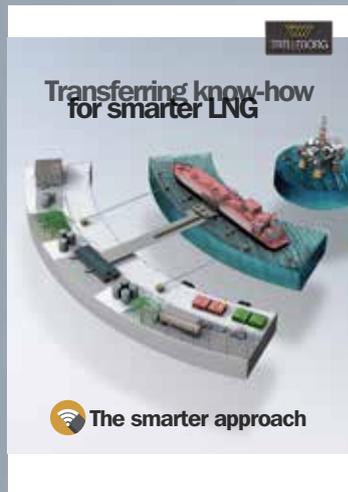


# Anchors

**HANDLING, STORAGE, INSTALLATION  
AND MAINTENANCE MANUAL**



# The Smarter Approach



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# Anchors Handling, Storage, Installation and Maintenance Manual

**Trelleborg Marine Systems is a world leader in the design and manufacture of advanced marine fender systems.**

We provide bespoke solutions for large and complex projects all over the world. Best practice design and quality materials ensure a long, low maintenance service life, no matter how demanding the working and environmental conditions.

All fenders are supplied fully tested and meet PIANC 2002 guidelines. Our pneumatic fenders are also completely ISO17357-1:2014 compliant. Our high-performance solutions combine low reaction force and hull pressure with good angular performance and rugged construction.

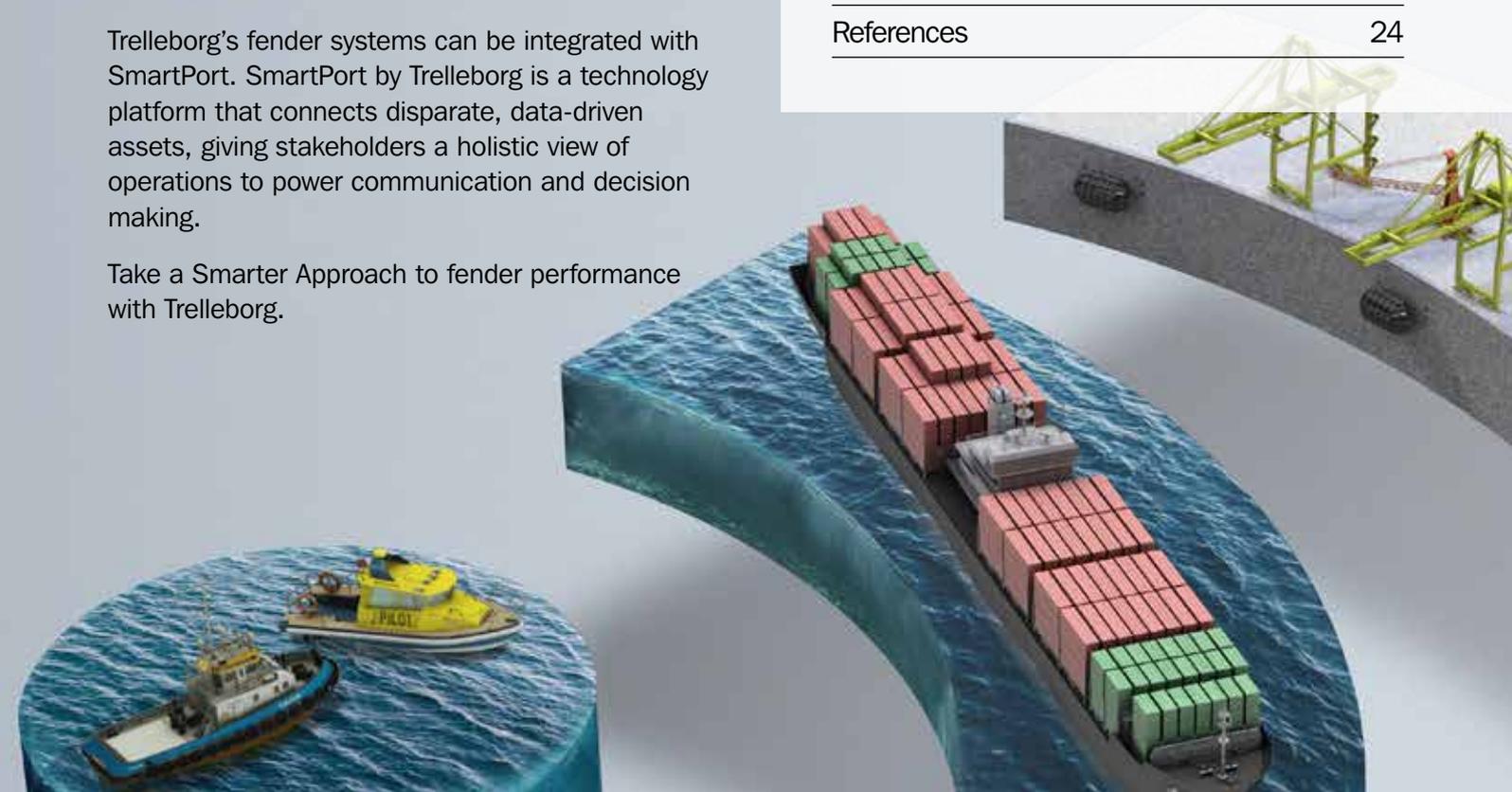
Trelleborg's fender systems can be integrated with SmartPort. SmartPort by Trelleborg is a technology platform that connects disparate, data-driven assets, giving stakeholders a holistic view of operations to power communication and decision making.

