The Stevtensioner

Introduction

The Stevtensioner is used for cross tensioning of diametrically opposed anchor legs moored by drag anchors or anchor piles. The Stevtensioner is generally used for the installation of (semi) permanent floating structures such as the SPM buoy, STL, TLP, FPS, FPSO, etc. After the tensioning operations the Stevtensioner is demobilised and ready for the next project. The Stevtensioner can however also be used for permanent tensioning purposes, becoming a part of the mooring system. The Stevtensioner can be deployed from a crane barge, AHV or any vessel having enough crane/winch capacity to pull the required vertical force. The existing models VA220 and VA500 were designed for handling a single size of chain. The new Stevtensioner models VA600, VA1000 and VA1250 can handle chain diameter ranging from 76 mm up to 152 mm. Because of this variety in chain sizes additional work chain may not be required *(fig. 3-105)*.

he working principle of the tensioner

The Stevtensioner is based on the principle that a vertical load to a horizontal string causes high horizontal loads. To achieve the required horizontal pretension load at the anchor points, the vertical pulling force only needs to be 40% of this pretension. The anchor line tension is measured by a measuring pin located inside the Stevtensioner and as such well protected against damage caused by handling and lifting operations *(fig. 3-106)*.

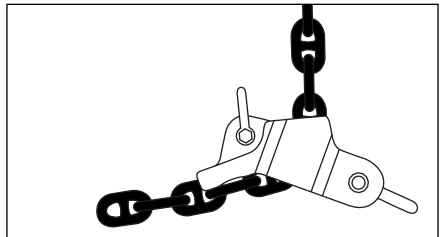

fig. 3-94

The new Stevtensioner models offer the following features:

- Smaller dimensions, reduced weight and improved handling, but heavy enough to easilty slide down the mooring line.
- Designed to smoothly guide at least 5 links and therefore prevent chain getting stuck inside.
- Due to economical volume/weight ratio, the new Stevtensioner models allow for containerised freight by either sea or, for rush deliveries, by air.
- The integrated shape allows for smooth passage over stern roller.
- Load measuring pin is equipped with two independent sets of strain gauges. The umbilical cable connections are protected against handling and lifting operations. These connections may be used for acoustic transfer of the signals.

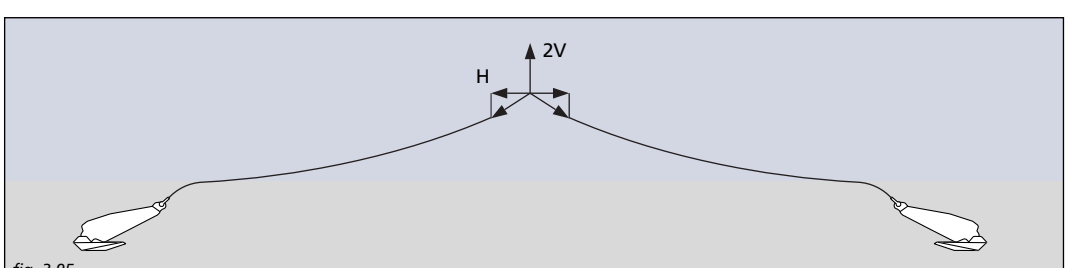

fig. 3-95

The Stevtensioner

One anchor line (passive line) is attached to the tension measuring pin at the Stevtensioner. The oppos-ite anchor line (active line) passes through the Stevtensioner. Tensioning starts by apply-ing the yo-yo movement to the active line *(fig. 3-107)*.

When the Stevtensioner is lifted by the active chain, it blocks the chain. When the Stevtensioner is lifted from the seabed, the passive and active mooring lines are also lifted. Consequently the anchors or piles are loaded and cause an inverse catenary of the mooring line in the soil, as well as causing the anchor to drag and embed. In other words: chain length is gained. Lowering the Stevtensioner slackens the anchor lines and allows it to slide down over the active chain. By repeating this several times (called the yo-yo movement), the horizontal load on the anchor points increases. Generally the required horizontal load is achieved after 5 to 7 steps. Once tensioning is completed, the Stevtensioner is recovered by pulling the lifting/pennant wire making it disengage. This allows the Stevtensioner to slide up along the active chain to the surface *(fig. 3-108)*.

