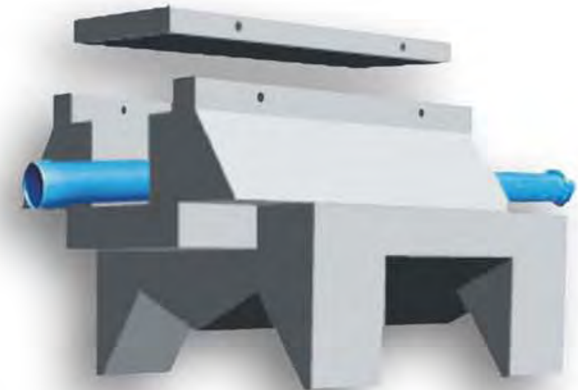

EMITE UNITS, ANCHORING, INSTALLATION AND PROTECTION
OF SUBMARINE EMISSARIES OR CANALISATIONS
ON SANDY BOTTOMS

EMITE

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EMITE UNIT

(Patent nº P200501346)

EMITE unit: Anchoring, installation and protection of submarine emissaries or canalisations on sandy bottoms.

INTRODUCTION

The project of submarine emissaries or submarine canalisations is closely linked to the geometrics of the works – diameter, length, depth of pouring- to the marine climate characteristics and hydrodynamics in the working zone, and especially to the building company's technical reliability, its experience and the availability of maritime means. For this reason, it is very difficult to separate the project itself from the real construction possibilities; any attempt to exhaustively systematise the different possibilities of materials, techniques and study methods will always lead to a result that differs, in a certain way, from the one finally obtained.

Fig. 1 Machinery for submarine works

The problem of the submarine emissary's or canalisation's stability on the sea bottom is the most important to avoid any fractures, which are always difficult and expensive to repair. For this purpose, the pipe is usually placed within a ditch, as it is done on land to place the draining tubes; but opening a ditch in a non-strengthened environment is a complicated business. One of the ways to place a pipe in the sand is moving it through suction and leaving the pipe to dig itself into the sand by its own weight.

is also the possibility of digging ditches with powerful, specialised and expensive mechanical submarine equipment (see Figure. 1).

The water on the bottom of the sea, with its different movements, weak as they might be, turn the sandy bottoms over and move the top layers to and fro, thus burying the pipe several metres under the sand, or uncovering it.

With rigid pipes, even those with strong joints leaving them the necessary degree of freedom, it is hardly possible to meet the necessary conditions to avoid breakings. Flexible pipes, on the other hand, require artificial anchoring blocks to remain firmly anchored on the bottom and keep the disposed route.
For the anchoring by means of mooring blocks, several kinds of mass concrete and reinforced concrete pieces, with very different concepts have been developed.

The oldest and simplest system consisted of preparing a rough coverage based on of sand and cement bags, placed on certain spots along the canalisation. These bags simply remained hooked with each other through a steel armour piece; the sea then would moist the cement and make it harden, thus forming a rudimentary anchoring system (Figure 2). The tempests, especially in the zone where the waves break, usually ended up destroying these concrete shields without any cohesion among each other.

Fig. 2 Sand and concrete bags

Another outworn system used a series of prefabricated cuboids of different shapes and dimensions, with a clamp where the pipe was attached to the block. But in many occasions it was actually rather the block that was held by the pipe than otherwise. Indeed, the water found a very easy passage under the pipe by moving the bottom sands, thus hollowing out the foundations. It only took the circumstance, that out of a series of mooring blocks, the two at the ends found a steadier placement than the intermediate ones, tiny as that difference might be, to make that part of the pipe lose its support and break.

Fig. 3 Broken pipe caused by a mooring block during a tempest

Another type of mass or reinforced concrete blocks are used, whether they may be shaped as a semi-circular tile or as an arcade, reminding of the protections placed on land to protect canalisations against the future digging of a ditch. These mooring blocks do not hold the pipe and are easily turned over by water movements during storms and subsequent morphological modifications of the bottom (see Figures. 3 and 4).