Take a Smarter Approach to fender performance with Trelleborg.

## Contents

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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.**

# Handling



# Handling

MATERIALS / EQUIPMENT REQUIRED	INFORMATION
<b>Forklift or crane</b>	Use a forklift or crane of suitable capacity when lifting the package.  Please refer to the packing list or shipping marks for the weight of the package.

- Fasteners are typically delivered to the project site in a wooden box / container or packed loose in tarpaulin, either separately or along with other fender system components, so as to align with the project schedule.
- Before unloading the shipment, the container must be visually inspected for any visible signs of damage. If significant damage is found, a photograph must be taken as evidence and sent to Trelleborg Marine Systems.
- Unloading of fasteners should be done using a forklift or crane of suitable capacity.

## Recommendations

- When unpacking, always lay components carefully on dry, firm ground.
- Always use certified lifting and rigging equipment.
- Always check the total weight before lifting any components / equipment.

**For weight information of anchors and other associated fasteners, please refer to the packing list or shipping marks.**

- All fasteners should be kept in their original packing until installation.
- When handling fasteners, ensure that the fastener threads are not damaged.



# Storage



Anchors supplied by Trelleborg are meant to be used in outdoor applications.

Trelleborg recommends that the equipment should be stored properly at all times to avoid any environmental damage or damage caused by moving equipment.

# Storage

MATERIALS / CONSUMABLES REQUIRED	INFORMATION
<b>Wooden boxes</b>	Fasteners should be well placed in closed wooden boxes or steel frame racks.
<b>Tarpaulin</b>	Should be heavy-duty waterproof plastic. Stored fasteners should be covered with tarpaulin to avoid damage to coating and threads.

EQUIPMENT REQUIRED	INFORMATION
<b>Forklift or crane</b>	Use a forklift or crane of suitable capacity when lifting the package. Please refer to the packing list or shipping marks for the weight of the package.

Stored anchors should be properly packed and labelled.

## Recommendations

- Always store fasteners at lower ground to avoid any accident during handling.

## PACKAGING GUIDELINES

- Fasteners must be properly lubricated (with grease or any thread protection material) before storing.
- Fasteners should be wrapped in a sealed, heavy-duty, waterproof, plastic bag and stored in wooden boxes, containers or steel frame racks to prevent damage due to handling, contamination of foreign objects and corrosion.

## Recommendations

- Packaging should be done according to batch type. Fasteners of the same size and batch should be packed together to avoid fitting issues during installation.
- Visual inspection of the anchors should be carried out every three months.

## LABELLING GUIDELINES

- Every package should be labelled with the below requisite information and this label should be visible from the outside of the package without breaking the seal.

LABELLING OF FASTENERS (DATA CAN BE OBTAINED FROM THE PRODUCT OR ITS MANUFACTURER)	
<b>Anchor type</b>	Cast-in anchor / retrofit anchor
<b>Anchor size</b>	MXX
<b>Year of manufacture</b>	xxxx(year)
<b>Quantity &amp; batch identification number (if any)</b>	XXX , XXXXXX

# Installation



## 3.1 CAST-IN ANCHORS (FOR A NEW CONCRETE STRUCTURE)

Cast-in anchors are generally installed on new concrete structures. These anchors should be installed at the correct location as per fender / bracket anchor layout.

EQUIPMENT REQUIRED	INFORMATION
<b>Anchors</b>	Supplied by Trelleborg
<b>Anchor bolt template</b>	Supplied by Trelleborg / others
<b>Spanner</b>	Suitable to supplied anchor size
<b>Rubber bush</b>	Suitable to supplied anchors size

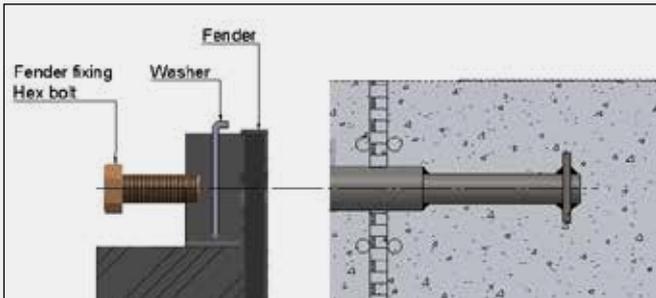
# Installation

## 3.1 CAST-IN ANCHORS (FOR A NEW CONCRETE STRUCTURE)

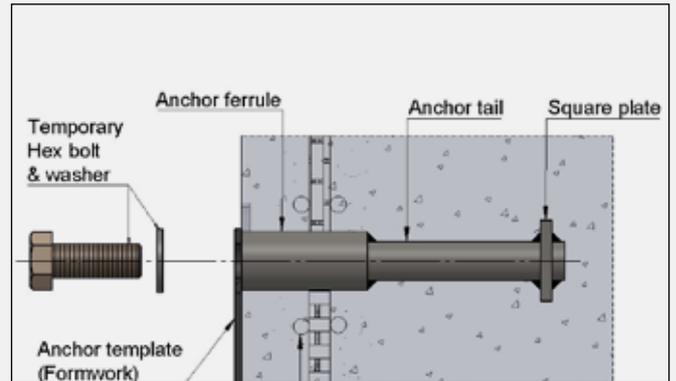
RECOMMENDED PERSONAL PROTECTIVE EQUIPMENT	INFORMATION
General PPE	As per site / plant requirements.

