NAUTICAL AND ENVIRONMENT: PRESENT AND FUTURE OF ENVIRONMENTAL QUALITY IN AREAS OF ANCHORAGE IN MARINE PROTECTED AREAS

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Abstract. *Recreational boating has experienced in recent decades a boom supported by the construction and development of port infrastructure. The establishment of marine protected areas attracts yachts and professionals seeking that prefer a well-preserved environment to develop their activities. Numerous studies have shown that the large volume of ships that frequent these areas has a significant impact on seagrass beds and other sensitive biological communities, due to the use of anchors and chains, which have a destructive effect of the seabed. There are different alternatives of "ecological mooring" depending on the type of substrate and desired strength. In Irta Marine Reserve (Peniscola, Spain) were installed a total of 33 mooring points using the Ellipse III anchoring system.*

Keywords: anchorage, seagrasses, Ellipse, ecological mooring.

1. INTRODUCTION

Traditional anchoring system causes extensive damage to the seabed. Anchors are inserted into the seabed and when anchor drag event occurs, remove any type organism. Moreover, the chains during swinging on changes in wind direction plow seagrass leaves and cause damage to numerous sessile organisms that habit these ecosystems [1] In recent years has created a new management model of nautical activities, based on the empowerment of areas that offer mooring systems of low impact. The installation of these systems requires a prior diagnosis of each case study to determine the type most appropriate and its goal is the conservation of seagrasses beds and sensitive biological communities.

Fig. 1. Anchorage system into *Posidonia oceanica* seabed.

2. ANCORAGE SYSTEMS

Anchoring systems of low impact or "ecological moorings" are composed of two main elements, the anchorage and mooring line. Are based on two principles, firstly, the seabed surface affected by the anchor is minimized and then, that the mooring line is not in contact with the seabed, which is achieved by using intermediate buoys that maintain the floating line. In this way, prevents the erosive halo caused by concrete ballasts, which can move, and mooring lines to crawl with its consequent effect of plowing.

Fig. 2. Anchorage system for sandy substrate.

Anchors alternatives presented in the market that must be evaluated by substrate existing, cost, difficulty of installation, etc. In areas where there are seagrass and soft bottoms, two systems are mainly considered, some are installed using hydraulic hammers devices (Manta Ray, Duckbill, Sting Ray, darn, etc.) and others, by rotating (Ellipse, Harmony, Helix, etc.).

The first system consists of a metallic anchor made of composition metal of spheroid graphite and aluminum bronze, which is introduced into the substrate, pushed along guides by using a hydraulic hammer. Once reached the desired depth, the anchor is blocked by a pull, remaining in horizontal position and offering great resistance. Depending on the size and depth of the full range of anchors, a resistance range between 10 and 150 KN is achieved. It can be installed on sandy bottom or seagrass beds.

The rotating system has two variants, one is a spiral-shaped structure made of galvanized steel that is inserted directly into the root ball of *Posidonia oceanica*[2]. In case of finding areas with sandy substrate, may be installed other

system composed of a principal axis that has helical structures of different diameters that are screwed into the soft bottom. Both structures can be produced in different sizes and offer the possibility of multiple assemblies, connecting up to 4 items using a bar of galvanized steel of 15 centimeters square section. Thereby can be achieved resistance range between 43 KN and 172 KN.

3. STUDY CASE

The Irta Natural Park and Irta Marine Reserve, in the province of Castellón, Spain, are also spaces cataloged as a Site of Community Importance according to the Habitats Directive Natura 2000. In this area, the company Mediterraneo Servicios Marinos took place the installation of 33 anchorage points at a depth of 5.5 m, using the Ellipse III double and quadruple system assembly. For that were joined several items using a square bar of galvanized steel, for boats up to 20 m in length. Each element is of 2 m in height and has a shaft of 28 mm in thickness with two helical structures of 30 cm and a diameter of 40 cm, reaching a weight of 28kg. At the top has a strongly welded to the main shaft which allows the attachment of the mooring line. The entire assembly reaches a weight of 86 kg. The metal is treated with a corrosion process in accordance with the rules of galvanizing NF ISO 1461 and 14713 and marked with the letters CMU or SWL specifying the maximum useful load.

1.1 Study of capacity

The mooring composed of the anchors and tie bar should resist shooting boat, it is very important to control the tensile stresses, shear and bending moment of the materials and the system used to oversize mooring boats anticipating higher length.

Each anchor is sized to withstand the effects of wind and current on the anchored boat. The wind generally acts horizontally in any direction and produces a dynamic pressure at the points where something gets in the stream.

The vessels are subject to the current exerts a drag force in influencing the fluid density and the area of the hull.

The calculations in the project capacity study were made taking a wind speed of 120 km / h and a flow velocity of 1.92 m / s.

1.2 Special features of the substrate

During previous studies implied the development of a project, a study of sedimentary power took place in the area by compressed air lances. The existence of a compacted clay layer located between the elevation of -1 to -2.3 m depending on the point, which could be inconvenient during installation or be favorable to give the system greater resistance was determined in this way.

1.3 Stress tests

A limiting factor found was the lack of tests conducted on a comparable substrate to the target area, so prior to installing a test was performed to ensure the strength in the specific substrate and provide greater assurance to the client. Tests on single and double anchor assembly is performed by using a vessel of 23 m and anchored calibrated dynamometer. In the first case, after a constant voltage of 5,700 kg at a 45° angle for 68 seconds, the shaft began to move and anchor was pulled from the substrate, showing the lower deformed blade, probably due to the layer of compacted clays. In the case of double anchor, with the same conditions a maximum load of 8,000 kg was achieved, resisting the tension until it withdrew to avoid overloading the machinery.