Fig. 4 Leak due to pipe breaking

EMITE units, due to their shape and studied design, are very useful elements for the anchoring, placing and protection of submarine drainpipes on sandy bottoms. **Thanks to their special shape and water dynamics on the sea bottom, they will settle quickly by burying themselves into the sand** which is a real advantage compared with the technical status of other kinds of units or blocks developed for the same purpose.

DESCRIPTION

Concerning its structure, the EMITE unit is designed within a parallelepipedic volume, with a ratio of 1.40 m high and 1.50 m wide and a constant length of 2.50 m.
The size of the unit can vary as long as this ratio is maintained in order to adequate its behaviour to surge conditions (wave height and period) and depth.

To describe it formally, we can decompose it into several parts:

Lower part:

This part stands on four independent flute-peak shaped legs with sharp edges at their end, placed at its corners.
Between the legs there are openings on each side of the lower part. Such openings allow surges to flow through the EMITE unit, thus producing a dragging of material from the sea bottom and consequently enabling its burying (Fig. 5).

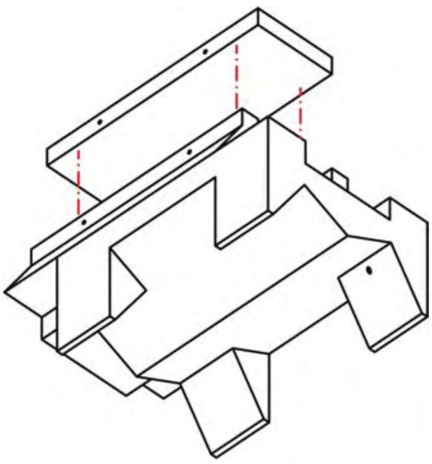


Fig. 5 Lower part:

The part between the four legs rises from the floor forming a belly in sharp edges and with the shape of a keel; this line goes right along the symmetry axis of the EMITE unit.
On its upper side there is a parallelepiped joint, with a hook on one of the ends and a nut on the other; this allows EMITE units to fit into each other. This dovetail joint is the limit of the piece's upper plane.

Upper part:

This element is shaped like a trapezoid prism, whose bigger basis rests on the lower volume, only shifted from it by the length of the joint. In the symmetry centre of the prism and limited by the basis of the trapezoid, there is a hole with a parallelepiped shape, located longitudinally on its bottom which forms a case for the piping that is to be moored and protected (Fig. 6).

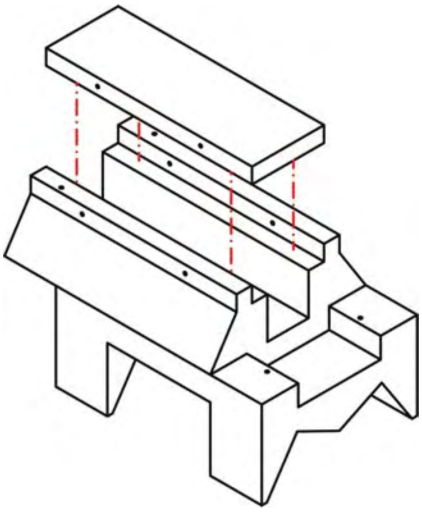


Fig. 6 Upper view

In the upper zone of the trapezoid prisms there are two longitudinal parallelepipeds on both ends of the smaller base; they are used as lugs to fit in another parallelepiped with the necessary dimensions so as to act as a closing cap of the upper volume, thus protecting the canalisation settled in the case. In order to anchor this cap there are two passing rods, going through the lugs and the cap itself which avoid the surge from taking the cap out of its place.

The unit has four hanging clamps made by U-shaped rods whose ends of the U anchored in the reinforced (or similar) concrete mass used to build the block; these clamps are aligned on the lugs of the upper part depending on the unit's gravity centre (Fig. 7).