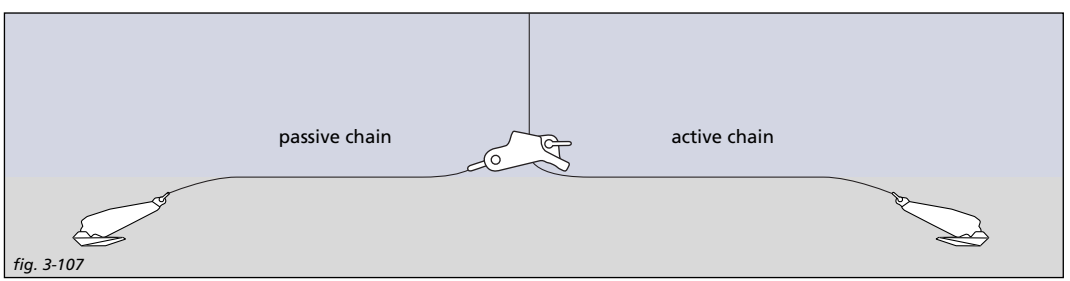

fig. 3-107

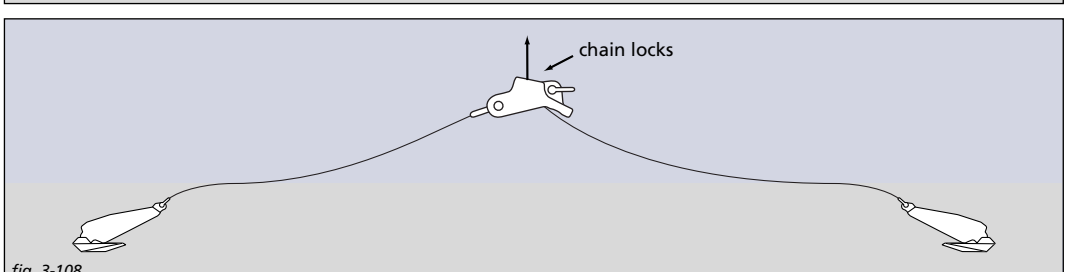

fig. 3-108

The Stevtensioner

Measurement of the tensions applied

Fig. 3-109 shows the curve recorded during tensioning of chains connected to piles for the Coveñas Pipeline Project in Colombia. The graph shows a total of 5 heaves (yo-yo's), each resulting in a higher tension.

When the Stevtensioner is lifted from the seabed, the passive and active mooring lines are also lifted from the seabed. Consequently the anchors or piles are loaded. The loading causes an inverse catenary of the mooring line in the soil, and also causes the anchor to drag and embed; in other words: chain length is gained. When lowering to seabed the gain in chain length (slack) is won by the Stevtensioner sliding down the chain (approximately 5 to 8 links). The next heave (yo-yo) will therefore create a higher tension in the system. In practise a total of 5 to 7 yo-yos are required to reach the required proof tension load.

Different methods can be applied to verify the tension in the chain. These are discussed below.

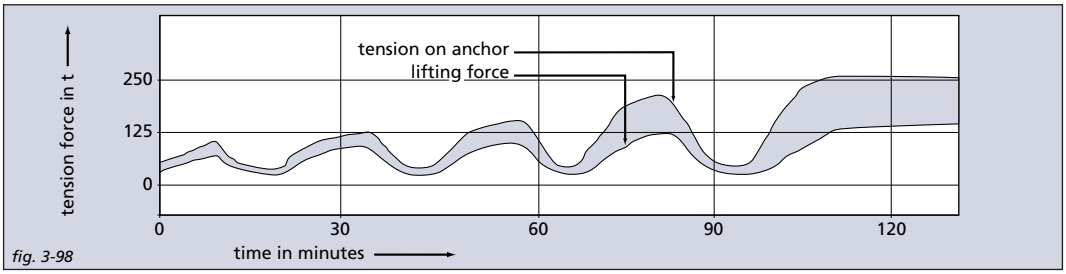

fig. 3-98

The Stevtensioner

Computer calculations

The tension in the chain can be calculated by means of computer catenary calculations. Besides known parameters such as submerged chain weight, and the length of the mooring line, other parameters measured during tensioning need to be incorporated in the calculation:

- Height Stevtensioner above seabed.
- Vertical pulling load.

By using this method the tension in the chain can be calculated at any height of the Stevtensioner above seabed. This method is independent of the waterdepth.

Umbilical cable and measuring pin

The chain tension can be measured with a measuring pin. The pin is part of the Stevtensioner housing and is equipped with strain gauges. The pin is connected to a tension read-out unit on the installation vessel by using an umbilical cable. The pin is connected to the passive chain. All tensioning data are measured on deck and presented during tensioning on a chart recorder. A hand winch with sliding contacts is used to veer and haul the umbilical without disconnecting the umbilical from the registration equipment. The measurement is insensitive for variations in cable length. The use of an umbilical is an effective method in waterdepths down to approximately 200 meters. Beyond this depth it becomes more efficient to use either an acoustic system or computer calculations.

Break-link

The passive chain can be attached to the Stevtensioner by a break-link. When, during the tensioning operation, a predetermined load has been reached, the link breaks. Consequently the passive chain falls to the bottom, and the Stevtensioner can be retrieved.