### PROCEDURE FOR CAST-IN TYPE ANCHOR INSTALLATION

Fender fixing using cast-in anchors



Cast-in anchor installation using template

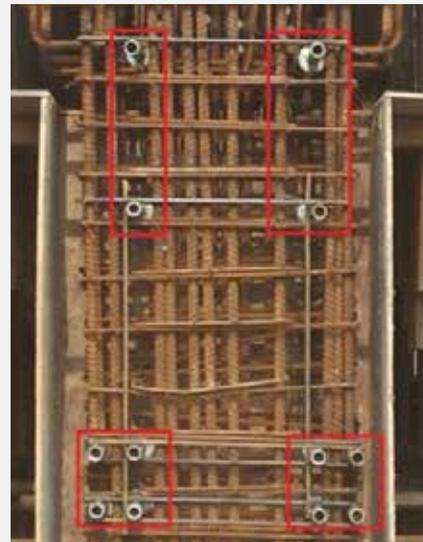


- All cast-in anchors must be fastened to the anchor template using suitable hex bolts (cage hold down bolts).
- Lift and position the pre-assembled anchor template.
- The pre-assembled anchor template must be tied to the reinforcement bars when pouring the concrete.

**If the template is not to be reused, it can be tack-welded to the reinforcement bars.**

- The anchors must be tied to the concrete reinforcement bars using the procedures provided in civil construction code.
- Always ensure that the anchors are perpendicular to the final concrete face and that the anchors and templates do not become misaligned during the concrete pour and pneumatic agitation processes.
- Do not disturb the anchors during curing of the concrete block.
- After the curing of the concrete block, the template should be dismantled and kept aside for further use. Until the fender system is installed, the ferrule should be secured by a suitable rubber bush to avoid ingress of any foreign particles and to prevent damage to the anchor threads.

Positioning of cast-in anchors before concrete pouring phase



Reinforced cast-in anchor



# Installation

## 3.1 CAST-IN ANCHORS (FOR A NEW CONCRETE STRUCTURE)

### Recommendations

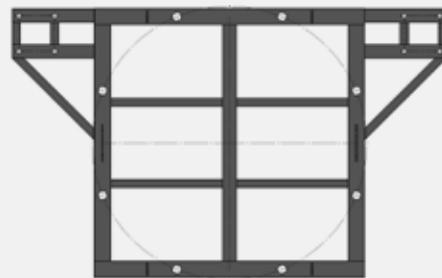
- Before installing the fender system, the cast-in anchors threads must be cleaned and lubricated with water-resistant grease.
- Always use the project-specific template issued by Trelleborg for locating anchors. If this template is not available, then an on-site or locally-fabricated template (prepared using the Trelleborg anchor layout drawing) can be used.
- After curing the concrete block, anchor location / position / perpendicularity must be verified against the project anchor layout drawing (issued by Trelleborg).
- The anchor template should be checked for dimensional accuracy before use, every time. If any discrepancy is found on the actual template dimensions, rectification must be made immediately before use.

### Caution

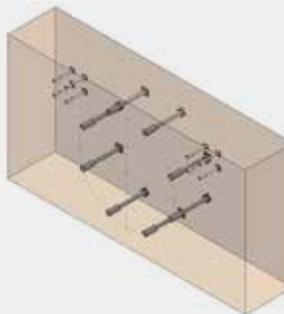
- Do not connect anchors for earthing purposes during welding operations.
- Adequate tension and shear reinforcement must be provided around cast-in anchors in accordance with ACI318 or relevant standards. If anchors become misaligned for any reason, please contact your local Trelleborg office.



**Figure 8**  
Concrete pouring during new wharf block preparation



**Figure 9**  
Anchor template (for positioning fender & bracket fixing anchors)



**Figure 10**  
Installed NC3 anchors



**Figure 11**  
Installed cast-in anchor



**Figure 12**  
Typical cast-in anchor

# Installation

## 3.2 EPOXY / ADHESIVE ANCHORS

EC2 type anchors / post-drilled anchors are generally installed on existing concrete structures. During system upgrade, fender replacement and, in some cases for new concrete structures, EC2 type anchors can also be used.

<b>MATERIALS/CONSUMABLES REQUIRED</b>	<b>INFORMATION</b>
<b>Epoxy / adhesive anchor</b>	The epoxy resin must comply with the project requirements (client's technical specifications).
<b>Concrete to anchor bonding agent</b>	Resin with good adhesion quality and breaking strength must be used.

<b>TOOLS REQUIRED</b>	<b>INFORMATION</b>
<b>Portable water unit (with water pump if necessary)</b>	For cooling the diamond core bit.
<b>Drilling rig with suitable diamond core bits and core drill extensions</b>	Suitable drill bits should be selected as per anchor size shown in anchor layout drawing.
<b>Measuring tape</b>	For checking the hole depth / embedment depth.
<b>Pressurized air nozzle / air blower / wet and dry industrial vacuum cleaner may also be used</b>	For removal of concrete dust from holes.