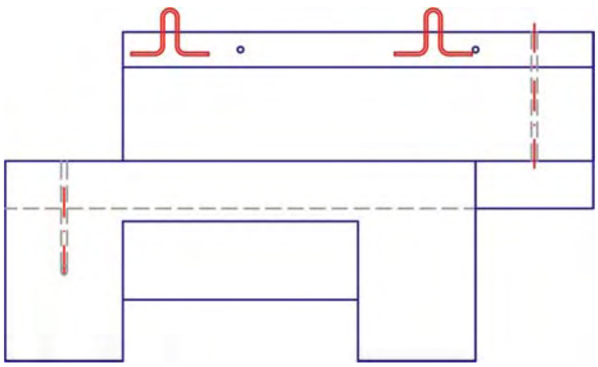


Fig. 7 Clamps and passing rods

The different elements will be joined by the dovetail; these units are, moreover, vertically gone through by passing rods, which are introduced from the upper lugs until reaching half the body of the lower part; this improves the connection between pieces and their correct settling (Fig. 8).

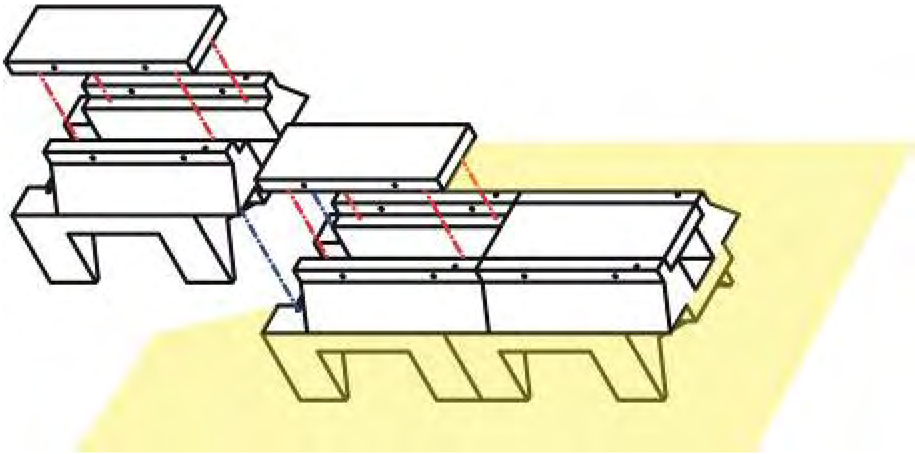


Fig. 8 Assembly of the EMITE unit

EMITE UNIT- CHARACTERISTICS

Generally speaking, the EMITE unit shows certain differences from the previous ones, which make it more effective. This system of prefabricated units completely covers the canalisation leaving, nonetheless, great freedom of movement to the flexible pipe, without transmitting damaging mechanical forces.

EMITE blocks allow the protection of submarine emissaries or drainpipes on sandy bottoms, by nailing themselves more and more into the sea ground as time goes by, and, therefore, increase the emissary's stability in case of storms and significantly reduce its environmental impact.

