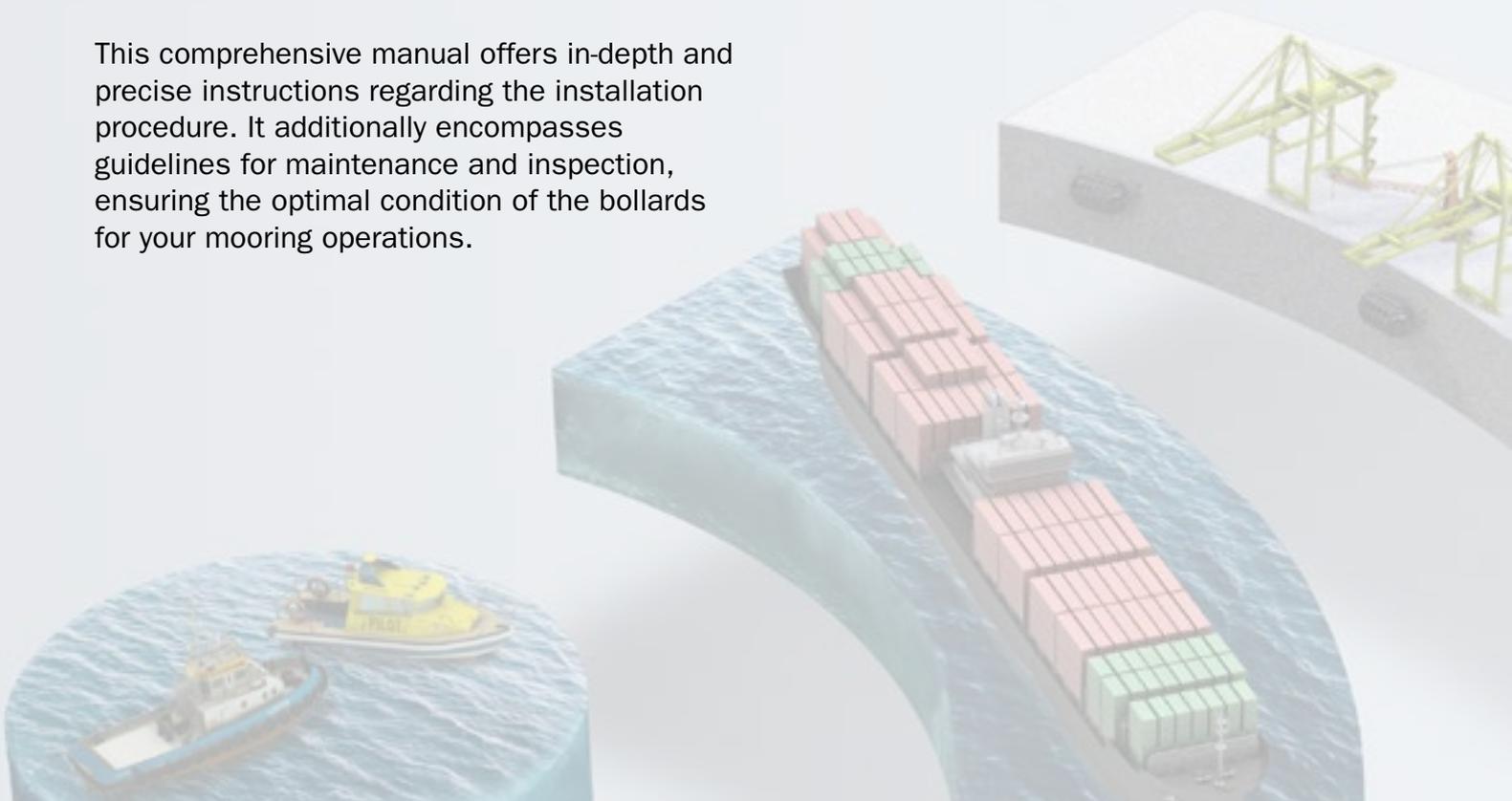
We offer safety critical bollards, anchoring, and fixing solutions tailored to your exact specifications.

This comprehensive manual offers in-depth and precise instructions regarding the installation procedure. It additionally encompasses guidelines for maintenance and inspection, ensuring the optimal condition of the bollards for your mooring operations.

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A smarter approach at every stage

CONSULTATION

Consultation from the earliest project phase to ensure the optimum fender systems and marine technology solutions are specified, with full technical support from our global offices.