<b>EQUIPMENT REQUIRED</b>	<b>INFORMATION</b>
<b>Holding down bolt template (mandatory)</b>	Supplied by Trelleborg / others.
<b>Crane or forklift of adequate capacity</b>	Refer to the packing list or shipping marks for weight details.

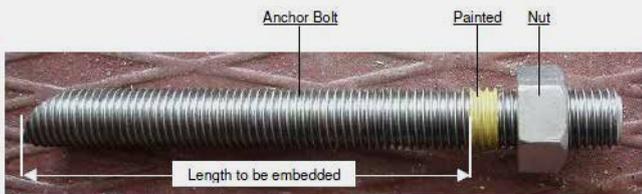
<b>RECOMMENDED PERSONAL PROTECTIVE EQUIPMENT</b>	<b>INFORMATION</b>
<b>General PPE</b>	As per site / plant requirements.
<b>Dust masks</b>	To avoid inhalation of concrete dust.
<b>Protective eyewear</b>	To protect the eyes from concrete debris.
<b>Gloves</b>	For handling selected epoxy resin.

# Installation

## 3.2 EPOXY / ADHESIVE ANCHORS

### Procedure for Epoxy / Adhesive anchor installation

**Figure 13**  
Typical EC2 Anchor



(Special note: Always mark embedment length on all anchors on site before proceeding with anchor installation as provided in the anchor layout supplied by Trelleborg)

Anchor installation consists of the following steps:

**Step 1 : Scaffolding set-up**

**Step 2 : Marking and coring of anchor hole**

**Step 3 : Hole cleaning**

**Step 4 : Resin injection and anchor loading**

**Step 5 : Settling and curing of anchor**

**All the above steps are explained in the following sections**

# Installation

## 3.2 EPOXY / ADHESIVE ANCHORS

### Step 1: Scaffolding set-up

Certified scaffolding must be used as a safe working platform.



# Installation

## 3.2 EPOXY / ADHESIVE ANCHORS

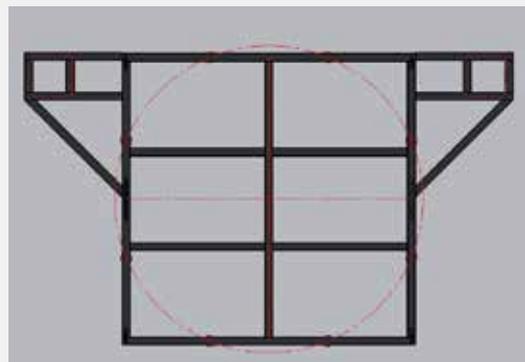
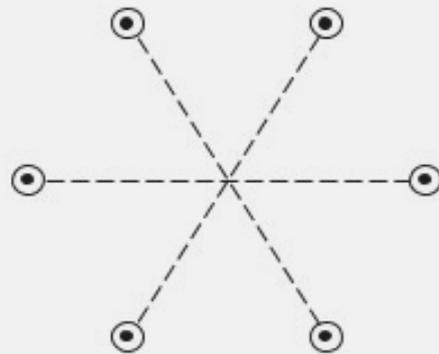
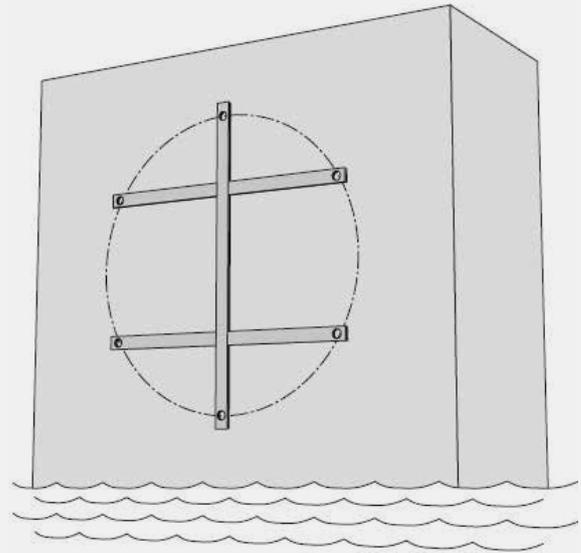
### Step 2: Marking and coring of anchor hole

- The anchor hole must be marked using the project-specific template (issued by Trelleborg or made on site as per anchor layout drawings submitted by Trelleborg).
- Lower the template using a crane and mark (using a marker) the hole positions.
- Remove the template, rest it on firm level ground and drill the required number of holes suitable for M12 mechanical (expansion) anchors.
- Lower the template using a crane lift and fix it on the wharf using temporary mechanical anchors and check water level alignment.

### Marking and coring of holes can be achieved by the following methods:

**Method 1:** Mark and core hole using the template and 8mm drill bit (for marking only).

- Keep the template in place and mark all holes required for fixing the fender system on the wharf structure using an 8mm drill bit up to 6mm-8mm depth only.
- Remove the template after ensuring that all required holes are marked.
- To initiate the coring process, set up the coring machine (unit) in such a way that the core bit axis and the center of the marked holes are aligned and concentric.
- Use a bubble gauge to verify that the drill bit is perpendicular to the wharf face.
- Use continuous flow of water to reduce heat generation in between the core bit and the concrete.
- Slowly drill the hole to achieve the required embedment depth/hole depth (as per the Trelleborg-issued anchor layout drawing).