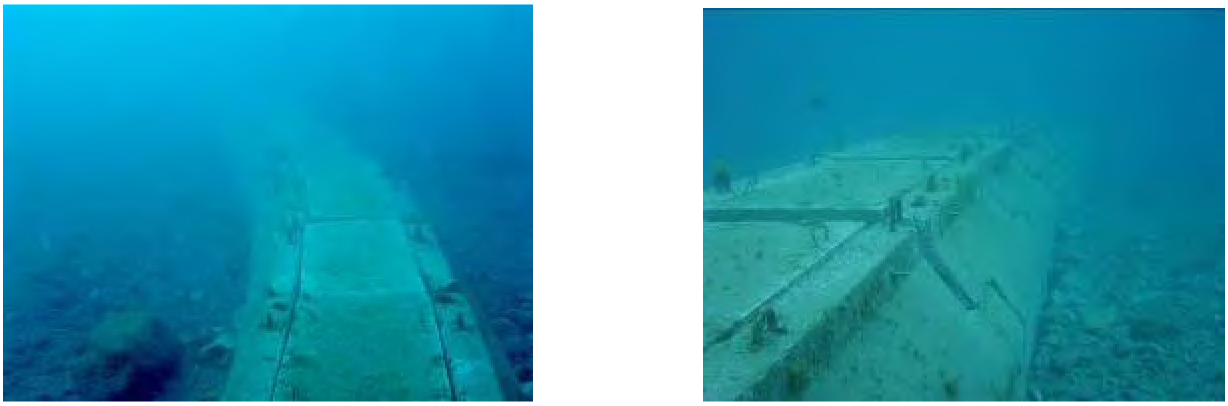


Fig. 9 Adaptation to the bottom

The EMITE unit could be described as a rigid and flexible block at the same time. It is rigid since it fully protects the emissary, avoiding a possible breaking as a consequence of exterior factors. It is flexible, though, because it adapts itself, in a certain way, to the bathymetry of the bottom, as it would happen in the case of a non-protected emissary. This flexibility, which allows the protected drainage pipe to adapt itself to the changes of the sandy ground, avoids the breaking of the protection in zones where it is not supported by the bottom (Fig. 9).

This kind of behaviour has been tested on a wave channel. In order to examine the storm behaviour of EMITE units, these tests on a smaller scale model were performed according to the following method:
For a first series of tests (characterised by the block weight, alignment, surge period and depth), EMITE blocks were placed just like in the prototype with its own weight, that is, with a determined degree of nailing in the sandy bottom. After this, the test surge conditions were generated.

As the conditions were intensified, it could be observed that the **EMITE blocks nailed more and more into the sea bottom as a consequence of the wedge shape of its legs and the sand particles moving with the surge. This sand movement enabled the nailing of EMITE units into the ground and covered the structure at the same time. Reaching the last step of wave height, we could verify that, in most cases, EMITE units were almost completely buried in the sea bottom, with an increased stability and functionality** (Fig. 10 y 11).

Fig. 10 Buried EMITE units, the lifting clamps are still visible

Fig. 11 Lifting caps while inspecting the emissary

With the results obtained from the tests the EMITE unit can be dimensioned according to the characteristics of the study zone, such as depth, significant wave height, peak period, as well as the canting angle of the EMITE units' alignment with respect to the incident wave.

The characteristics just mentioned about EMITE blocks are one of the main reasons why we can considerably lower their weight, taking into account the surge and environmental conditions of the study zone:

- In zones of little depth, the breaking of the waves filters the incident energy on the emissary or canalization, which allows to reduce the weight reduction of the EMITE unit.
- In zones of great depth the influence of surge on the bottom is minimal and, consequently, the influence of surge on the EMITE units is lower as well, thus allowing, like before, less weight on each unit.
- In zones of intermediate depth, where surge energy reaches the EMITE units, the characteristics of incident surge do have a certain influence, especially its period. Bigger period surges, for example, are the ones that, at a certain stage, can cause a bigger instability of the blocks.
- In zones where the surge reaches little obliquely with respect to the emissary or canalisation alignment, EMITE blocks guarantee great stability as a consequence of the compression forces between the EMITE units, which increases the strength of their mutual linking.

Therefore, the tests performed in the wave channel have been important to check the good functional and structural behaviour of EMITE units in the protection of submarine emissaries or drainpipes, guaranteeing even an increasing durability of them, due to their burying in the sand.

As a summary, we can say that EMITE prefabricated unit guarantees, on sandy sea bottoms, a significant improvement regarding the costs of protecting submarine emissaries, by reducing considerably the weight of the needed protection and by allowing the improvement of their functional and structural behaviour as time goes by. They are very stable, independent from the studied conditions and, at the same time, their placing on the site does not decrease its construction feasibility at all (see Figures. 12 and 13).