Fig. 3. Vessel during the stress test.

1.4 Manufacture of a hydraulic screwdriver

Technicians of Mediterranean Marine Services manufactured in the company facilities an hydraulic screwdriver of reduced dimensions that allowed the installation of the anchors with the use of a small vessel. Its main features are:

-The metal supporting structure is made of stainless steel AISI 316 marine welded so that the central tube is hollow to provide buoyancy to the assembly.

-It can be operated by a diver through a manually operated distributor, allowing work more safely.

-Has bidirectional movement, it allows screwing and unscrewing the anchors.

-The speed should it be slow, is about 20 rpm

-The optimal rate of operation is 19 l / m.

-The working pressure at which the hydraulic unit injects the oil is 160 bars.

-Finally, it has an interchangeable tool to use with other products on the market head.

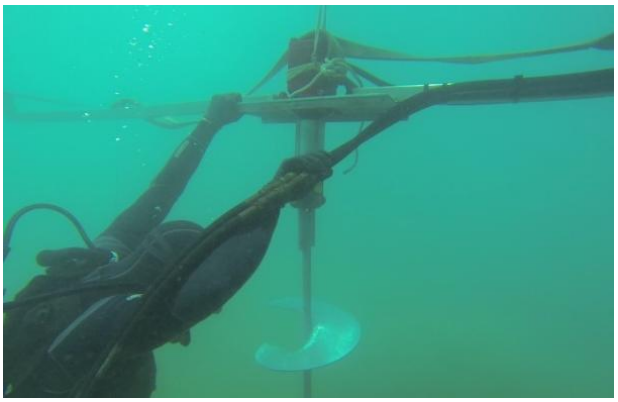

Fig. 4. Hydraullic screwdriver operated by diver.

1.5 Installation

1.5.1 Checking the power substrate by air lances.

Prior to the installation work of the anchors was carried out a campaign to revise the substrate with air lance at the points where the anchors should be installed to ensure that they could achieve the necessary depth. In this campaign was determinate the existence of compacted clay layer, which no offered problems during installation, only more resistance during screwing.

1.5.2 Installing anchors in anchorage areas.

Installation work is carried out by a team of professional divers and operators of surface support. The yield, including navigation, positioning, installation and assembly double anchor was 4 mooring systems per day.

1.5.3 Preparation and installation of mooring lines.

The mooring lines were made according to the project by offering a simple mooring system. The use of quality materials ensures durability anchoring systems.

The anchor line is polyamide 22 mm and has a tensile strength of 10,000 kg. It is attached to the anchor through a shackle high-strength galvanized steel workload of 8,750 kg. The peculiarity of the design is that the mooring line has an intermediate buoy that prevents drag on the bottom line, avoiding damage to the bottom and suffer rupture gall to anchor itself.

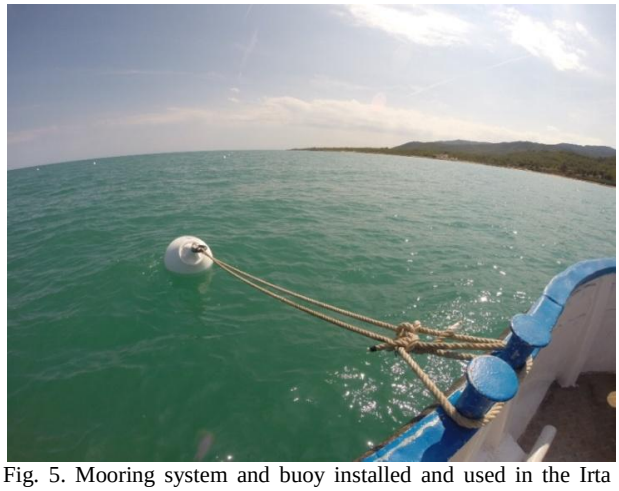

Fig. 5. Mooring system and buoy installed and used in the Irta Marine Reserve.

1.6 Maintenance and Inspection

For the correct operation of mooring systems it is necessary to establish a program of periodic maintenance of all elements to ensure correct operation and avoid risks for boats. Depending on the area can influence factors:

- Epiphytic organisms.
- Misuse by lack of vigilance.
- Propeller accident.
- Sabotage.
- Exposure to time.
- Inappropriate design.
- Fretting corrosion or friction.

4. RESULTS AND CONCLUSIONS

- The mooring systems installed are operating a year later, so that the materials offer a high degree of durability and strength.
- The system used was chosen after conducting empirical tests of resistance with different shooting angles and different substrates, which provided assurance about the capability of the anchorages in this area. The double system provides an equivalent resistance to 8 tons concrete ballast depending on substrate type.
- Previously, took place a campaign for review the substrate with air lance at points where it should install the anchorages to ensure that they could achieve the necessary thickness. In this campaign was determined the existence of a layer of compacted clay, which gave no problems during installation.
- With this system, in addition, the problem of the loss of depth at the point of anchorage that result from use of concrete ballast is resolved, since in shallow areas like this may be problematic.
- For installation of moorings was made a hydraulic instrument in the metalwork assembly shop of the company under the guidance of experts. This device was operated by two divers and a technical surface allowing the installation of anchors using a vessel of reduced dimensions.
- The mooring buoys used were the model AMR 650 40Q of Mobilis, with accessible loop in surface and made of high density polyethylene, suitable for areas exposed to currents and waves. This system protects the anchor line of propellers.
- The use of mooring systems allows to combine low-impact water sports at AMP conservation of the marine environment.
- Many installation projects funding trains launched but more are needed.

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