**Figure 15**  
Marking and coring of anchor hole using template

# Installation

## 3.2 EPOXY / ADHESIVE ANCHORS

### Step 2: Marking and coring of anchor hole

**Method 2:** Hole marking and coring using template and suitable core bit for coring (as per anchor size).

- Keep the template in place until the marking and coring process is completed for all required anchors.
- Set up the coring machine (unit) in such a way that the core bit axis and the center of the marked holes are aligned and concentric. Only use a core bit that is suitable for the anchor size.
- Ensure that the core bit axis is perpendicular to the wharf face by using a bubble gauge.
- Use continuous flows of water to reduce heat generation in between the core bit and the concrete.
- Slowly drill the hole to achieve the required embedment depth / hole depth (as per the Trelleborg-issued anchor layout drawing).

### Recommendations

- A template (provided by Trelleborg or made using a Trelleborg anchor layout drawing) should be used to correctly mark/drill the anchor positions in the structure.
- The anchor template should be checked for dimensional accuracy before use, every time. If any discrepancy is found, this should be rectified.
- Always use the core bit with a guided pin.
- Always use the proper stand to fix the core bit machine to avoid vibrations while drilling that could lead to oncrete cracking / spalling.
- Roughening of the hole surface after coring is recommended as it will improve the bonding of the epoxy and concrete, but it is not mandatory.

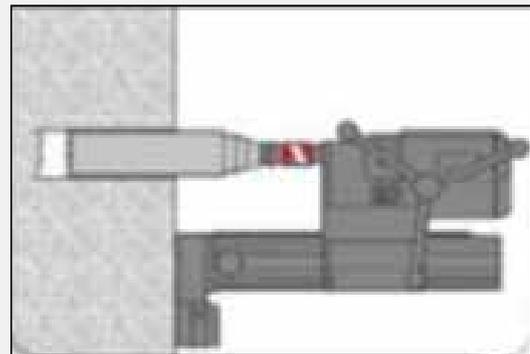
**Figure 16**

Anchor hole coring with one machine



**Figure 17**

Diamond core drilling machine and corresponding core bit



**Figure 18**

Marking of anchor hole



# Installation

## 3.2 EPOXY / ADHESIVE ANCHORS

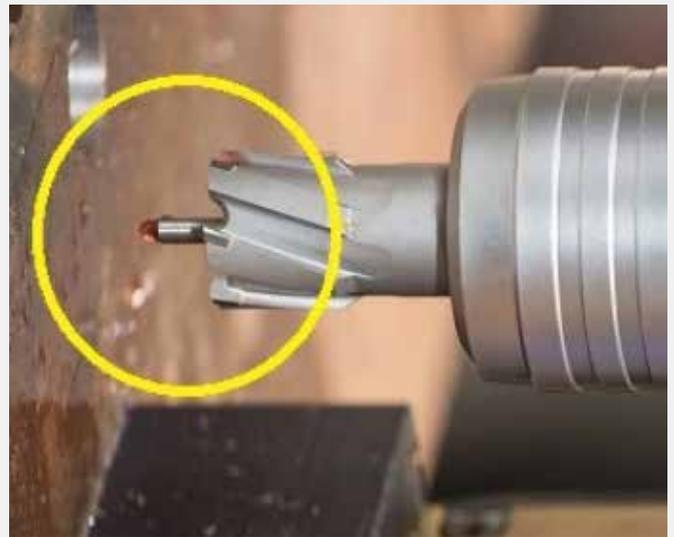
### Step 2: Marking and coring of anchor hole

#### Caution

- Verify that the core bit size is suitable for the anchor size.
- Verify that the depth and diameter of the holes are within tolerance ranges mentioned in the anchor layout drawing (issued by Trelleborg).
- Ensure that each anchor hole location does not interfere with the concrete reinforcement bar. Any cutting of rebar should be assessed by a civil engineer to ensure it has no effect on the concrete structure.

**Figure 19**

Core bit with guided pin



**Figure 20**

Roughening of hole



Roughed surface of hole

Tool used for roughening

# Installation

## 3.2 EPOXY / ADHESIVE ANCHORS

### Step 3: Hole Cleaning

- Use pressurized water to flush inside the hole.
- Continue flushing until clean water flows out without any dust and impurities.
- Brush twice with the specified brush size (brush  $\varnothing \geq$  cored hole  $\varnothing$ ).
- Blow oil-free compressed air into the hole until the return air stream is free from visible dust and water.
- Repeat the above water and air cleaning processes twice.