The Stevtensioner

Duration of pretensioning anchors and piles

Once the required tension has been achieved, the tension has to be maintained for a certain duration. This period is described in the table below for various Certification Authorities.

Certification Authority	Required duration of maintaining tension
Lloyds Register of Shipping	20 minutes
American Bureau of Shipping	30 minutes
Det Norske Veritas (NMD)	15 minutes

The Stevtensioner

Handling the Stevtensioner

Handling operations can generally be described as follows:

- Positioning the anchors and paying out the chain
- Hook-up all necessary hardware for tensioning operations on deck of barge or AHV
- Deployment Stevtensioner to the seabed and positioning of the installation vessel
- First lift (yo-yo)
- Series of yo-yo's
- Maintain required tension for a specified period of time
- Retrieve the Stevtensioner and disconnect
- Prepare for next tensioning

A Stevtensioner can be deployed from a crane barge, Anchor Handling Vessel or any vessel having enough crane/winch capacity to lift the required vertical force.

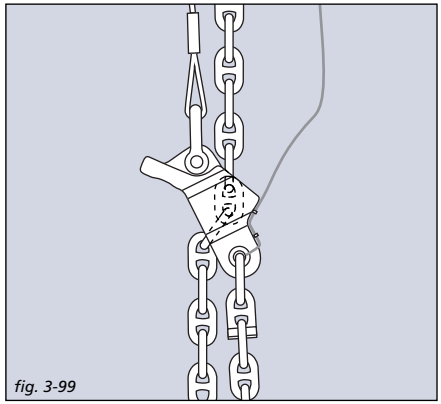

fig. 3-99

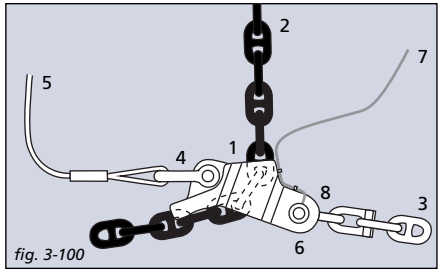

fig. 3-100

General tensioning procedures

General tensioning procedures using crane barge or AHV for Stevtensioner models VA1000 and VA1250 are presented in *fig. 3-110 and 3-111*.

The Stevtensioner

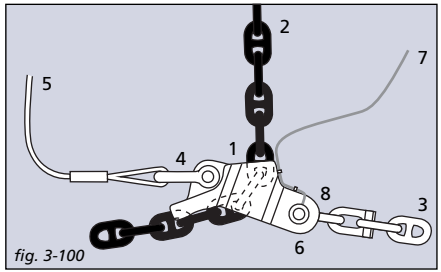

fig. 3-100

Hook-up

Pass the active chain (2) through the tensioner (1) on deck. Connect passive chain (3) to measuring pin shackle (8). Connect dislock wire (5) to shackle (4). Connect umbilical cable (7) to read-out system on deck and to the measuring pin (6).

Lowering

Fix active chain (2) to winch or crane hook. Slack dislock wire (5) and lower Stevtensioner to seabed. Stevtensioner will pass over active chain (2).

Tensioning mode

When Stevtensioner is on seabed, slack dislock wire (5) before the first yo-yo, and keep slack during all yo-yos!

Tensioning is achieved by pulling on active chain (2). The mooring lines will be lifted from the seabed causing the anchors or piles to be loaded. After each yo-yo active chain is gained. The active chain can only pass through the Stevtensioner in one direction. Approximately 4 to 7 yo-yos are required to obtain the required pretension load *(fig. 3-111)*.

The Stevtensioner

Retrieving

When tensioning is completed be sure to lower the Stevtensioner to seabed and slack off active chain (2) before retrieving Stevtensioner with dislock wire (5). Pull on dislock wire (5). Stevtensioner will pass over chain (2). Disconnect Stevtensioner on deck of the barge or AHV.

Stevtensioner Product Range

The following Stevtensioners are available from vryhof anchors.

Stevtensioner model	Maximum horizontal load [t]	Suitable* for chain size with Kenter shackle [mm]	Suitable* for chain size without Kenter shackle [mm]	Size Stevtensioner lxhxw [m]	Weight Stevtensioner [t]
VA 220	220	50	60	2.6 x 1.2 x 1.0	5
VA 500	500	102	112	5.4 x 2.6 x 2.4	20
VA 600	600	76 - 84	76 - 87	2.2 x 0.9 x 0.6	2.5
VA1000	1000	102 - 117	102 - 135	3.1 x 1.2 x 0.8	6
VA1250	1250	114 - 132	114 - 152	3.5 x 1.4 x 0.9	9

** The suitability only refers to the section of chain passing through the Stevtensioner. Chain or wire not passing through the Stevtensioner may have any dimension.*