CONCEPT

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 Center of Excellence in India 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 produced in our state-of-the-art manufacturing facilities located strategically, allowing us to maintain complete quality control at every stage of the production process.



TESTING

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

INSTALLATION

Dedicated project management, from solution design through to on-site installation support. We design products and solutions considering 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 onsite 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, we ensure your expectations will be met, through a truly comprehensive end-to-end service – retaining vigilance and full control at every stage.

Loading, unloading and handling



Proper loading, unloading, and handling of marine bollards is essential to minimize risks, optimize performance, and maintain the longevity of the bollards. Incorrect handling can lead to equipment damage, personal injury, and operational disruptions. By adhering to proper handling procedures, you will not only safeguard the integrity of these crucial mooring equipment but also contribute to the overall safety and efficiency of maritime operations.

Ensuring Safe Loading, Unloading, and Handling of Marine Bollards

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

- 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	RECOMMENDATIONS
<ul style="list-style-type: none"> ■ 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. 	<ul style="list-style-type: none"> ■ 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 and Infrastructure. ■ 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



Proper storage of marine bollards is crucial for ensuring their longevity, functionality, and readiness for maritime operations. Inadequate storage practices can result in premature wear, corrosion, and decreased performance of marine bollards. For efficient utilization of marine bollards, it is also important to consider efficient packaging and labeling procedures, which are essential for overall operational efficiency, the protection of assets, and the safety of personnel involved in the handling of marine bollards.

Storage

2.1 STORAGE RECOMMENDATIONS FOR BOLLARDS

- Store bollards in a secure location that shields them from potential 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	RECOMMENDATIONS
<ul style="list-style-type: none">■ Get recommendations from Trelleborg if the bollards are to be stored in temperatures below 0°C.■ Before moving the packaging at any time, check first for any signs of damage.■ Bollards that have been in storage should be visually inspected prior to installation.■ Bollards should be inspected every 2 years if they are stored as per the above guidelines.	<ul style="list-style-type: none">■ 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.

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.

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

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



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

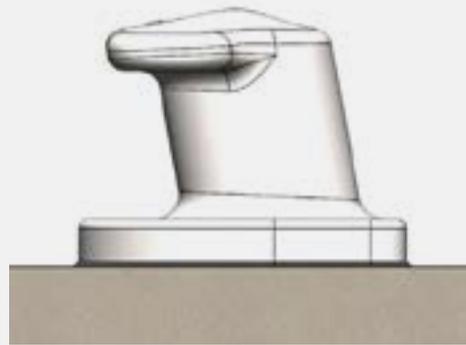
RECESS MOUNTED

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.



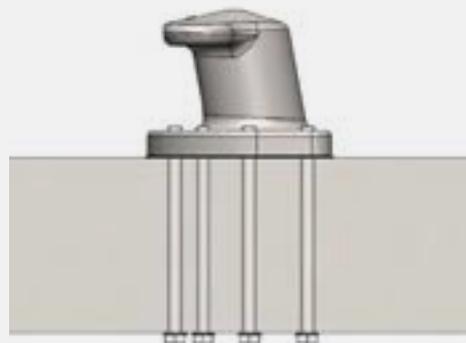
SURFACE MOUNTED

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 or on a concrete deck. The 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 or concrete 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

- 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 ≤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

CAST-IN ANCHORS need to be installed at their designated position before the concrete is poured. Steel reinforcements have to be provided to the anchors.

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



STEP 1

Step 2. Use two anchor templates to locate and align the anchors vertically straight.

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 2

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.

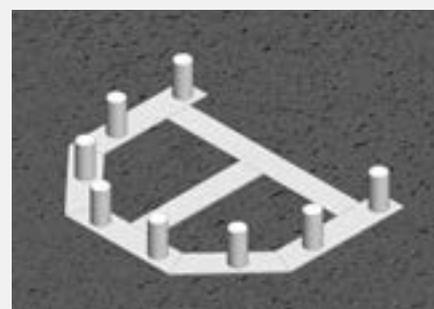
Step 4. Provide enough time to cure the concrete.

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.