### Recommendations

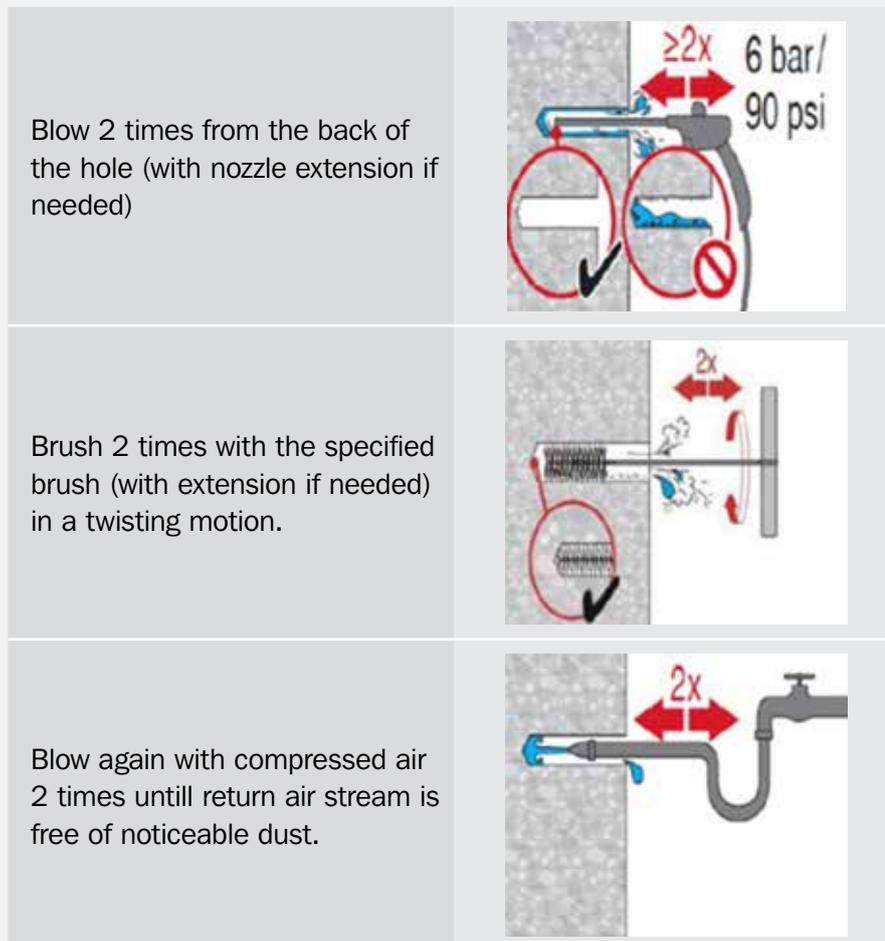
Before setting an anchor, ensure that the hole is free from dust / debris or any other bond-inhibiting material.

### Caution

Always measure the depth of the hole with measuring tape to ensure it matches the project construction drawing. Inadequate hole cleaning leads to poor load values.

**Figure 21**

Hole cleaning



# Installation

## 3.2 EPOXY / ADHESIVE ANCHORS

### Step 4: Anchor insertion / loading / installation

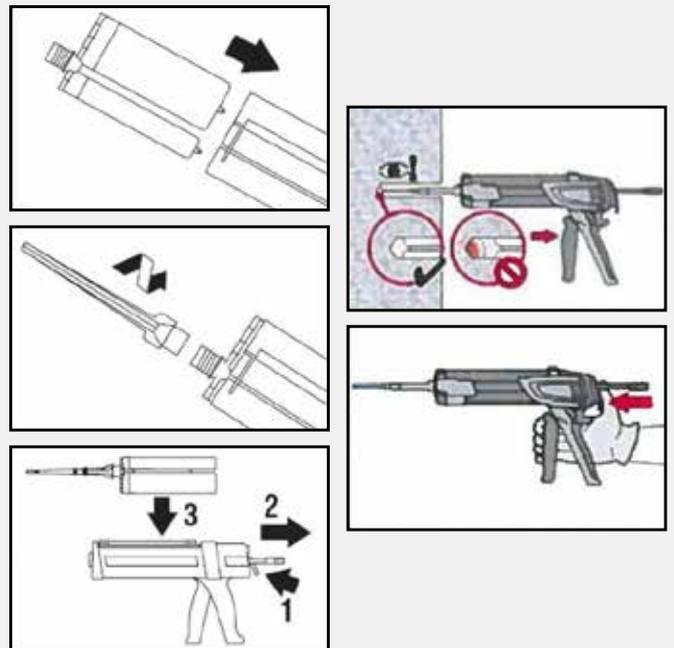
Refer to the guidelines provided by the epoxy suppliers before starting. The below steps are recommendations only.

- Insert the epoxy / chemical resin into the cored hole using an injection gun.
- Inject the epoxy/adhesive starting from the bottom of the cored hole to avoid formation of air pockets. Slowly inject the mixer with each trigger pull. (Follow the epoxy / injection gun supplier guidelines).
- Continue filling the cored hole either up to recommended amount of adhesive or until the hole is filled up to 2/3 of its depth.
- Insert the anchor into the hole up to the marked line (up to the required embedment depth) and rotate by hand for approximately 10 seconds to ensure proper contact of the epoxy with the anchor threads or grooves (refer to resin supplier guidelines or until additional torque is required to rotate the anchor due to the chemical anchor setting).
- Anchor installation should be completed within the recommended time frame as per the epoxy supplier. While epoxy curing, ensure the anchors are perpendicular to the wharf surface and not inclined.

### Recommendations

- Do not modify the composition of the original epoxy mixture.
- Always keep the epoxy material in the original container until required for application
- Discharge a small amount of epoxy mixture from the gun, outside the core (in a waste container box) before injecting it into the core.

**Figure 22**  
Epoxy insertion using gun (HILTI)



**Figure 23**  
Manual epoxy insertion and anchor loading



**Figure 24**  
Loaded EC2 anchor



**Figure 25**  
Fastening of EC2 anchor



# Installation

## 3.2 EPOXY / ADHESIVE ANCHORS

### Step 5: Settling and curing of anchors

Check the epoxy resin datasheet to determine the cure time for grout to achieve the maximum strength before tensioning the anchor bolts.