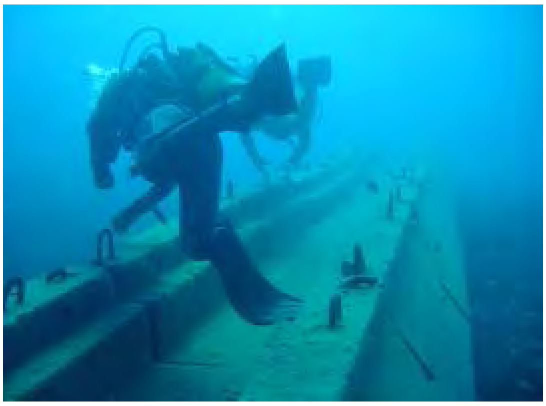



Fig. 12 Placing EMITE units


Fig. 13 The dovetail joint allows perfect alignment

COMPOSITION AND FABRICATION

The material employed to make the units is concrete of the type and quality specified by the rules and regulations to be applied on each occasion.

Fig. 14 Concreting of EMITE units

Fig. 15 Factory

The units will be produced individually by moulding them with shuttering.

The unit's geometry is especially designed to allow regular and homogeneous cementing on each side of the piece and easy de-moulding (figures 14 and 15). The top closing cap is produced independently at the same time.

SETTLING THE CHANNELS

Once the EMITE units are placed, the flexible pipes are joined on the shore. Then the openings at both ends are closed and the pipe is tugged to its sinking place (Fig. 16)

Fig. 16 Pipes joined on the shore

Fig. 17 Placing the pipe

Once tugged to its place, the pipe is sunk and placed in the settling case of EMITE blocks, which are then sealed with their closing caps (see Figures. 17 and 18).

The procedure can be executed quickly; therefore, even short intervals of a relatively calm sea may be used to do this work.

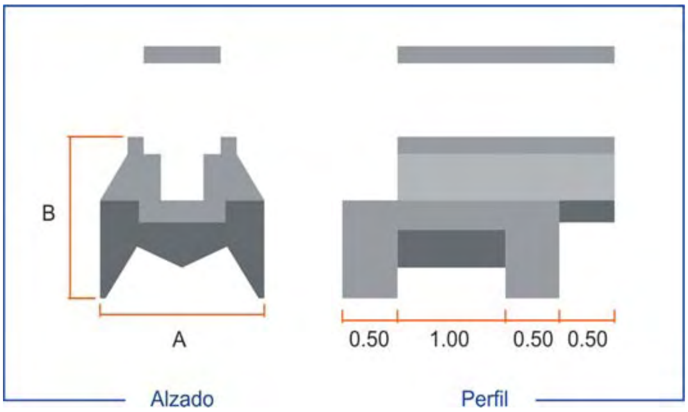
Fig. 18 Caps

Fig. 19 Settling case ready for another inner pipe

Another great advantage of the EMITE unit's design is the possibility to add new pipes to the already installed one in the future, a circumstance that significantly reduces the time of achievement of those works and their cost (Fig. 19).

PARAMETRES OF THE EMITE UNIT'S DESIGN

The unit's weight may vary, depending on the extreme conditions of the sea weather.



Pre-dimensioning of EMITE units according to Tp, depth, Hs and incident angle. (Chart 1)