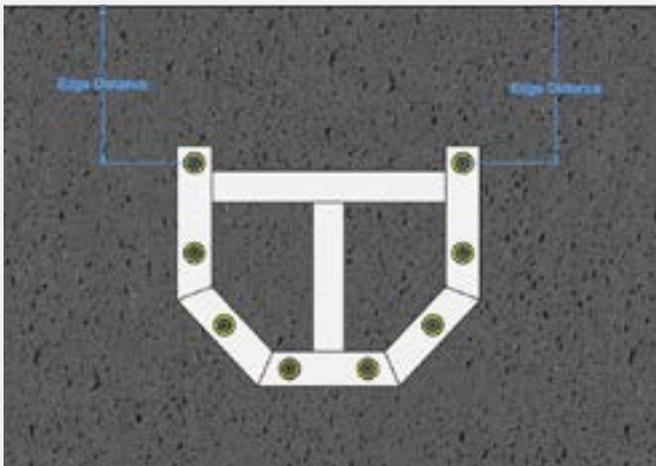
STEP 5

3.1.2 EPOXY/RESIN ANCHOR INSTALLATION

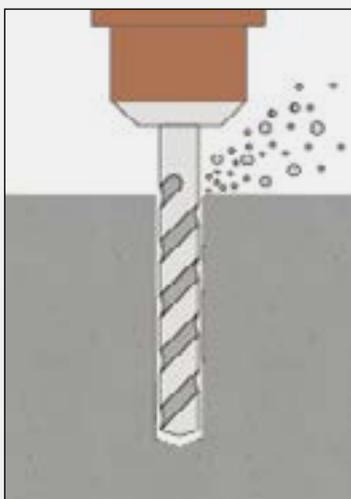
Fully threaded anchors are used with resin/epoxy bond materials to achieve a bond between the anchors and the existing concrete. The detailed 5 step procedure is as follows:

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

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.

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.

- 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.

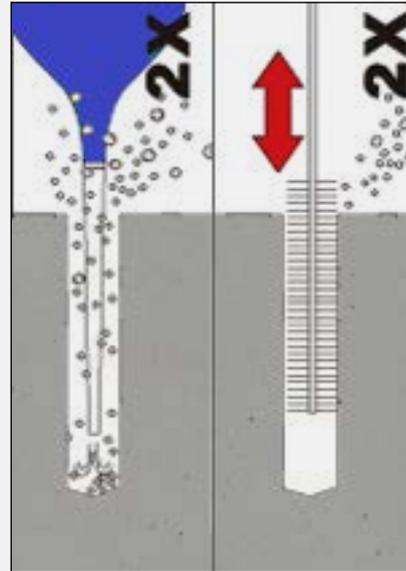
(Roughing the surface of the hole is a recommendation and not a requirement.)

Recommendation:

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

Step 3. Cleaning

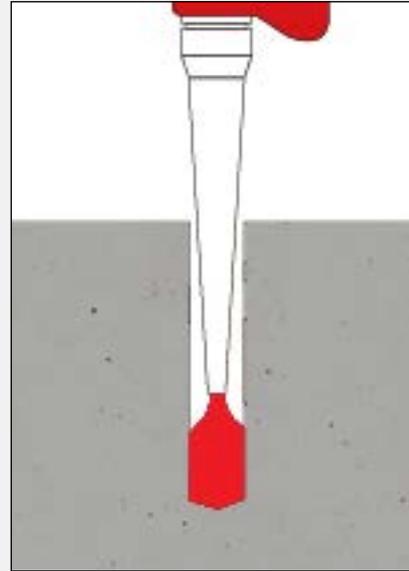
- Starting from the bottom surface of each hole, use a pressurised water flow to clean the holes.
- Run a flow of water continuously into the holes until the water runs out clear.
- Brush two times with the specified brush size (brush $\varnothing \geq$ bore hole \varnothing , see Table 7 in Hilti manual) 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

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

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.

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.



3.3 ANCHOR INSTALLATION TORQUE

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)
Tee Bollard 	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%
Horn Bollard 	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%
Kidney Bollard 	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%

3.3 ANCHOR INSTALLATION TORQUE

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)
Cleat Bollard 	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%
Double Bitt Bollard 	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%
Single Bitt Bollard 	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%
Pillar Bollard 	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 below 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, or contact the manufacturer for guidelines.	
4	Inspect the barrel for wear.	Inspect the barrel for localized wear > 2 mm.	If wear is > 2 mm please consult Trelleborg for appropriate action plan.	Trelleborg can perform a design check to ensure the integrity, or depending on the bollard type, grade, and type of wear, local repairs (i.e. welding) can be performed.
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.



Telleborg provides a comprehensive visual inspection service, ensuring the integrity and reliability of marine bollards through meticulous assessment and reporting.



To schedule a bollard inspection at your port, get in touch today.

Email: marine_infra@trelleborg.com



MN-I&M-BO-V1.1-EN,2023

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 and Infrastructure.

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