- Allow the recommended time for curing of the adhesive. On average, anchors should be left for between 24–48 hours before fenders or brackets are attached.
- Detach the nuts with a wrench after the resin has hardened.

### Recommendations

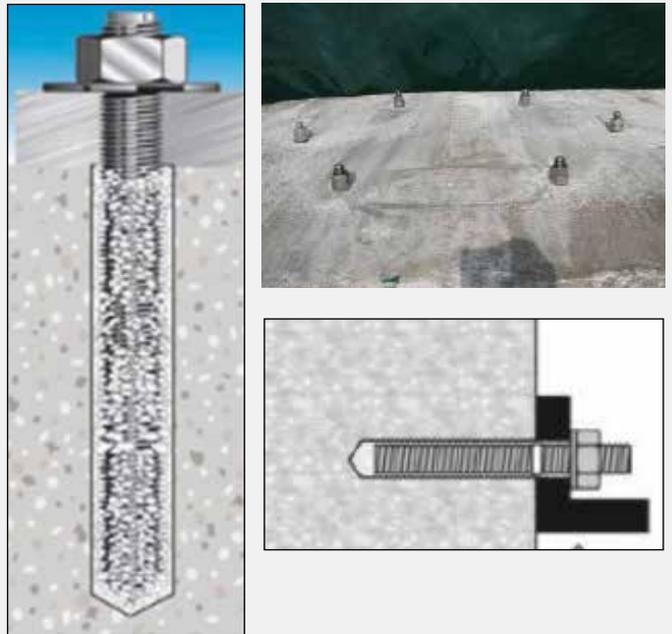
The marine fender can be installed at least 5 hours after the anchor bolts are inserted. The vessel can be berthed to the fender 24 hours after the fender is installed.

### Caution

Do not apply any load to the anchor bolts until the resin is hardened to protect bolt threads from damage.

**Figure 26**  
**Settling and curing of anchors**

Special Note: Do not disturb the loaded anchor until curing is complete as per the time recommended by the epoxy manufacturer.



# Maintenance and Inspection



An inspection and maintenance guideline is important to identify the maintenance scope of the installed fasteners of the fender system.

Two levels of inspection and maintenance are recommended (as per table – 5, applicable for temperate climates).

# Inspection and Maintenance

## INSPECTION SCHEDULE

Table – 5 (Inspection schedule)

ITEM NO.	INTERVALS	
	3 MONTHS	6 MONTHS
1	✓	
2	✓	
3		✓
4		✓

Table – 6 (Anchor inspection procedure)

ITEM NO.	SCOPE OF MAINTENANCE	ACTION	CHECK
1	<ul style="list-style-type: none"> <li>■ Visually inspect the fasteners to see if any associated parts are missing.</li> <li>■ Check for loose or missing bolts or washers (for cast-in type anchors) and nuts or washers (for epoxy / adhesive anchors).</li> </ul>	<ul style="list-style-type: none"> <li>■ Replace any missing fasteners.</li> <li>■ If any fasteners are loose, tighten as necessary using a suitable tool.</li> </ul>	
2	Inspect for any corrosion on fasteners / anchors or on their associated parts i.e., nut, bolt, washer, etc.	<ul style="list-style-type: none"> <li>■ Remove any corrosion from nuts/bolts using rust inhibitor or replace them.</li> <li>■ Ensure that a non-soluble vegetable grease is applied to the bolt and the ferrule before refitting.</li> </ul>	
3	Inspect for any thread damage (applicable to exposed threads only).	<ul style="list-style-type: none"> <li>■ If damaged, replace.</li> <li>■ If rusted, wire brush the threads and treat with rust inhibiting paint.</li> <li>■ If rust is serious, replace the fasteners.</li> </ul>	

# Appendix

## Torque table based on Anchor Loading

### SCN FENDERS (F1.9 TO F3.1)

FENDER	AXIAL FORCE (kN) (F)	BOLT SIZE	CO-EFFICIENT (k)	TORQUE (T) N.m $T = KFD$
SCN 2250	401	M64	0.18	4614
SCN 2250	374	M56		3765
SCN 2000	317	M56		3190
SCN 1800	279	M56		2812
SCN 1600	264	M48		2281
SCN 1400	203	M42		1531
SCN 1300	177	M42		1338
SCN 1200	167	M42		1259
SCN 1100	128	M36		826
SCN 1050	143	M36		923
SCN 1000	131	M36		846
SCN 950	117	M30		632
SCN 900	107	M30		575
SCN 860	98	M30		527
SCN 800	84	M30		454
SCN 700	84	M30		454
SCN 600	63	M30		340
SCN 550	54	M24		233
SCN 500	41	M24		175
SCN 400	29	M20		103
SCN 350	21	M16		60
SCN 300	17	M16		48