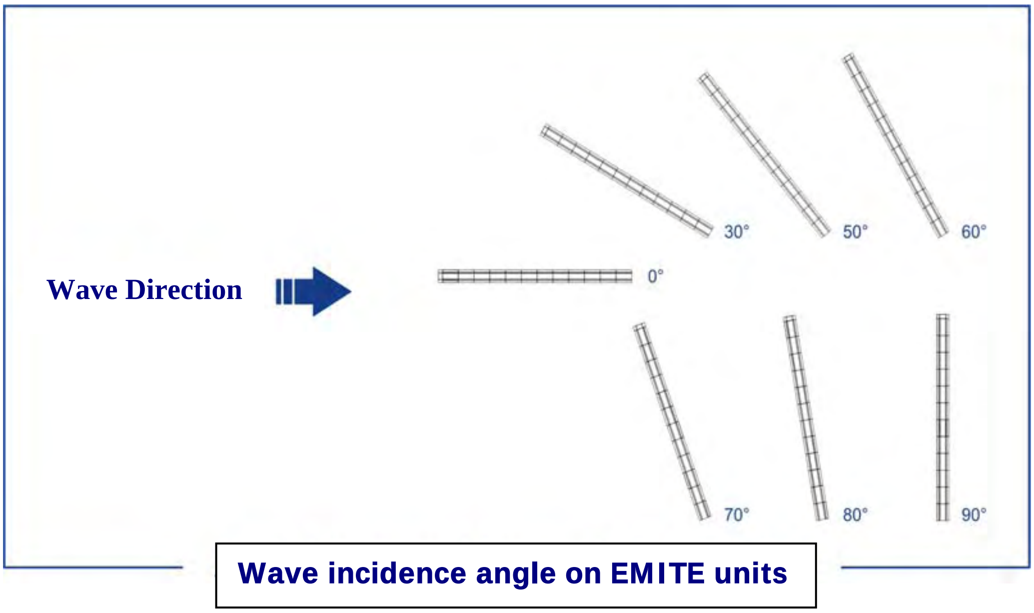
Surge period	Depth	Design wave height	Incident angle (º), (Surge / Channel) Weight in tons (t) of EMITE Unit						
T_p (s)	**h (m)**	**H_s (m)**	**90º**	**80º**	**70º**	**60º**	**50º**	**30º**	**0º**
10	5	<9,00	4 t	4 t	4 t	4 t	4 t	4 t	4 t
	10	<9,00	4 t	4 t	4 t	4 t	4 t	4 t	4 t
	15	<9,00	4 t	4 t	4 t	4 t	4 t	4 t	4 t
14	5	<9,00	4 t	4 t	4 t	4 t	4 t	4 t	4 t
	10	< 5,75	4 t	4 t	4 t	4 t	4 t	4 t	4 t
		$5,75<H_s<9,00$	6 t	6 t	6 t	6 t	4 t	4 t	4 t
	15	<9,00	4 t	4 t	4 t	4 t	4 t	4 t	4 t
18	5	<9,00	4 t	4 t	4 t	4 t	4 t	4 t	4 t
	10	< 5,75	4 t	4 t	4 t	4 t	4 t	4 t	4 t
		$5,75<H_s<6,50$	6 t	6 t	6 t	6 t	4 t	4 t	4 t
		$6,50<H_s<9,00$	8 t	6 t	6 t	6 t	4 t	4 t	4 t
	15	< 5,00	4 t	4 t	4 t	4 t	4 t	4 t	4 t
		$5,00<H_s<7,75$	6 t	6 t	4 t	4 t	4 t	4 t	4 t
		$7,75<H_s<9,00$	8 t	6 t	4 t	4 t	4 t	4 t	4 t

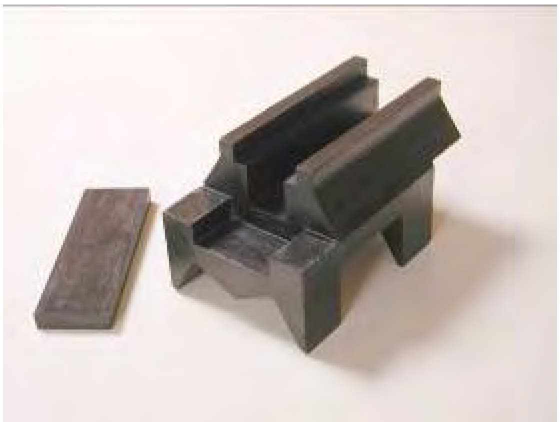
Chart 1

The dimensions of the settling case made of EMITE units must be adapted to the diameter of the pipe, independently from the EMITE unit's weight defined in Chart 1. In case of height and surge periods higher than the ones in the chart of as special pipe diameters, you can contact Guer Ingeniería to determine the parameters of a correct design.

WAVE CHANNEL

Wave channel tests





Detail of the final configuring of the EMITE units used in the model

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This project has been financed by EDF funds. (European Development Funds)