## Torque table based on Anchor Loading

### SCN FENDERS (F0.7 TO F1.8)

FENDER	AXIAL FORCE (kN) (F)	BOLT SIZE	CO-EFFICIENT (k)	TORQUE (T) N.m T = KFD
SCN 2250	254	M48	0.18	2190
SCN 2250	236	M48		2035
SCN 2000	200	M42		1508
SCN 1800	177	M42		1338
SCN 1600	167	M42		1259
SCN 1400	128	M36		826
SCN 1300	111	M36		719
SCN 1200	96	M30		518
SCN 1100	81	M30		437
SCN 1050	90	M30		486
SCN 1000	83	M30		446
SCN 950	75	M30		405
SCN 900	68	M30		365
SCN 860	62	M24		266
SCN 800	54	M24		233
SCN 700	54	M24		233
SCN 600	38	M20		135
SCN 550	35	M20		124
SCN 500	26	M20		92
SCN 400	18	M16		52
SCN 350	14	M16	39	
SCN 300	11	M16	30	

k=0.18 for hot-dip galvanized screw threads with normal metric thread, clean and dry (ungreased).

k=0.15 for bolts with normal metric thread, clean and light oiled, in the manner the manufacturer usually delivers.

k=0.12 for bolts with normal metric thread of which the screw thread and the nut face are lightly greased with a Moly slip screw thread paste (or similar).

■ Torque value calculated considering  $k = 0.18$ .

■ Above 'k' values are for reference only. Appropriate 'k' values shall be considered as per lubricant manufacturer datasheet.

■ If a digital torque wrench is not available, measure the initial clamping thickness and allow the rubber to compress not more than 2-3 mm.

# References

This section contains references to other associated installation and maintenance manuals as mentioned below.

DOCUMENT NO.	DESCRIPTION
MN-I&M-RUB-SCN&SCK-v1.0-EN, 2017	Handling, Storage, Installation, Inspection & Maintenance Manual for SCN/SCK Rubber Fender System
MN-I&M-FEN-SYS-v1.0-EN, 2017	Handling, Storage, Installation, Inspection & Maintenance Manual for Fender System
MN-I&M-PMF-SYS-v1.0-EN, 2017	Handling, Storage, Installation, Inspection & Maintenance Manual for PMF System



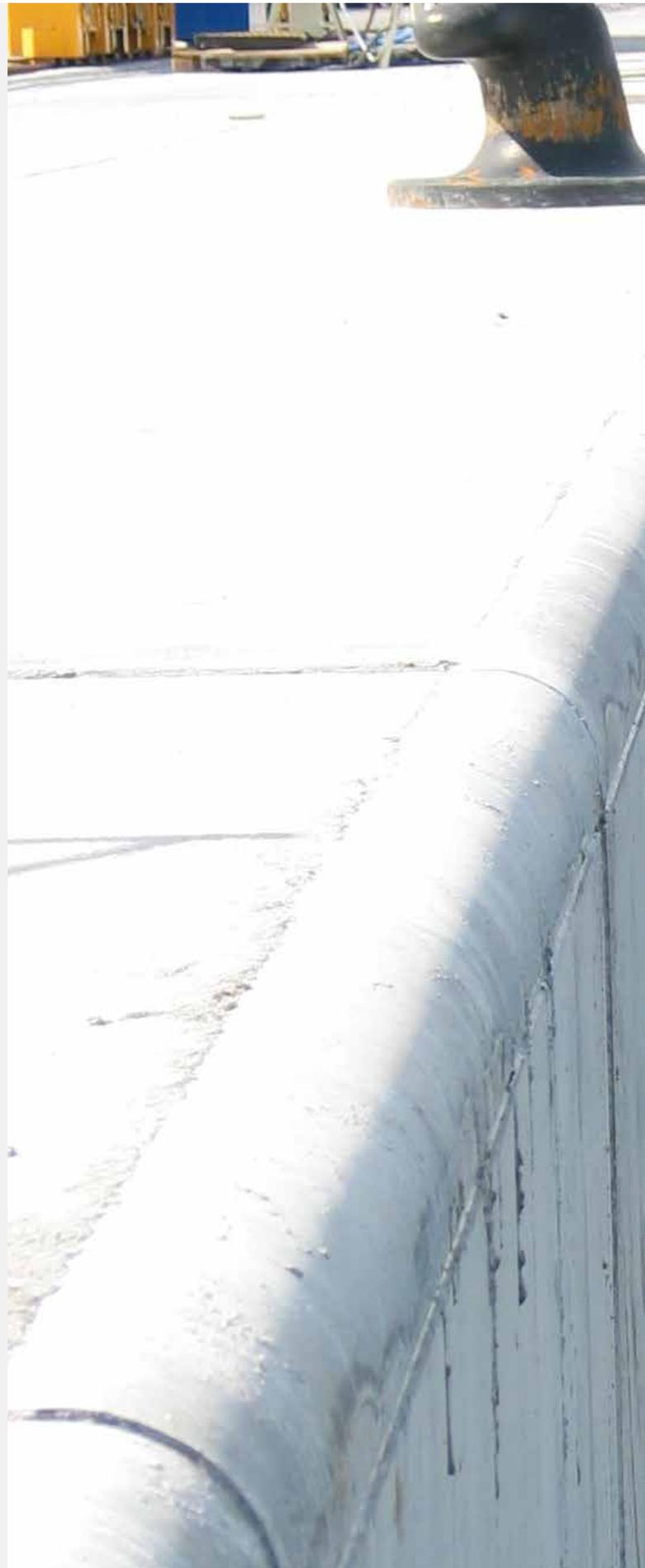
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